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PURE, GENDER AND SOCIAL INEQUALITIES IN SUICIDE MORTALITY IN IRAN, 2006-2010: A TIME TREND PROVINCE-LEVEL STUDY

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Abstract

Objectives: Suicide is a major global health problem imposing a considerable burden on population in terms of disability-adjusted life years. There has been an increasing trend in fatal and attempted suicide in Iran over the past few decades. The aim of the current study was to assess pure, gender and social inequalities across Iran's provinces during 2006-2010.

Design: Ecological study.

Setting: The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. The data on the annual number of death caused by suicide in each province were gathered from the Iranian Forensic Medicine Organization.

Methods: Suicide mortality rate per 100,000 population was calculated. Human Development Index was used as the provinces' social rank. Gini coefficient, rate ratio and Kunst and Mackenbach relative index of inequality (RII_{KM}) were used to assess pure, gender and social inequalities, respectively. Annual percentage change was calculated using Joinpoint regression.

Results: Suicide mortality has slightly increased in Iran during 2006-2010. There was a substantial and constant pure inequality across the country over the study period. Male to female rate ratio was 2.34 (95% CI 1.45-3.79) over the same period. There were social inequalities in suicide mortality in favor of people in better-off provinces. In addition, there was an increasing trend in these social disparities over time, although it was not statistically significant.

Conclusion: We found substantial pure, gender and social disparities in the distribution of suicide mortality across the provinces in Iran. The findings showed that men in the provinces with low socio-economic status are at higher risk of suicide mortality. Further analyses are needed to explain these disparities.

Article Summary

Strength and limitations of this study

- This is the first national study to evaluate regional social inequalities in suicide mortality over five-year period.
- Social inequality in suicide mortality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM})
- Age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces.

Introduction

Suicide is considered as one of the three leading causes of death among 15 to 44 years age group and the second cause of death in 15-19 years age group [1]. It imposes a considerable burden on population in terms of disability-adjusted life year (DALY) and it has been projected that suicide will compose about 2.4% of global burden of diseases by 2020 [2].

Similar to other developing countries, Iran has been experienced a rapid increase in suicide rate during recent years. A recent study showed that suicide and attempted suicide in Iran have increased from 8.3 per 100,000 population in 2001 to 16.3 in 2007 [3]. Moreover, suicide account for 4% of the injury cases admitted to the general hospitals in the country [4].

The risk factors of suicide are consisted of some demographical characteristics [5], socio-economic situations [6] and medical conditions [7]. However, there are factors related to the area of residence that influence the suicide rate [8]. Evidence demonstrates persistent geographical disparities in distribution of suicide between and within countries which support area-level correlates of suicide [9].

Iran is a Middle Eastern country with 1,628,550 square kilometer land area [10] and is consisted of 31 provinces [11] that are in different levels of development. Ethnic groups tend to reside in neighboring provinces. Therefore, there are variations in socioeconomic level and ethnicity across provinces as well as geographical and ecological differences that could cause a disparity among suicide mortality rate.

While information on the individual risk factors and outcomes of suicide attempts have been well documented in previous studies in Iran [3, 4, 12-15], there is little information on the role of socio-economic factors and suicide incidence. In particular, there is no known study evaluating regional socio-economic disparities and their impact on suicide rate in Iran.

To fill the gap, this study aimed to describe pure and social inequality in suicide mortality rates across all the provinces in Iran from 2006 to 2010. Though this is an ecological study, it will provide a useful starting point for examining the social disparity of suicide and provide valuable information for policy makers in order to prioritize prevention strategies.

METHODS

The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. It should be noted that at the time of conducting the current study, Iran constituted of 30 provinces and it was later when Tehran province was split into two provinces. The data on the annual number of death caused by suicide in each province were gathered from the published reports [16] of Iranian Forensic Medicine Organization which is affiliated to the Judicial Authority in Iran. According to the Iranian law, all deaths due to external causes should be reported to this organization for examination and recording and to issue the death certificate. It is considered as the most reliable source of mortality data in Iran [17]. Then, annual suicide mortality rates per 100,000 population were calculated for each province. Human Development Index (HDI) was used as the provinces' social rank and related data were obtained from the President Deputy of Strategic Planning and Control. The HDI is a composite index of three basic dimensions of human development, including life expectancy at birth, educational attainment (based on a combination of adult literacy rate and primary education to tertiary education enrolment rates), and income (based on GDP per head adjusted for purchasing-power parity [US$]) [18] As a composite index, it is expected that HD might capture socioeconomic development more comprehensively than single indicators such as average income or expenditures.

Pure inequality was examined using Lorenz curve and Gini coefficient. These two measures are commonly used in assessing pure inequality in distribution of health care resources and outcomes [19-21]. Lorenz curve is used to compare distribution of health measure with perfect

equality (diagonal line). In the current study, Lorenz curve was plotted as the cumulative share of population ranked by suicide mortality rate, in an increasing order, against the cumulative share of suicide mortality. The further the distance from diagonal line implies the greater degree of inequality. The Gini coefficient is equal to twice the area between the Lorenz curve and diagonal and its value ranges from 0 (perfect equality) to one (maximum possible inequality). This measure takes into account the distribution of health variable across the entire population. In the current study, we used *fastgini* command in STATA to calculate Gini coefficient and its jackknife 95% confidence interval. To examine gender inequality, we calculated the male to female rate ratio and its 95% confidence interval using negative binomial regression with a robust variance. As we had only data stratified by sex groups for the whole study period and not for every specific year, an overall rate ratio was calculated.

Social inequality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM}) [22]. Cuzick's test for trend is an extension of the Wilcoxon rank-sum test and is used as a non-parametric test for trend across ordered groups [23]. To calculate RR, the provinces were ranked and divided in five quintiles by HDI (weighted by their population). Then, negative binomial regression with a robust variance was used to calculate RR and its 95% confidence interval to compare the highest versus the lowest quintile. One problem with RR is that it only considers the population in two extreme socioeconomic groups. To take into account the whole population distribution across socioeconomic groups and also to remove differences in the size of socioeconomic groups, as a source of variation in the magnitude of health inequalities, RII_{KM} was calculated [22]. RII is widely used to measure social inequality and is recommended when making comparisons over time or across populations [24]. To calculate RII, after determine the relative position of the population in the provinces ranked by HDI, the number of deaths in the provinces was regressed on these relative ranks using negative binomial regression with a robust variance and population as offset variable. With the lowest social rank as reference, an RII_{KM} value greater (lesser) than 1 show that suicide mortality rate was higher among the provinces with higher (lower) social rank (more distance from 1 implies more inequality) [20]. To account for sex and age differences between the provinces, we also estimated adjusted RII_{KM} by including proportion of male in population, mean age of females and mean age of males in our negative binomial regression.

To examine temporal changes of suicide mortality rate across the provinces and also across the quintiles of HDI, we calculated annual percentage change (APC) and its 95% confidence

interval for each province and quintile using the Joinpoint Regression Program 3.5.4. Moreover, this program was used to calculate APC of pure and socioeconomic inequality measures over study period. APC is estimated using following regression:

$$\text{Ln}\ (I_t) = b_0 + b_1\ (t)$$

$$APC = (e^{b_1} - 1) \times 100$$

Where I_t shows the suicide mortality rate and estimated inequality indices for year t.

In a sensitivity analysis, Tehran was excluded from the analysis to examine the pure, gender and social inequalities across the remaining provinces. The reason for this was that Tehran has special situation as the capital of the country and being the centre of economic, social and political activities. Excel office and STATA version 11 (StataCorp LP, College Station, TX, USA) were used for statistical analysis.

Results

Table 1 shows mean population, HDI, suicide mortality rate and APC (%) across the provinces for years 2006-2010. Ilam and Hormozgan provinces had the highest and the lowest suicide mortality rate during the study period, respectively (8.8-fold difference). Most provinces (56.6%) had a suicide mortality rate of 3 to 6 per 100,000 population. In addition, suicide mortality rate was more prevalent among the western provinces of Iran.

The estimated APC values show that only five provinces experienced significant changes in suicide mortality rate over the study period (significant increases in Ilam, Isfahan, North Khorasan and Tehran provinces and significant decrease in Markazi province).

Figure 1a shows temporal changes of suicide mortality rate for the country. While the graph shows a slight increase in suicide mortality rate over the study period (from 4.25 in 2006 to 4.88 in 2010), this was not statistically significant (APC=3.05%, P=0.23). Figure 1b presents suicide mortality rates for five quintiles of HDI and examining the trends showed that APC was significant only in the highest quintile (APC=17.98, P=0.01). Figure 2 shows scatter graphs of HDI and suicide mortality rates. It is evident that the higher HDI was associated with the lower suicide mortality rate and Cuzick's test confirmed this (Z=-4.61, P<0.011).

Male to female rate ratio was 2.34 (95% CI 1.45-3.79) implying a significant higher suicide mortality rate among males than females over the study period. Examining this ratio in the provinces showed that in all provinces but Kordestan men had a higher suicide mortality rate than women. Excluding Tehran from the sample did not change this finding (2.33; 95% CI 1.43-3.79).

Table 2 presents the pure and social inequality measures in distribution of suicide mortality rate across the country through 2006-2010. The Gini coefficient ranged from 0.248 to 0.302 implying substantial pure inequality across the provinces. The Lorenz curves corresponded to this Gini coefficient is been shown in Figure 3. There was a 14.5% decrease in Gini coefficient between the first year and the last year of study implying decreasing pure inequality between these two points of time. Over the study period, the APC of Gini coefficient was -4.28 and statistically non-significant. Excluding Tehran resulted in a 6.9% increase in Gini coefficient between the first and the last year of the study period and a statistically non-significant APC of 1.42 was estimated.

RR was significantly lower than 1 in overall and for all years of the study period, implying a higher suicide mortality rate among people in the lowest quintile of HDI compared with the highest one. Over the study period, RR was approaching 1 and the APC of RR was 12.20 and statistically significant implying a decrease in the gap between the highest and the lowest social ranks. Although excluding Tehran from the sample did not change the overall picture of social inequality, an inverse trend (increasing social inequality) was observed.

RII_{KM} was also lower than 1 in overall and for all years of the study, showing a persistent inequality in favor of people living in the provinces with higher social rank. Temporal analysis showed that RII_{KM} did not significantly change over the study period. Adjusting for age and sex this observation. When we excluded the Tehran province, the APC value for adjusted RII_{KM} was statistically significant showing an increase in social disparity across the remaining provinces in Iran.

Discussion

In this study, for the first time, we assessed pure and social disparities in the distribution of suicide mortality across the provinces of Iran over a period of five years (2006-2010). The findings showed that suicide mortality has slightly increased over the study period. The findings also indicated that there were substantial pure, gender and social disparities in the

distribution of suicide mortality across the country, and it was higher in the provinces with lower social rank. These disparities were generally stable and persistent over the study period.

The findings from the current study showed an inverse association between the provinces' social rank and suicide mortality in Iran. Although the studies on association between area social rank and suicide mortality reported mixed results [9, 25], the results of this study is in line with previous ecological studies investigating the relationship between socioeconomic characteristics and suicide rate, in particular the studies focused on high income settings [9, 26-32]. Rehkopf and Buka[9] in their systematic review of suicide and socioeconomic characteristics of geographical areas found that, among studies with statistically significant results, 50% and 73% of studies reported an inverse relation between area income and education characteristics and completed suicide, respectively. They also found that the probability of reporting an inverse relationship between area social rank and suicide mortality was higher among the studies conducted in Asia (94% of studies with statistically significant results) [9]. Similar finding was reported by another study [33] focusing on the countries in Eastern Mediterranean region (where Iran is located), indicating that high income countries had lower suicide mortality rate than their low and middle income counterparts. It is argued that people in the provinces with lower social rank generally have more adverse experiences, poorer mental health, lower access to psychiatric services, and lower access to health facilities. These factors might partly explain higher suicide mortality rate in the provinces with lower social rank in Iran.

The four Western provinces of Iran (i.e., Ilam, Kermanshah, Lorestan and Hamedan) had the highest suicide mortality rate in the country. One potential explanation for this observation can be low socioeconomic status of these provinces. These provinces are among the provinces with the highest unemployment rate and the lowest HDI in the country. High divorce rates in these provinces (except for Ilam) can be another potential explanation. A recent study has reported divorce as one of the risk factors for completed suicides in Iran [3]. In addition, cultural issues such as the tribal structure of communities and the extreme fanaticism prevailing in these provinces have been considered as another potential explanation for this finding [34].

The high gender gap in suicide mortality rate observed in the current study is in line with the previous epidemiological studies in Iran [3, 4, 14] and is comparable to the studies conducted in

other settings, in particular high income countries [6, 9, 35, 36]. Although many studies, including the previous studies in Iran [3, 4, 14], have shown higher suicide attempt rate among females, completed (fatal) suicides are higher among males. One potential explanation can be the difference in methods of attempting suicide among males and females. For example, the most common methods of attempting suicide used by males in Iran are hanging and firearms which have higher fatality rate compared with self-burning method commonly used by females [3, 14, 36, 37]. Greater psychosocial impact of problems, such as unemployment or retirement, on males compared to female [36, 38, 39] and adopting coping strategies such as emotional inexpressiveness, lack of help-seeking, risk-taking behaviour, violence, alcohol and drug abuse by males (which are triggered by norms of traditional masculinity) [40, 41] are other potential factors which have been discussed in the literature.

Temporal analysis of suicide mortality showed interesting results indicating that among five quintiles of HDI, it was only the highest quintile that experienced a significant change in suicide mortality over the study period. This finding potentially can be explained by increasing prevalence of mental disorders, raising unemployment rate [13, 42] and increasing trend in divorce rate [13] in the provinces with higher HDI, such as Tehran, the capital city of Iran.

The current study has several limitations that should be considered when interpreting its findings. Firstly, age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces. Secondly, there is the issue of availability and quality of data on suicide which is common in developing countries settings [25, 43] and leads to underestimation and misclassification of suicide. This might be an issue in this study because of the social stigma of suicide and religious sanctions and some legal issues in the Iranian context [33, 4]. Moreover, the underestimation and misclassification of suicide mortality might be more common in the provinces with lower social rank; therefore, we expect that the social disparity to be more profound than what has been reported here. Thirdly, the current study is an ecological study using province as unit of analysis which embraces substantial heterogeneity within provinces. This implies that the observed disparities in suicide mortality are between-provinces and it is not necessarily applicable to smaller geographic units or individuals. Furthermore, no causal inference can be drawn due to ecological nature of the study and that there was no control for confounders in this study.

Conclusion

The present study indicated that there were substantial pure, gender and social disparities in the distribution of suicide mortalities across the provinces in Iran. Moreover, the study showed an inverse association between the provinces' social rank and suicide mortality. The findings imply that prevention resources should be targeted high risk groups, in particular men in the provinces with low socio-economic status. Further investigations are needed to explain these disparities in suicide mortality across the provinces. Moreover, more studies needed to explore the association of socio-economic factors and suicide (attempt and fatal) focusing on the smaller geographical units and at the individual level in order to design better prevention strategies.

List of Abbreviations

DALY: Disability-adjusted Life Years, HDI: Human Development Index, RR: rate ratio, RII_{KM}: Kunst and Mackenbach relative index of inequality, APC: annual percentage change

Authors' contributions

AAK was involved in the study conception and design, data collection and analysis, interpretation of the data, and writing the manuscript. HHB and SS were involved in the study design, results interpretation, and writing the manuscript. HS was involved in the study design, data collection and finalization of the manuscript. All authors read and approved the final manuscript

Competing interests

The authors declare that they have no competing interests. No funding has been received for the conduct of this study and/or preparation of this manuscript.

Data sharing statetment

No additional data

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Table 1. Mean population, human development index (HDI), suicide mortality rate and annual percentage change across the provinces in Iran, 2006-2010 (Ranked by Suicide mortality rate).

	Population	HDI	Suicide mortality rate per 100,000 population	APC (%)*
Ilam	555,929	0.729	19.53	**10.11**
Kermanshah	1,892,100	0.748	13.74	0.46
Lorestan	1,736,946	0.761	10.64	1.18
Hamedan	1,700,960	0.740	9.59	-1.52
Gilan	2,428,553	0.769	6.52	9.98
Ardebil	1,235,234	0.735	6.22	-2.32
East Azerbaijan	3,646,459	0.763	5.58	1.31
Zanjan	973,739	0.752	5.53	12.14
Kohgyluyeh & Boyerahmad	651,577	0.718	5.25	-4.20
Khuzestan	4,372,242	0.762	5.11	-7.13
West Azerbaijan	2,944,224	0.713	4.72	-2.74
Kordestan	1,453,503	0.713	4.69	5.25
Golestan	1,651,708	0.737	4.49	5.67
Overall (Iran)	72,599,045	0.758	4.46	3.05
Qazvin	1,177,582	0.783	4.25	-1.13
North Khorasan	824,979	0.759	4.24	**10.64**
Fars	4,431,684	0.783	4.16	1.56
Chaharmahal Bakhtiari	875,207	0.749	4.00	-7.72
Qom	1,087,011	0.773	3.75	7.89
Mazandaran	2,979,189	0.745	3.66	-5.71
Isfahan	4,680,831	0.810	3.64	**4.62**
Kerman	2,799,417	0.750	3.10	-5.03
Bushehr	914,710	0.786	3.02	15.55
South Khorasan	656,469	0.723	3.02	-2.28
Tehran	14,106,297	0.843	2.92	**17.98**
Yazd	1,028,152	0.809	2.68	-4.48
Razavi Khorasan	5,765,706	0.777	2.66	-2.64
Semnan	606,982	0.814	2.60	4.27
Markazi	1,371,514	0.785	2.38	**-10.73**
Sistan & Baluchestan	2,569,107	0.643	2.23	6.11
Hormozgan	1,481,031	0.766	2.21	-5.59

*Bold figures show statistically significant results ($p<0.05$)

Table 2. Pure and social inequality measures of suicide mortality in Iran, 2006-2010.

	Total sample (n=30)						
	2006	2007	2008	2009	2010	Overall	APC (Pvalue)
Gini index	0.290 (0.193-0.386)	0.302 (0.212-0.392)	0.271 (0.182-0.361)	0.268 (0.165-0.371)	0.248 (0.151-0.345)	0.281 (0.240-0.322)	-4.28 (0.050)
Rate ratio*	0.359 (0.256-0.503)	0.325 (0.225-0.469)	0.428 (0.284-0.646)	0.496 (0.296-0.830)	0.535 (0.316-0.906)	0.426 (0.275-0.659)	12.20 (0.049)
RII_{KM}	0.345 (0.174-0.686)	0.257 (0.127-0.521)	0.289 (0.142-0.588)	0.337 (0.147-0.776)	0.341 (0.148-0.784)	0.339 (0.166-0.671)	1.75 (0.745)
Adjusted RII_{KM}**	0.279 (0.129-0.600)	0.205 (0.098-0.431)	0.224 (0.102-0.489)	0.133 (0.039-0.455)	0.160 (0.051-0.507)	0.171 (0.054-0.548)	-13.75 (0.073)
	Sample excluding Tehran (n=29)						
Gini index	0.259 (0.168-0.350)	0.285 (0.187-0.382)	0.282 (0.187-0.378)	0.292 (0.192-0.392)	0.277 (0.191-0.363)	0.282 (0.243-0.322)	1.42 (0.38)
Rate ratio*	0.646 (0.444-0.938)	0.397 (0.226-0.695)	0.415 (0.247-0.696)	0.520 (0.277-0.974)	0.492 (0.262-0.924)	0.584 (0.380-0.896)	-6.59 (0.403)
RII_{KM}	0.460 (0.257-0.823)	0.339 (0.179-0.644)	0.352 (0.185-0.672)	0.397 (0.187-0.839)	0.389 (0.185-0.819)	0.411 (0.215-0.785)	-2.76 (0.575)
Adjusted RII_{KM}**	0.402 (0.224-0.722)	0.301 (0.168-0.541)	0.310 (0.165-0.580)	0.211 (0.077-0.577)	0.241 (0.093-0.623)	0.241 (0.090-0.649)	-12.95 (0.045)

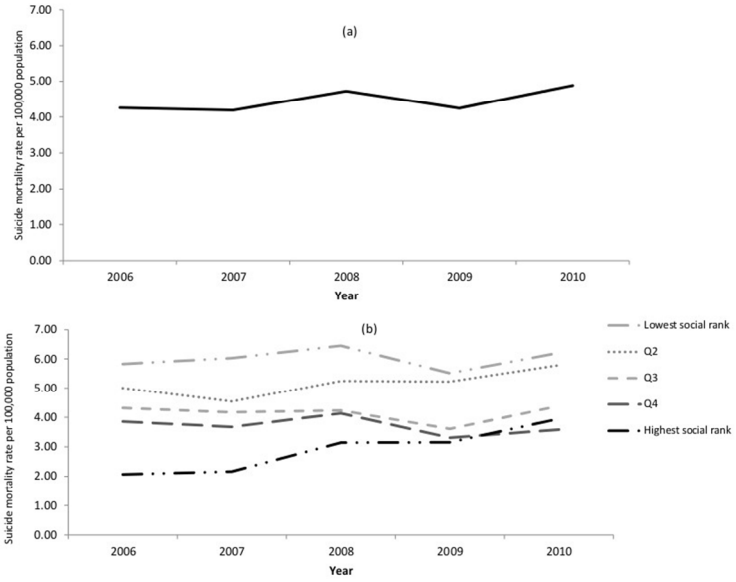
*The highest vs. the lowest quintile of HDI

**Adjusted for proportion of males and mean age of males and females in the provinces.

Figure 1. Suicide mortality rates per 100,000 populations in a) total sample; b) quintiles of HDI, 2006-2010.

Figure 2. Scatter plots of HDI and suicide mortality rates, stratified by year of study.

Figure 3. Lorenz curves of the distribution of suicide mortality in Iran, 2006-2010.



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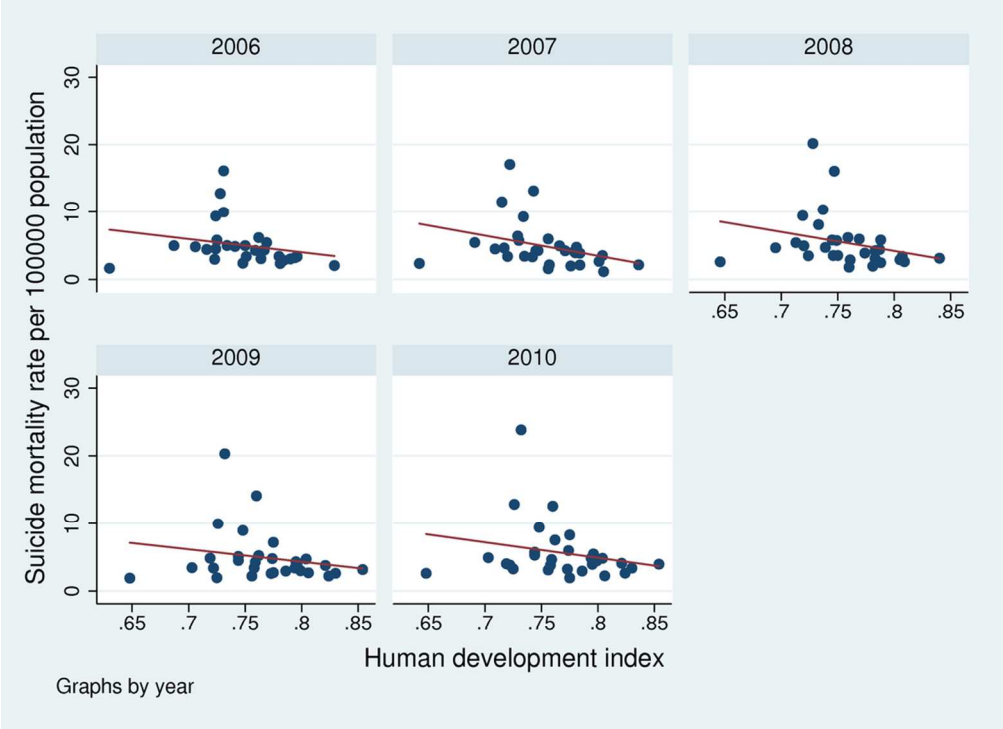

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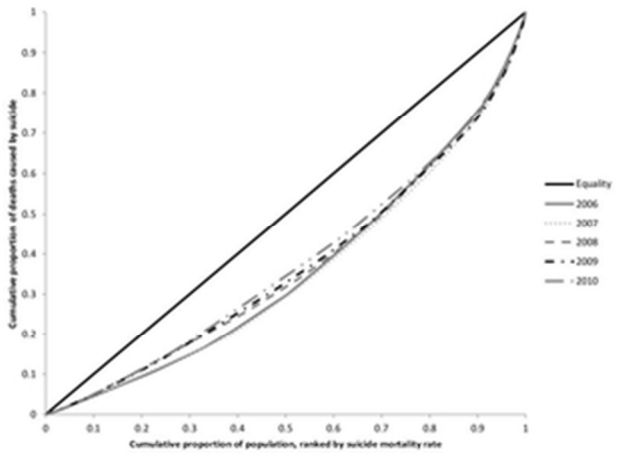

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

OVERALL, GENDER AND SOCIAL INEQUALITIES IN SUICIDE MORTALITY IN IRAN, 2006-2010: A TIME TREND PROVINCE-LEVEL STUDY

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Keywords:	Suicide mortality, Social inequality, Pure inequality, Temporal analysis, Iran

OVERALL, GENDER AND SOCIAL INEQUALITIES IN SUICIDE MORTALITY IN IRAN, 2006-2010: A TIME TREND PROVINCE-LEVEL STUDY

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Running Title: Inequalities in suicide mortality in Iran

Key words: Suicide mortality, Social inequality, Overall inequality, Temporal analysis, Iran.

Word Count: 3125

Abstract

Objectives: Suicide is a major global health problem imposing a considerable burden on population in terms of disability-adjusted life years. There has been an increasing trend in fatal and attempted suicide in Iran over the past few decades. The aim of the current study was to assess overall, gender and social inequalities across Iran's provinces during 2006-2010.

Design: Ecological study.

Setting: The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. The data on the annual number of death caused by suicide in each province were gathered from the Iranian Forensic Medicine Organization.

Methods: Suicide mortality rate per 100,000 population was calculated. Human Development Index was used as the provinces' social rank. Gini coefficient, rate ratio and Kunst and Mackenbach relative index of inequality (RII_{KM}) were used to assess overall, gender and social inequalities, respectively. Annual percentage change was calculated using Joinpoint regression.

Results: Suicide mortality has slightly increased in Iran during 2006-2010. There was a substantial and constant overall inequality across the country over the study period. Male to female rate ratio was 2.34 (95% CI 1.45-3.79) over the same period. There were social inequalities in suicide mortality in favor of people in better-off provinces. In addition, there was an increasing trend in these social disparities over time, although it was not statistically significant.

Conclusion: We found substantial overall, gender and social disparities in the distribution of suicide mortality across the provinces in Iran. The findings showed that men in the provinces with low socio-economic status are at higher risk of suicide mortality. Further analyses are needed to explain these disparities.

Article Summary

Strength and limitations of this study

- This is the first national study to evaluate regional social inequalities in suicide mortality over five-year period.
- Social inequality in suicide mortality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM})
- Age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces.

Introduction

Suicide is considered as one of the three leading causes of death among 15 to 44 years age group and the second cause of death in 15-19 years age group [1]. It imposes a considerable burden on population in terms of disability-adjusted life year (DALY) and it has been projected that suicide will compose about 2.4% of global burden of diseases by 2020 [2].

Similar to other developing countries, Iran has been experienced a rapid increase in suicide rate during recent years. A recent study showed that suicide and attempted suicide in Iran have increased from 8.3 per 100,000 population in 2001 to 16.3 in 2007 [3]. Moreover, suicide account for 4% of the injury cases admitted to the general hospitals in the country [4].

The risk factors of suicide are consisted of some demographical characteristics [5], socio-economic situations [6] and medical conditions [7]. However, there are factors related to the area of residence that influence the suicide rate [8]. Evidence demonstrates persistent geographical disparities in distribution of suicide between and within countries which support area-level correlates of suicide [9].

Iran is a Middle Eastern country with 1,628,550 square kilometer land area [10] and is consisted of 31 provinces [11] that are in different levels of development. Ethnic groups tend to reside in neighboring provinces. Therefore, there are variations in socioeconomic level and ethnicity across provinces as well as geographical and ecological differences that could cause a disparity among suicide mortality rate.

While information on the individual risk factors and outcomes of suicide attempts have been well documented in previous studies in Iran [3, 4, 12-15], there is little information on the role of socio-economic factors and suicide incidence. In particular, there is no known study evaluating regional socio-economic disparities and their impact on suicide rate in Iran.

To fill the gap, this study aimed to describe overall and social inequality in suicide mortality rates across all the provinces in Iran from 2006 to 2010. Though this is an ecological study, it will provide a useful starting point for examining the social disparity of suicide and provide valuable information for policy makers in order to prioritize prevention strategies.

METHODS

The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. It should be noted that at the time of conducting the current study, Iran constituted of 30 provinces and it was later when Tehran province was split into two provinces. The data on the annual number of death caused by suicide in each province were gathered from the published reports [16] of Iranian Forensic Medicine Organization which is affiliated to the Judicial Authority in Iran. According to the Iranian law, all deaths due to external causes should be reported to this organization for examination and recording and to issue the death certificate. It is considered as the most reliable source of mortality data in Iran [17]. Then, annual suicide mortality rates per 100,000 population were calculated for each province. Human Development Index (HDI) was used as the provinces' social rank and related data were obtained from the President Deputy of Strategic Planning and Control. The HDI is a composite index of three basic dimensions of human development, including life expectancy at birth, educational attainment (based on a combination of adult literacy rate and primary education to tertiary education enrolment rates), and income (based on GDP per head adjusted for purchasing-power parity [US$]) [18] .As a composite index, it is expected that HDI might capture socioeconomic development more comprehensively than single indicators such as average income or expenditures.

Overall inequality measures inequalities in health irrespective of the other characteristics of the individuals [19]. To measure overall inequality we followed the same approach as measuring income inequality and used Lorenz curve and Gini coefficient. These two measures are commonly used in assessing overall inequality in distribution of health care resources and outcomes [20-22]. Lorenz curve is used to compare distribution of health measure with perfect equality (diagonal line). In the current study, Lorenz curve was plotted as the cumulative share of population ranked by suicide mortality rate, in an increasing order, against the cumulative share of suicide mortality. The further the distance from diagonal line implies the greater degree of inequality. The Gini coefficient is equal to twice the area between the Lorenz curve and diagonal and its value ranges from 0 (perfect equality) to one (maximum possible inequality). This measure takes into account the distribution of health variable across the entire population. In the current study, we used *fastgini* command in STATA to calculate Gini coefficient and its jackknife 95% confidence interval. In order to examine gendered nature of suicide mortalities (i.e. gender inequality) in Iran, we calculated the male to female rate ratio and its 95% confidence interval using negative binomial

regression with a robust variance. As we had only data stratified by sex groups for the whole study period and not for every specific year, an overall rate ratio was calculated.

Social inequality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM}) [23]. Cuzick's test for trend is an extension of the Wilcoxon rank-sum test and is used as a non-parametric test for trend across ordered groups [24]. To calculate RR, the provinces were ranked and divided in five quintiles by HDI (weighted by their population). Then, negative binomial regression with a robust variance was used to calculate RR and its 95% confidence interval to compare the highest versus the lowest quintile. One problem with RR is that it only considers the population in two extreme socioeconomic groups. To take into account the whole population distribution across socioeconomic groups and also to remove differences in the size of socioeconomic groups, as a source of variation in the magnitude of health inequalities, RII_{KM} was calculated [23]. RII is widely used to measure social inequality and is recommended when making comparisons over time or across populations [25]. To calculate RII, after determine the relative position of the population in the provinces ranked by HDI, the number of deaths in the provinces was regressed on these relative ranks using negative binomial regression with a robust variance and population as offset variable. With the lowest social rank as reference, an RII_{KM} value greater (lesser) than 1 show that suicide mortality rate was higher among the provinces with higher (lower) social rank (more distance from 1 implies more inequality) [21]. To account for sex and age differences between the provinces, we also estimated adjusted RII_{KM} by including proportion of male in population, mean age of females and mean age of males in our negative binomial regression.

To examine temporal changes of suicide mortality rate across the provinces and also across the quintiles of HDI, we calculated annual percentage change (APC) and its 95% confidence interval for each province and quintile using the Joinpoint Regression Program 3.5.4. Moreover, this program was used to calculate APC of overall and socioeconomic inequality measures over study period. APC is estimated using following regression:

$$\text{Ln}\,(I_t) = b_0 + b_1\,(t)$$

$$APC = (e^{b_1} - 1) \times 100$$

Where I_t shows the suicide mortality rate and estimated inequality indices for year t.

In a sensitivity analysis, Tehran was excluded from the analysis to examine the overall, gender and social inequalities across the remaining provinces. The reason for this was that Tehran has special situation as the capital of the country and being the centre of economic, social and political activities. Excel office and STATA version 11 (StataCorp LP, College Station, TX, USA) were used for statistical analysis.

Results

Table 1 shows mean population, HDI, suicide mortality rate and APC (%) across the provinces for years 2006-2010. Ilam and Hormozgan provinces had the highest and the lowest suicide mortality rate during the study period, respectively (8.8-fold difference). Most provinces (56.6%) had a suicide mortality rate of 3 to 6 per 100,000 population. In addition, suicide mortality rate was more prevalent among the western provinces of Iran (Figure 1).

The estimated APC values show that only five provinces experienced significant changes in suicide mortality rate over the study period (significant increases in Ilam, Isfahan, North Khorasan and Tehran provinces and significant decrease in Markazi province).

Figure 2a shows temporal changes of suicide mortality rate for the country. While the graph shows a slight increase in suicide mortality rate over the study period (from 4.25 in 2006 to 4.88 in 2010), this was not statistically significant (APC=3.05%, P=0.23). Figure 2b presents suicide mortality rates for five quintiles of HDI and examining the trends showed that APC was significant only in the highest quintile (APC=17.98, P=0.01). Figure 3 shows scatter graphs of HDI and suicide mortality rates. It is evident that the higher HDI was associated with the lower suicide mortality rate and Cuzick's test confirmed this (Z=-4.61, P<0.011).

Male to female rate ratio was 2.34 (95% CI 1.45-3.79) implying a significant higher suicide mortality rate among males than females over the study period. Examining this ratio in the provinces showed that in all provinces but Kordestan men had a higher suicide mortality rate than women. Excluding Tehran from the sample did not change this finding (2.33; 95% CI 1.43-3.79).

Table 2 presents the overall and social inequality measures in distribution of suicide mortality rate across the country through 2006-2010. The Gini coefficient ranged from 0.248 to 0.302 implying substantial overall inequality across the provinces. The Lorenz curves corresponded

to this Gini coefficient is been shown in Figure 4. There was a 14.5% decrease in Gini coefficient between the first year and the last year of study implying decreasing overall inequality between these two points of time. Over the study period, the APC of Gini coefficient was -4.28 and statistically non-significant. Excluding Tehran resulted in a 6.9% increase in Gini coefficient between the first and the last year of the study period and a statistically non-significant APC of 1.42 was estimated.

RR was significantly lower than 1 in overall and for all years of the study period, implying a higher suicide mortality rate among people in the lowest quintile of HDI compared with the highest one. Over the study period, RR was approaching 1 and the APC of RR was 12.20 and statistically significant implying a decrease in the gap between the highest and the lowest social ranks. Although excluding Tehran from the sample did not change the overall picture of social inequality, an inverse trend (increasing social inequality) was observed.

RII_{KM} was also lower than 1 in overall and for all years of the study, showing a persistent inequality in favor of people living in the provinces with higher social rank. Temporal analysis showed that RII_{KM} did not significantly change over the study period. Adjusting for age and sex this observation. When we excluded the Tehran province, the APC value for adjusted RII_{KM} was statistically significant showing an increase in social disparity across the remaining provinces in Iran.

Discussion

In this study, for the first time, we assessed overall and social disparities in the distribution of suicide mortality across the provinces of Iran over a period of five years (2006-2010). The findings showed that suicide mortality has slightly increased over the study period. The findings also indicated that there were substantial overall, gender and social disparities in the distribution of suicide mortality across the country, and it was higher in the provinces with lower social rank. These disparities were generally stable and persistent over the study period.

The findings from the current study showed an inverse association between the provinces' social rank and suicide mortality in Iran. Although the studies on association between area social rank and suicide mortality reported mixed results [9, 26], the results of this study is in line with previous ecological studies investigating the relationship between socioeconomic characteristics and suicide rate, in particular the studies focused on high income settings [9, 27-

[33]. Rehkopf and Buka[9] in their systematic review of suicide and socioeconomic characteristics of geographical areas found that, among studies with statistically significant results, 50% and 73% of studies reported an inverse relation between area income and education characteristics and completed suicide, respectively. They also found that the probability of reporting an inverse relationship between area social rank and suicide mortality was higher among the studies conducted in Asia (94% of studies with statistically significant results) [9]. Similar finding was reported by another study [34] focusing on the countries in Eastern Mediterranean region (where Iran is located), indicating that high income countries had lower suicide mortality rate than their low and middle income counterparts. It is argued that people in the provinces with lower social rank generally have more adverse experiences, poorer mental health, lower access to psychiatric services, and lower access to health facilities. These factors might partly explain higher suicide mortality rate in the provinces with lower social rank in Iran.

The four Western provinces of Iran (i.e., Ilam, Kermanshah, Lorestan and Hamedan) had the highest suicide mortality rate in the country. One potential explanation for this observation can be low socioeconomic status of these provinces. These provinces are among the provinces with the highest unemployment rate and the lowest HDI in the country. High divorce rates in these provinces (except for Ilam) can be another potential explanation as divorce is considered as a risk factor for suicide mortality [35, 36]. In addition, cultural issues such as the tribal structure of communities and the extreme fanaticism prevailing in these provinces have been considered as another potential explanation for this finding [37].

The high gender gap in suicide mortality rate observed in the current study is in line with the previous epidemiological studies in Iran [3, 4, 14] and is comparable to the studies conducted in other settings, in particular high income countries [6, 9, 38, 39]. Although many studies, including the previous studies in Iran [3, 4, 14], have shown higher suicide attempt rate among females, completed (fatal) suicides are higher among males. One potential explanation can be the difference in methods of attempting suicide among males and females. For example, the most common methods of attempting suicide used by males in Iran are hanging and firearms which have higher fatality rate compared with self-burning method commonly used by females [3, 14, 39, 40]. Greater psychosocial impact of problems, such as unemployment or retirement, on males compared to female [39, 41, 42] and adopting coping strategies such as emotional inexpressiveness, lack of help-seeking, risk-taking behaviour, violence, alcohol and drug abuse by males (which are triggered by norms of traditional masculinity) [43, 44] are other

potential factors which have been discussed in the literature. The findings of the gender analysis are important for designing and implementing suicide prevention strategies as the factors, patterns, and behaviours associated with suicide are affected by gender.

Temporal analysis of suicide mortality showed interesting results indicating that among five quintiles of HDI, it was only the highest quintile that experienced a significant change in suicide mortality over the study period. This finding potentially can be explained by increasing prevalence of mental disorders, raising unemployment rate [13, 45] and increasing trend in divorce rate [13] in the provinces with higher HDI, such as Tehran, the capital city of Iran.

To our knowledge, this is the first national study evaluating social inequalities across different regions over time. Although this study conducted in the context of Iran, however, the findings may also be applicable to other middle-income countries, in particular countries in the Middle East region, which share similar culture. Moreover, we believe that, in terms of methodology, our analysis present a good example for employing a triangulation of different methods for evaluating inequalities in suicide mortalities. However, the current study has several limitations that should be considered when interpreting its findings. Firstly, age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces. Secondly, there is the issue of availability and quality of data on suicide which is common in developing countries settings [26, 46] and leads to underestimation and misclassification of suicide. This might be an issue in this study because of the social stigma of suicide and religious sanctions and some legal issues in the Iranian context [34, 4]. Moreover, the underestimation and misclassification of suicide mortality might be more common in the provinces with lower social rank; therefore, we expect that the social disparity to be more profound than what has been reported here. Thirdly, the current study is an ecological study using province as unit of analysis which embraces substantial heterogeneity within provinces. This implies that the observed disparities in suicide mortality are between-provinces and it is not necessarily applicable to smaller geographic units or individuals. Furthermore, no causal inference can be drawn due to ecological nature of the study and that there was no control for confounders in this study.

Conclusion

The present study indicated that there were substantial overall, gender and social disparities in the distribution of suicide mortalities across the provinces in Iran. Moreover, the study showed an inverse association between the provinces' social rank and suicide mortality. The findings imply that prevention resources should be targeted high risk groups, in particular men in the provinces with low socio-economic status. Further investigations are needed to explain these disparities in suicide mortality across the provinces. Moreover, more studies needed to explore the association of socio-economic factors and suicide (attempt and fatal) focusing on the smaller geographical units and at the individual level in order to design better prevention strategies.

List of Abbreviations

DALY: Disability-adjusted Life Years, HDI: Human Development Index, RR: rate ratio, RII_{KM}: Kunst and Mackenbach relative index of inequality, APC: annual percentage change

Funding

No funding has been received for the conduct of this study and/or preparation of this manuscript.

Authors' contributions

AAK was involved in the study conception and design, data collection and analysis, interpretation of the data, and writing the manuscript. HHB and SS were involved in the study design, results interpretation, and writing the manuscript. HS was involved in the study design, data collection and finalization of the manuscript. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests. No funding has been received for the conduct of this study and/or preparation of this manuscript.

Data Sharing Statement

No additional data available

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Table 1. Mean population, human development index (HDI), suicide mortality rate and annual percentage change across the provinces in Iran, 2006-2010 (Ranked by Suicide mortality rate).

	Population	HDI	Suicide mortality rate per 100,000 population	APC (%)*
Ilam	555,929	0.729	19.53	**10.11**
Kermanshah	1,892,100	0.748	13.74	0.46
Lorestan	1,736,946	0.761	10.64	1.18
Hamedan	1,700,960	0.740	9.59	-1.52
Gilan	2,428,553	0.769	6.52	9.98
Ardebil	1,235,234	0.735	6.22	-2.32
East Azerbaijan	3,646,459	0.763	5.58	1.31
Zanjan	973,739	0.752	5.53	12.14
Kohgyluyeh & Boyerahmad	651,577	0.718	5.25	-4.20
Khuzestan	4,372,242	0.762	5.11	-7.13
West Azerbaijan	2,944,224	0.713	4.72	-2.74
Kordestan	1,453,503	0.713	4.69	5.25
Golestan	1,651,708	0.737	4.49	5.67
Overall (Iran)	72,599,045	0.758	4.46	3.05
Qazvin	1,177,582	0.783	4.25	-1.13
North Khorasan	824,979	0.759	4.24	**10.64**
Fars	4,431,684	0.783	4.16	1.56
Chaharmahal Bakhtiari	875,207	0.749	4.00	-7.72
Qom	1,087,011	0.773	3.75	7.89
Mazandaran	2,979,189	0.745	3.66	-5.71
Isfahan	4,680,831	0.810	3.64	**4.62**
Kerman	2,799,417	0.750	3.10	-5.03
Bushehr	914,710	0.786	3.02	15.55
South Khorasan	656,469	0.723	3.02	-2.28
Tehran	14,106,297	0.843	2.92	**17.98**
Yazd	1,028,152	0.809	2.68	-4.48
Razavi Khorasan	5,765,706	0.777	2.66	-2.64
Semnan	606,982	0.814	2.60	4.27
Markazi	1,371,514	0.785	2.38	**-10.73**
Sistan & Baluchestan	2,569,107	0.643	2.23	6.11
Hormozgan	1,481,031	0.766	2.21	-5.59

*Bold figures show statistically significant results ($p<0.05$)

Table 2. Overall and social inequality measures of suicide mortality in Iran, 2006-2010.

	2006	2007	2008	2009	2010	Overall	APC (Pvalue)
	Total sample (n=30)						
Gini index	0.290 (0.193-0.386)	0.302 (0.212-0.392)	0.271 (0.182-0.361)	0.268 (0.165-0.371)	0.248 (0.151-0.345)	0.281 (0.240-0.322)	-4.28 (0.050)
Rate ratio*	0.359 (0.256-0.503)	0.325 (0.225-0.469)	0.428 (0.284-0.646)	0.496 (0.296-0.830)	0.535 (0.316-0.906)	0.426 (0.275-0.659)	12.20 (0.049)
RII_{KM}	0.345 (0.174-0.686)	0.257 (0.127-0.521)	0.289 (0.142-0.588)	0.337 (0.147-0.776)	0.341 (0.148-0.784)	0.339 (0.166-0.671)	1.75 (0.745)
Adjusted RII_{KM}**	0.279 (0.129-0.600)	0.205 (0.098-0.431)	0.224 (0.102-0.489)	0.133 (0.039-0.455)	0.160 (0.051-0.507)	0.171 (0.054-0.548)	-13.75 (0.073)
	Sample excluding Tehran (n=29)						
Gini index	0.259 (0.168-0.350)	0.285 (0.187-0.382)	0.282 (0.187-0.378)	0.292 (0.192-0.392)	0.277 (0.191-0.363)	0.282 (0.243-0.322)	1.42 (0.38)
Rate ratio*	0.646 (0.444-0.938)	0.397 (0.226-0.695)	0.415 (0.247-0.696)	0.520 (0.277-0.974)	0.492 (0.262-0.924)	0.584 (0.380-0.896)	-6.59 (0.403)
RII_{KM}	0.460 (0.257-0.823)	0.339 (0.179-0.644)	0.352 (0.185-0.672)	0.397 (0.187-0.839)	0.389 (0.185-0.819)	0.411 (0.215-0.785)	-2.76 (0.575)
Adjusted RII_{KM}**	0.402 (0.224-0.722)	0.301 (0.168-0.541)	0.310 (0.165-0.580)	0.211 (0.077-0.577)	0.241 (0.093-0.623)	0.241 (0.090-0.649)	-12.95 (0.045)

*The highest vs. the lowest quintile of HDI

**Adjusted for proportion of males and mean age of males and females in the provinces.

Figure 1. Distribution of suicide mortality rate across the provinces in Iran.

Figure 2. Suicide mortality rates per 100,000 populations in a) total sample; b) quintiles of HDI, 2006-2010.

Figure 3. Scatter plots of HDI and suicide mortality rates, stratified by year of study.

Figure 4. Lorenz curves of the distribution of suicide mortality in Iran, 2006-2010.

OVERALL, GENDER AND SOCIAL INEQUALITIES IN SUICIDE MORTALITY IN IRAN, 2006-2010: A TIME TREND PROVINCE-LEVEL STUDY

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Abstract

Objectives: Suicide is a major global health problem imposing a considerable burden on population in terms of disability-adjusted life years. There has been an increasing trend in fatal and attempted suicide in Iran over the past few decades. The aim of the current study was to assess overall, gender and social inequalities across Iran's provinces during 2006-2010.

Design: Ecological study.

Setting: The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. The data on the annual number of death caused by suicide in each province were gathered from the Iranian Forensic Medicine Organization.

Methods: Suicide mortality rate per 100,000 population was calculated. Human Development Index was used as the provinces' social rank. Gini coefficient, rate ratio and Kunst and Mackenbach relative index of inequality (RII_{KM}) were used to assess overall, gender and social inequalities, respectively. Annual percentage change was calculated using Joinpoint regression.

Results: Suicide mortality has slightly increased in Iran during 2006-2010. There was a substantial and constant overall inequality across the country over the study period. Male to female rate ratio was 2.34 (95% CI 1.45-3.79) over the same period. There were social inequalities in suicide mortality in favor of people in better-off provinces. In addition, there was an increasing trend in these social disparities over time, although it was not statistically significant.

Conclusion: We found substantial overall, gender and social disparities in the distribution of suicide mortality across the provinces in Iran. The findings showed that men in the provinces with low socio-economic status are at higher risk of suicide mortality. Further analyses are needed to explain these disparities.

Article Summary

Strength and limitations of this study

- This is the first national study to evaluate regional social inequalities in suicide mortality over five-year period.
- Social inequality in suicide mortality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM})
- Age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces.

Introduction

Suicide is considered as one of the three leading causes of death among 15 to 44 years age group and the second cause of death in 15-19 years age group [1]. It imposes a considerable burden on population in terms of disability-adjusted life year (DALY) and it has been projected that suicide will compose about 2.4% of global burden of diseases by 2020 [2].

Similar to other developing countries, Iran has been experienced a rapid increase in suicide rate during recent years. A recent study showed that suicide and attempted suicide in Iran have increased from 8.3 per 100,000 population in 2001 to 16.3 in 2007 [3]. Moreover, suicide account for 4% of the injury cases admitted to the general hospitals in the country [4].

The risk factors of suicide are consisted of some demographical characteristics [5], socio-economic situations [6] and medical conditions [7]. However, there are factors related to the area of residence that influence the suicide rate [8]. Evidence demonstrates persistent geographical disparities in distribution of suicide between and within countries which support area-level correlates of suicide [9].

Iran is a Middle Eastern country with 1,628,550 square kilometer land area [10] and is consisted of 31 provinces [11] that are in different levels of development. Ethnic groups tend to reside in neighboring provinces. Therefore, there are variations in socioeconomic level and ethnicity across provinces as well as geographical and ecological differences that could cause a disparity among suicide mortality rate.

While information on the individual risk factors and outcomes of suicide attempts have been well documented in previous studies in Iran [3, 4, 12-15], there is little information on the role of socio-economic factors and suicide incidence. In particular, there is no known study evaluating regional socio-economic disparities and their impact on suicide rate in Iran.

To fill the gap, this study aimed to describe overall and social inequality in suicide mortality rates across all the provinces in Iran from 2006 to 2010. Though this is an ecological study, it will provide a useful starting point for examining the social disparity of suicide and provide valuable information for policy makers in order to prioritize prevention strategies.

METHODS

The data on distribution of population at the provinces were obtained from the Statistical Centre of Iran. It should be noted that at the time of conducting the current study, Iran constituted of 30 provinces and it was later when Tehran province was split into two provinces. The data on the annual number of death caused by suicide in each province were gathered from the published reports [16] of Iranian Forensic Medicine Organization which is affiliated to the Judicial Authority in Iran. According to the Iranian law, all deaths due to external causes should be reported to this organization for examination and recording and to issue the death certificate. It is considered as the most reliable source of mortality data in Iran [17]. Then, annual suicide mortality rates per 100,000 population were calculated for each province. Human Development Index (HDI) was used as the provinces' social rank and related data were obtained from the President Deputy of Strategic Planning and Control. The HDI is a composite index of three basic dimensions of human development, including life expectancy at birth, educational attainment (based on a combination of adult literacy rate and primary education to tertiary education enrolment rates), and income (based on GDP per head adjusted for purchasing-power parity [US$]) [18] .As a composite index, it is expected that HDI might capture socioeconomic development more comprehensively than single indicators such as average income or expenditures.

Overall inequality measures inequalities in health irrespective of the other characteristics of the individuals [19]. To measure overall inequality we followed the same approach as measuring income inequality and used Lorenz curve and Gini coefficient. These two measures are commonly used in assessing overall inequality in distribution of health care

resources and outcomes [20-22]. Lorenz curve is used to compare distribution of health measure with perfect equality (diagonal line). In the current study, Lorenz curve was plotted as the cumulative share of population ranked by suicide mortality rate, in an increasing order, against the cumulative share of suicide mortality. The further the distance from diagonal line implies the greater degree of inequality. The Gini coefficient is equal to twice the area between the Lorenz curve and diagonal and its value ranges from 0 (perfect equality) to one (maximum possible inequality). This measure takes into account the distribution of health variable across the entire population. In the current study, we used *fastgini* command in STATA to calculate Gini coefficient and its jackknife 95% confidence interval. In order to examine gendered nature of suicide mortalities (i.e. gender inequality) in Iran, we calculated the male to female rate ratio and its 95% confidence interval using negative binomial regression with a robust variance. As we had only data stratified by sex groups for the whole study period and not for every specific year, an overall rate ratio was calculated.

Social inequality was evaluated using Cuzick's test for trend and two common inequality measures: rate ratio (RR) and Kunst and Mackenbach relative index of inequality (RII_{KM}) [23]. Cuzick's test for trend is an extension of the Wilcoxon rank-sum test and is used as a non-parametric test for trend across ordered groups [24]. To calculate RR, the provinces were ranked and divided in five quintiles by HDI (weighted by their population). Then, negative binomial regression with a robust variance was used to calculate RR and its 95% confidence interval to compare the highest versus the lowest quintile. One problem with RR is that it only considers the population in two extreme socioeconomic groups. To take into account the whole population distribution across socioeconomic groups and also to remove differences in the size of socioeconomic groups, as a source of variation in the magnitude of health inequalities, RII_{KM} was calculated [23]. RII is widely used to measure social inequality and is recommended when making comparisons over time or across populations [25]. To calculate RII, after determine the relative position of the population in the provinces ranked by HDI, the number of deaths in the provinces was regressed on these relative ranks using negative binomial regression with a robust variance and population as offset variable. With the lowest social rank as reference, an RII_{KM} value greater (lesser) than 1 show that suicide mortality rate was higher among the provinces with higher (lower) social rank (more distance from 1 implies more inequality) [21]. To account for sex and age differences between the provinces, we also estimated adjusted RII_{KM} by including proportion of male in population, mean age of females and mean age of males in our negative binomial regression.

To examine temporal changes of suicide mortality rate across the provinces and also across the quintiles of HDI, we calculated annual percentage change (APC) and its 95% confidence interval for each province and quintile using the Joinpoint Regression Program 3.5.4. Moreover, this program was used to calculate APC of overall and socioeconomic inequality measures over study period. APC is estimated using following regression:

$$\text{Ln}\,(I_t) = b_0 + b_1\,(t)$$

$$APC = (e^{b_1} - 1) \times 100$$

Where I_t shows the suicide mortality rate and estimated inequality indices for year t.

In a sensitivity analysis, Tehran was excluded from the analysis to examine the overall, gender and social inequalities across the remaining provinces. The reason for this was that Tehran has special situation as the capital of the country and being the centre of economic, social and political activities. Excel office and STATA version 11 (StataCorp LP, College Station, TX, USA) were used for statistical analysis.

Results

Table 1 shows mean population, HDI, suicide mortality rate and APC (%) across the provinces for years 2006-2010. Ilam and Hormozgan provinces had the highest and the lowest suicide mortality rate during the study period, respectively (8.8-fold difference). Most provinces (56.6%) had a suicide mortality rate of 3 to 6 per 100,000 population. In addition, suicide mortality rate was more prevalent among the western provinces of Iran (Figure 1).

The estimated APC values show that only five provinces experienced significant changes in suicide mortality rate over the study period (significant increases in Ilam, Isfahan, North Khorasan and Tehran provinces and significant decrease in Markazi province).

Figure 2a shows temporal changes of suicide mortality rate for the country. While the graph shows a slight increase in suicide mortality rate over the study period (from 4.25 in 2006 to 4.88 in 2010), this was not statistically significant (APC=3.05%, P=0.23). Figure 2b presents suicide mortality rates for five quintiles of HDI and examining the trends showed that APC was significant only in the highest quintile (APC=17.98, P=0.01). Figure 3 shows scatter

graphs of HDI and suicide mortality rates. It is evident that the higher HDI was associated with the lower suicide mortality rate and Cuzick's test confirmed this (Z=-4.61, P<0.011).

Male to female rate ratio was 2.34 (95% CI 1.45-3.79) implying a significant higher suicide mortality rate among males than females over the study period. Examining this ratio in the provinces showed that in all provinces but Kordestan men had a higher suicide mortality rate than women. Excluding Tehran from the sample did not change this finding (2.33; 95% CI 1.43-3.79).

Table 2 presents the overall and social inequality measures in distribution of suicide mortality rate across the country through 2006-2010. The Gini coefficient ranged from 0.248 to 0.302 implying substantial overall inequality across the provinces. The Lorenz curves corresponded to this Gini coefficient is been shown in Figure 4. There was a 14.5% decrease in Gini coefficient between the first year and the last year of study implying decreasing overall inequality between these two points of time. Over the study period, the APC of Gini coefficient was -4.28 and statistically non-significant. Excluding Tehran resulted in a 6.9% increase in Gini coefficient between the first and the last year of the study period and a statistically non-significant APC of 1.42 was estimated.

RR was significantly lower than 1 in overall and for all years of the study period, implying a higher suicide mortality rate among people in the lowest quintile of HDI compared with the highest one. Over the study period, RR was approaching 1 and the APC of RR was 12.20 and statistically significant implying a decrease in the gap between the highest and the lowest social ranks. Although excluding Tehran from the sample did not change the overall picture of social inequality, an inverse trend (increasing social inequality) was observed.

RII_{KM} was also lower than 1 in overall and for all years of the study, showing a persistent inequality in favor of people living in the provinces with higher social rank. Temporal analysis showed that RII_{KM} did not significantly change over the study period. Adjusting for age and sex this observation. When we excluded the Tehran province, the APC value for adjusted RII_{KM} was statistically significant showing an increase in social disparity across the remaining provinces in Iran.

Discussion

In this study, for the first time, we assessed overall and social disparities in the distribution of suicide mortality across the provinces of Iran over a period of five years (2006-2010). The

findings showed that suicide mortality has slightly increased over the study period. The findings also indicated that there were substantial overall, gender and social disparities in the distribution of suicide mortality across the country, and it was higher in the provinces with lower social rank. These disparities were generally stable and persistent over the study period.

The findings from the current study showed an inverse association between the provinces' social rank and suicide mortality in Iran. Although the studies on association between area social rank and suicide mortality reported mixed results [9, 26], the results of this study is in line with previous ecological studies investigating the relationship between socioeconomic characteristics and suicide rate, in particular the studies focused on high income settings [9, 27-33]. Rehkopf and Buka[9] in their systematic review of suicide and socioeconomic characteristics of geographical areas found that, among studies with statistically significant results, 50% and 73% of studies reported an inverse relation between area income and education characteristics and completed suicide, respectively. They also found that the probability of reporting an inverse relationship between area social rank and suicide mortality was higher among the studies conducted in Asia (94% of studies with statistically significant results) [9]. Similar finding was reported by another study [34] focusing on the countries in Eastern Mediterranean region (where Iran is located), indicating that high income countries had lower suicide mortality rate than their low and middle income counterparts. It is argued that people in the provinces with lower social rank generally have more adverse experiences, poorer mental health, lower access to psychiatric services, and lower access to health facilities. These factors might partly explain higher suicide mortality rate in the provinces with lower social rank in Iran.

The four Western provinces of Iran (i.e., Ilam, Kermanshah, Lorestan and Hamedan) had the highest suicide mortality rate in the country. One potential explanation for this observation can be low socioeconomic status of these provinces. These provinces are among the provinces with the highest unemployment rate and the lowest HDI in the country. High divorce rates in these provinces (except for Ilam) can be another potential explanation as divorce is considered as a risk factor for suicide mortality [35, 36]. In addition, cultural issues such as the tribal structure of communities and the extreme fanaticism prevailing in these provinces have been considered as another potential explanation for this finding [37].

The high gender gap in suicide mortality rate observed in the current study is in line with the previous epidemiological studies in Iran [3, 4, 14] and is comparable to the studies conducted in other settings, in particular high income countries [6, 9, 38, 39]. Although many studies, including the previous studies in Iran [3, 4, 14], have shown higher suicide attempt rate among females, completed (fatal) suicides are higher among males. One potential explanation can be the difference in methods of attempting suicide among males and females. For example, the most common methods of attempting suicide used by males in Iran are hanging and firearms which have higher fatality rate compared with self-burning method commonly used by females [3, 14, 39, 40]. Greater psychosocial impact of problems, such as unemployment or retirement, on males compared to female [39, 41, 42] and adopting coping strategies such as emotional inexpressiveness, lack of help-seeking, risk-taking behaviour, violence, alcohol and drug abuse by males (which are triggered by norms of traditional masculinity) [43, 44] are other potential factors which have been discussed in the literature. The findings of the gender analysis are important for designing and implementing suicide prevention strategies as the factors, patterns, and behaviours associated with suicide are affected by gender.

Temporal analysis of suicide mortality showed interesting results indicating that among five quintiles of HDI, it was only the highest quintile that experienced a significant change in suicide mortality over the study period. This finding potentially can be explained by increasing prevalence of mental disorders, raising unemployment rate [13, 45] and increasing trend in divorce rate [13] in the provinces with higher HDI, such as Tehran, the capital city of Iran.

To our knowledge, this is the first national study evaluating social inequalities across different regions over time. Although this study conducted in the context of Iran, however, the findings may also be applicable to other middle-income countries, in particular countries in the Middle East region, which share similar culture. Moreover, we believe that, in terms of methodology, our analysis present a good example for employing a triangulation of different methods for evaluating inequalities in suicide mortalities. However, the current study has several limitations that should be considered when interpreting its findings. Firstly, age and gender differences between the provinces were naïvely adjusted which might have not fully captured differences in age distribution across provinces. Secondly, there is the issue of availability and quality of data on suicide which is common in developing countries settings [26, 46] and leads to underestimation and misclassification of suicide. This might be an issue in

this study because of the social stigma of suicide and religious sanctions and some legal issues in the Iranian context [34, 4]. Moreover, the underestimation and misclassification of suicide mortality might be more common in the provinces with lower social rank; therefore, we expect that the social disparity to be more profound than what has been reported here. Thirdly, the current study is an ecological study using province as unit of analysis which embraces substantial heterogeneity within provinces. This implies that the observed disparities in suicide mortality are between-provinces and it is not necessarily applicable to smaller geographic units or individuals. Furthermore, no causal inference can be drawn due to ecological nature of the study and that there was no control for confounders in this study.

Conclusion

The present study indicated that there were substantial overall, gender and social disparities in the distribution of suicide mortalities across the provinces in Iran. Moreover, the study showed an inverse association between the provinces' social rank and suicide mortality. The findings imply that prevention resources should be targeted high risk groups, in particular men in the provinces with low socio-economic status. Further investigations are needed to explain these disparities in suicide mortality across the provinces. Moreover, more studies needed to explore the association of socio-economic factors and suicide (attempt and fatal) focusing on the smaller geographical units and at the individual level in order to design better prevention strategies.

List of Abbreviations

DALY: Disability-adjusted Life Years, HDI: Human Development Index, RR: rate ratio, RII_{KM}: Kunst and Mackenbach relative index of inequality, APC: annual percentage change

Competing interests

The authors declare that they have no competing interests. No funding has been received for the conduct of this study and/or preparation of this manuscript.

Authors' contributions

AAK was involved in the study conception and design, data collection and analysis, interpretation of the data, and writing the manuscript. HHB and SS were involved in the study design, results interpretation, and writing the manuscript. HS was involved in the study

design, data collection and finalization of the manuscript. All authors read and approved the final manuscript.

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Table 1. Mean population, human development index (HDI), suicide mortality rate and annual percentage change across the provinces in Iran, 2006-2010 (Ranked by Suicide mortality rate).

	Population	HDI	Suicide mortality rate per 100,000 population	APC (%)*
Ilam	555,929	0.729	19.53	**10.11**
Kermanshah	1,892,100	0.748	13.74	0.46
Lorestan	1,736,946	0.761	10.64	1.18
Hamedan	1,700,960	0.740	9.59	-1.52
Gilan	2,428,553	0.769	6.52	9.98
Ardebil	1,235,234	0.735	6.22	-2.32
East Azerbaijan	3,646,459	0.763	5.58	1.31
Zanjan	973,739	0.752	5.53	12.14
Kohgyluyeh & Boyerahmad	651,577	0.718	5.25	-4.20
Khuzestan	4,372,242	0.762	5.11	-7.13
West Azerbaijan	2,944,224	0.713	4.72	-2.74
Kordestan	1,453,503	0.713	4.69	5.25
Golestan	1,651,708	0.737	4.49	5.67
Overall (Iran)	72,599,045	0.758	4.46	3.05
Qazvin	1,177,582	0.783	4.25	-1.13
North Khorasan	824,979	0.759	4.24	**10.64**
Fars	4,431,684	0.783	4.16	1.56
Chaharmahal Bakhtiari	875,207	0.749	4.00	-7.72
Qom	1,087,011	0.773	3.75	7.89
Mazandaran	2,979,189	0.745	3.66	-5.71
Isfahan	4,680,831	0.810	3.64	**4.62**
Kerman	2,799,417	0.750	3.10	-5.03
Bushehr	914,710	0.786	3.02	15.55
South Khorasan	656,469	0.723	3.02	-2.28
Tehran	14,106,297	0.843	2.92	**17.98**
Yazd	1,028,152	0.809	2.68	-4.48
Razavi Khorasan	5,765,706	0.777	2.66	-2.64
Semnan	606,982	0.814	2.60	4.27
Markazi	1,371,514	0.785	2.38	**-10.73**
Sistan & Baluchestan	2,569,107	0.643	2.23	6.11
Hormozgan	1,481,031	0.766	2.21	-5.59

*Bold figures show statistically significant results ($p<0.05$)

Table 2. Overall and social inequality measures of suicide mortality in Iran, 2006-2010.

	2006	2007	2008	2009	2010	Overall	APC (Pvalue)
	Total sample (n=30)						
Gini index	0.290 (0.193-0.386)	0.302 (0.212-0.392)	0.271 (0.182-0.361)	0.268 (0.165-0.371)	0.248 (0.151-0.345)	0.281 (0.240-0.322)	-4.28 (0.050)
Rate ratio*	0.359 (0.256-0.503)	0.325 (0.225-0.469)	0.428 (0.284-0.646)	0.496 (0.296-0.830)	0.535 (0.316-0.906)	0.426 (0.275-0.659)	12.20 (0.049)
RII_{KM}	0.345 (0.174-0.686)	0.257 (0.127-0.521)	0.289 (0.142-0.588)	0.337 (0.147-0.776)	0.341 (0.148-0.784)	0.339 (0.166-0.671)	1.75 (0.745)
Adjusted RII_{KM}**	0.279 (0.129-0.600)	0.205 (0.098-0.431)	0.224 (0.102-0.489)	0.133 (0.039-0.455)	0.160 (0.051-0.507)	0.171 (0.054-0.548)	-13.75 (0.073)
	Sample excluding Tehran (n=29)						
Gini index	0.259 (0.168-0.350)	0.285 (0.187-0.382)	0.282 (0.187-0.378)	0.292 (0.192-0.392)	0.277 (0.191-0.363)	0.282 (0.243-0.322)	1.42 (0.38)
Rate ratio*	0.646 (0.444-0.938)	0.397 (0.226-0.695)	0.415 (0.247-0.696)	0.520 (0.277-0.974)	0.492 (0.262-0.924)	0.584 (0.380-0.896)	-6.59 (0.403)
RII_{KM}	0.460 (0.257-0.823)	0.339 (0.179-0.644)	0.352 (0.185-0.672)	0.397 (0.187-0.839)	0.389 (0.185-0.819)	0.411 (0.215-0.785)	-2.76 (0.575)
Adjusted RII_{KM}**	0.402 (0.224-0.722)	0.301 (0.168-0.541)	0.310 (0.165-0.580)	0.211 (0.077-0.577)	0.241 (0.093-0.623)	0.241 (0.090-0.649)	-12.95 (0.045)

*The highest vs. the lowest quintile of HDI

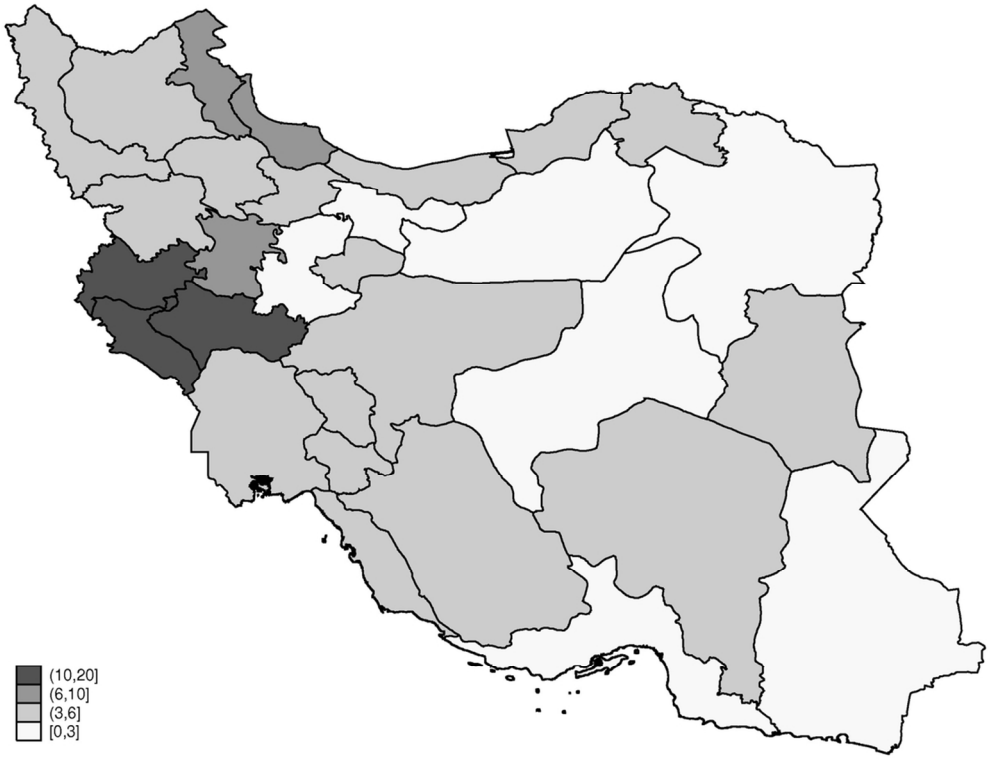
**Adjusted for proportion of males and mean age of males and females in the provinces.

Figure 1. Distribution of suicide mortality rate across the provinces in Iran.

Figure 1. Suicide mortality rates per 100,000 populations in a) total sample; b) quintiles of HDI, 2006-2010.

Figure 2. Scatter plots of HDI and suicide mortality rates, stratified by year of study.

Figure 3. Lorenz curves of the distribution of suicide mortality in Iran, 2006-2010.



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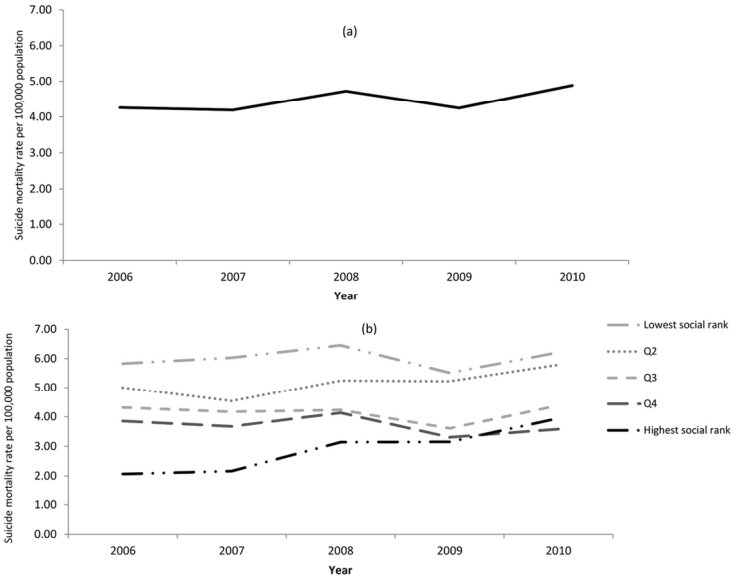

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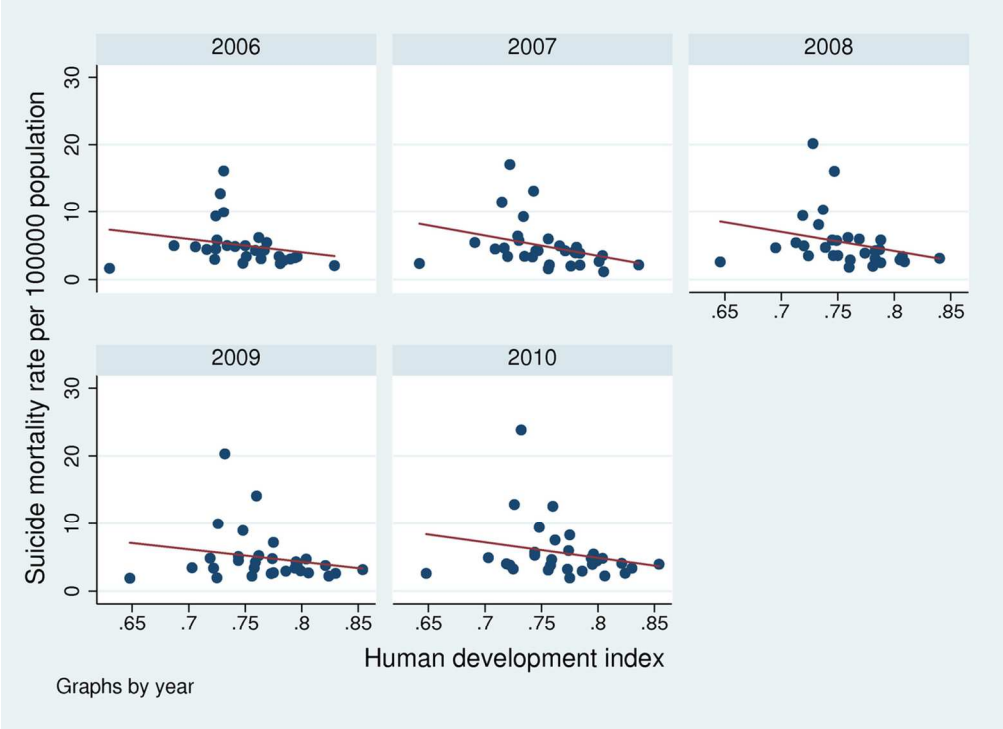

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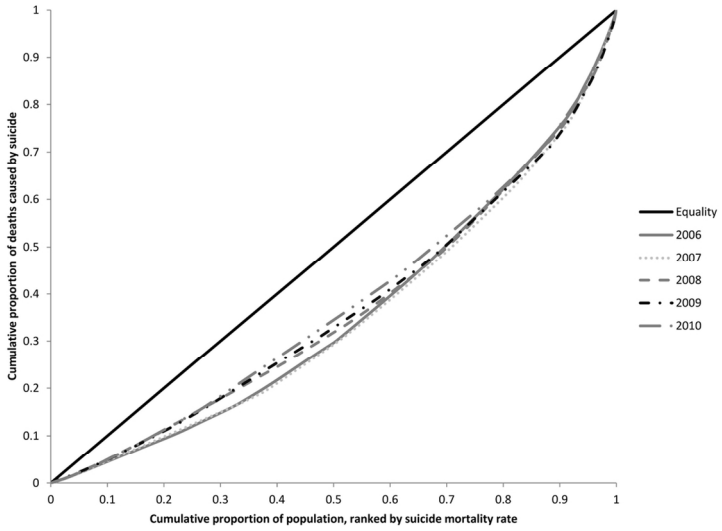

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results		
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.