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Original Article

A comprehensive spatial epidemiology of suicide and suicide attempts in Fars Province

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Abstract

Background and Objectives: Suicidal behavior is considered as one of the main issues of public health. The WHO has estimated that approximately 800,000 people lose their lives by suicide worldwide per year. This study aimed to spatially analyze suicide and attempted suicide in Fars province in southwestern Iran during 2010-2013.
Materials and Methods: The present ecological study was conducted on 17,342 cases of suicides and attempted suicide in Fars province, Iran. To collect data, a checklist of monthly reports of a suicide prevention program was used. The data were analyzed using SPSS software, ver. 21, R software, ver. 3.1.2, Arc GIS software, ver. 9.3, and SAS software, ver. 9.1.
Results: The spatial pattern of suicide in all age and sex groups in Fars province represented the highest suicide rates in the northern and southwestern parts of the province and the lowest rates in Kavār, Gerāsh, and Ābādeh townships. Also, the results of the research showed that the rates of suicide and attempted suicide have not been affected by any of the study socio-economic factors.
Conclusion: Generally, the spatial patterns of suicide in all age and gender groups in the province were indicative of the highest suicide rates in the north and southwest of the province. Conducting prevention planning for the high-risk areas throughout the province is essential.

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Suicide,
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Introduction

Suicidal behavior is regarded as one of the main issues in the public health [1] as the WHO has estimated that each year, nearly 800,000 people lose their lives by suicide worldwide [2].

Several studies reveal that substantial geographical variations have occurred in the incidence of suicide so that the highest and lowest suicide rates belong to Eastern Europe, and some countries in Latin America [3-4].

According to current studies almost half of the suicides have occurred in the 3 countries of India, China, and Japan [5]. It seems that suicide rate is low in most Muslim countries, for example, the suicide rate in Kuwait has been reported to be 0.1 per 100,000 people and less than 5 per 100,000 people in countries like Turkey and Pakistan [6-7].

Suicide in Iran is lower than most Western countries, but higher than other Middle Eastern countries [8]. According to the recent studies, the suicide rate in Iran has reached a figure of 9.4 per 100,000 people [9]. The rate varies between different regions of the country with distinctive geographical distribution in Iran, so that the 3 provinces of Ilam, Kermanshah, and Hamadan have accounted for the highest suicide rates [10]. In the meantime, Ilam Province has experienced a significant increase in the suicide phenomenon and has the highest suicide rate in the country [11].

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However, the results of a 5-year study in Fars province showed that suicide rates among men and women had been 5.7 and 3.1 per 100,000 people, respectively [12]. Also, the results of this study demonstrated that most suicide cases were related to the age group of 20-29 years, while the age group of 60-69 accounted for the least frequency [12]. Moreover, the suicide rate has been decreased with age after adolescence [12], consistent with the results of studies suggesting an increased rate of suicide among the youth [9, 13].

The relationship between the mortalities caused by suicide and social, economic, and cultural status has been long focused on by suicide researchers [14]. Since Durkheim studied the effect of socioeconomic status on the risk for suicide [15], a large scientific interest has been drawn towards this field [16-18]. To the end of the first decade of the 1800′s, it was argued that the suicide burden of a society reflects the political, religious, economic, and social atmospheres in which suicidal behaviors occur [14].

Although most studies have only dealt with the risk factors on an individual level, that are vital for the preventive efforts of suicide, few studied suicide on the ecological level. Nowadays, a great interest has been created for the study of the spatial patterns of suicide and suicide attempts, as well as assessment of demographic and socio-economic factors as the possible determinants of its geographical distribution [9].

Studying spatial patterns of suicide and identifying high-risk areas provide us with a richer understanding of the risk factors at the individual level. Therefore, identification of areas at risk of suicide using spatial statistical techniques may be of great importance to better target resources for the prevention of suicide in the future [2]. Thus, we decided to conduct a study aimed at the spatial epidemiology of suicide and attempted suicide in Fars Province using Geographic Information System; GIS-based environmental design and statistical techniques during 2010 to 2013.

Materials and Methods

The present research was an ecological study to assess the spatial epidemiology of suicide and attempted suicide based on a census in Fars Province. The study population consisted of all cases of suicide and attempted suicide referring to the health units (emergency departments of hospitals and forensic medical centers of the cities) in the 27 townships of Fars Province from the beginning of 2010 to the end of 2013.

To collect data on suicide and attempted suicide, the checklist of monthly reports of the suicide prevention program was applied [21]. In addition, some information on the socio-economic indices, including marriage, divorce, unemployment, economic participation, literacy, etc., was also collected from Shiraz University of Medical Sciences (SUMS), Center for Statistics, Data and GIS Center of Fars Governor, and the Bureau of Labor and Social Welfare for the 27 townships, separately.

To draw maps of geographical distribution of suicide separately for the townships based on age and gender groups, 3 classifications of 15-34 years, 35-54 years, and 55 years and older were separately created for men and women. Also, for an attempted suicide, 4 age and gender groups of 5-14 years, 15-34 years, 35-54 years, and 55 years and older were separately created for men and women. Then, the smoothed Standardized Mortality Ratios (SMRs) were separately calculated for the 27 townships based on an indirect method by the following formula:

$$\text{SMR} = \frac{\text{The number of cases observed}}{\text{The number of cases expected}}$$

And the number of expected cases was calculated by the following formula (22):

$$\text{The number of cases expected} = \frac{\text{The number of cases in the province}}{\text{Population of the province}} \times \text{Population of the city}$$

It is worth noting that to calculate the rates of suicide and attempted suicide separately for the age and gender groups, the demographic census of 2011 was used [23].

Finally, due to the small population and reducing incidence of suicide in some of the townships and to show a clear spatial pattern of suicide and attempted suicide [24], the smoothed SMRs were separately calculated for the age and gender groups of suicide and attempted suicide in the 27 townships of the province using hierarchical Bayesian modeling before drawing a map [22].

Bayesian hierarchical models are based on Poisson assumption for the observed cases of suicide so that they provide the possibilities of random effects for non-structural diversities (heterogeneity in all the regions of the area under consideration) and structural diversities (correlation between the neighboring areas) [24- 25]. The Bayesian hierarchical models were estimated using Monte Carlo Markov Chain methods in R software, ver. 3.1.2 [26].

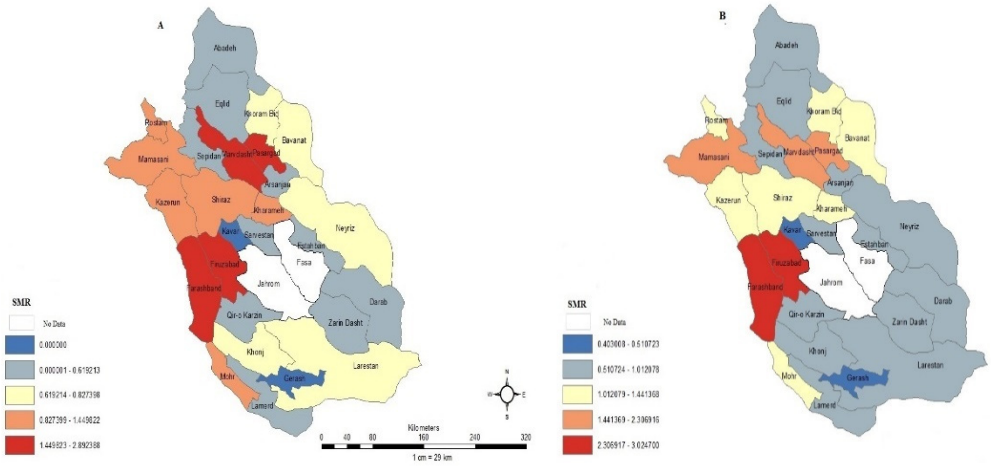
Blue and red colors represented the regions with the lowest and highest risks, respectively. To display the geographic distribution of smoothed SMRs of suicide and attempted suicide in the townships of Fars province, Arc GIS software, ver. 9.3 was utilized.

To achieve a spatial correlation or aggregation of the smoothed values of age and sex groups of suicide and attempted suicide, Moran's I statistical index was used by employing R software, ver. 3.1.2 [27]. The numerical value of zero of this index and positive values represented lack of spatial correlation and correlation between the regions (maximum numerical value of Moran's I is 1) [22]. At the end, to investigate the correlation between socioeconomic variables and rates of suicide and its attempt, log-linear Poisson regression model [28] was used as the rate ratio (RR), 95% confidence interval for RR, and P-value. The significance level was considered at 0.05 in the tests. It should be noted that the two townships of Fasa and Jahrom are not covered by SUMS.

Results

Based on the inclusion criteria, 17,342 cases have

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Map 1. Maps of unsmoothed (A) and smoothed (B) SMRs of suicide at 27 townships of Fars Province

included 646 cases of suicide registered in the forensic medical center and 16,696 cases of attempted suicide which occurred in 27 townships of Fars province during the study years.

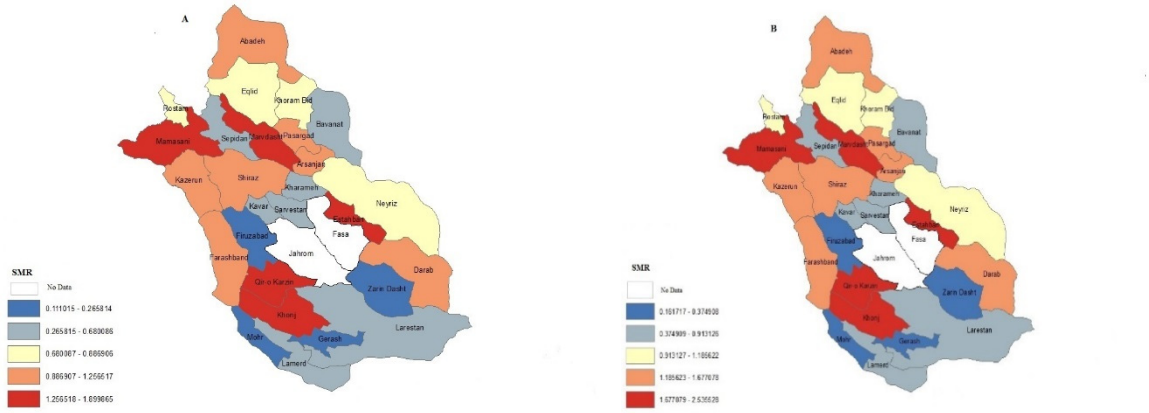
On the average, suicide rate in the townships of Fars Province was found to be 3.85 per 100,000 people per year. The frequency distribution based on the demographic variables revealed that of the 646 suicides that occurred, 328 persons (50.8%) and 318 cases (49.2%) have been men and women, respectively. Singles with a frequency of 321 persons (49.7%), age group of 15-24 years with a frequency of 277 cases (42.9%), and housewives with a frequency of 220 persons (34.1/%) accounted for most suicide cases.

On the other hand, a number of 16,696 suicide attempts had been registered to be involving 6,598 males (39.5%) and 10,098 females (60.5%). On the average, the rate of attempted suicide in Fars province was found to be 99.53 per 100,000 people per year. The majority of the individuals attempting suicide were singles with a frequency of 9,469 subjects (56.7%) and the age group of 15-24 years with a frequency of 9,565 subjects (57.3%). Most of those attempting suicide had a college degree with a frequency of 1,201 people (98.5%), housewives with a frequency of 5,664 cases (33.9%), and city residents with a frequency of 11,723 persons (70.2%).

Spatial Patterns of Suicide and Suicide Attempts in All Age and Sex Groups

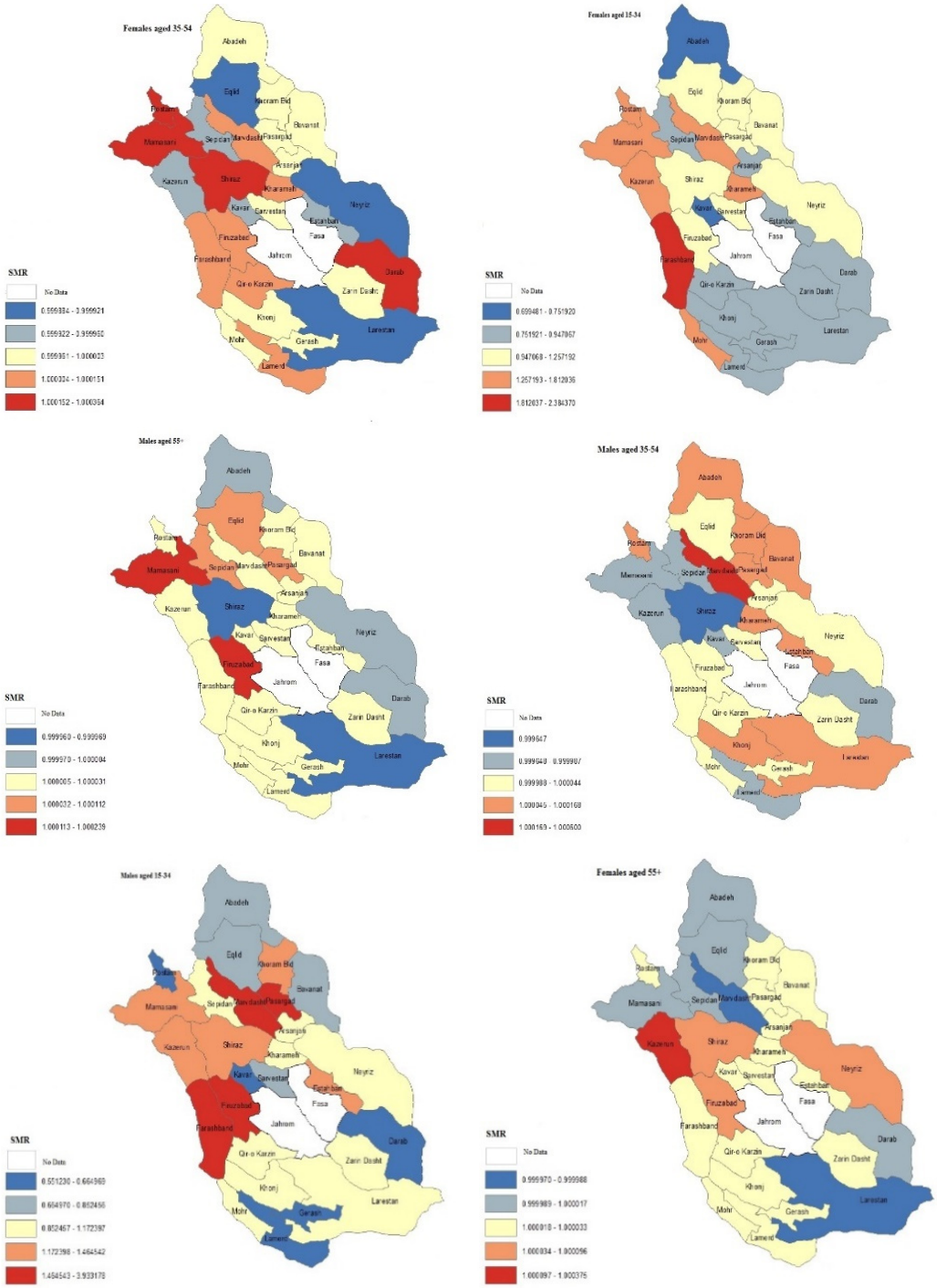
Map 1 shows the geographical distribution of smoothed and unsmoothed SMRs of suicide in all age and gender groups at 27 townships of Fars province. The unsmoothed SMR values of suicide ranged between 0 and 2.892388, while the smoothed SMR values of suicide increased between 0.40300 and 3.024700. The statistical indicator of Moran's I=0.01 indicated a lack of spatial correlation with the value of p=0.177.

The smoothed and unsmoothed maps of suicide demonstrate 2 main geographical features: (A) The highest suicide rates in Farashband and Firuzabad townships in the southwestern part and Marvdasht in the northern part of Fars province; and (B) the lowest rates in 3 townships of the province (Kavār, Gerāsh, and Ābādeh)



Map 2. Maps of unsmoothed (A) and smoothed (B) SMRs of attempted suicides in 27 townships of Fars Province

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Map 3. SMR smoothed maps of suicide separately for men and women aged 15-34, 35-54, +55 years in 27 townships of Fars Province

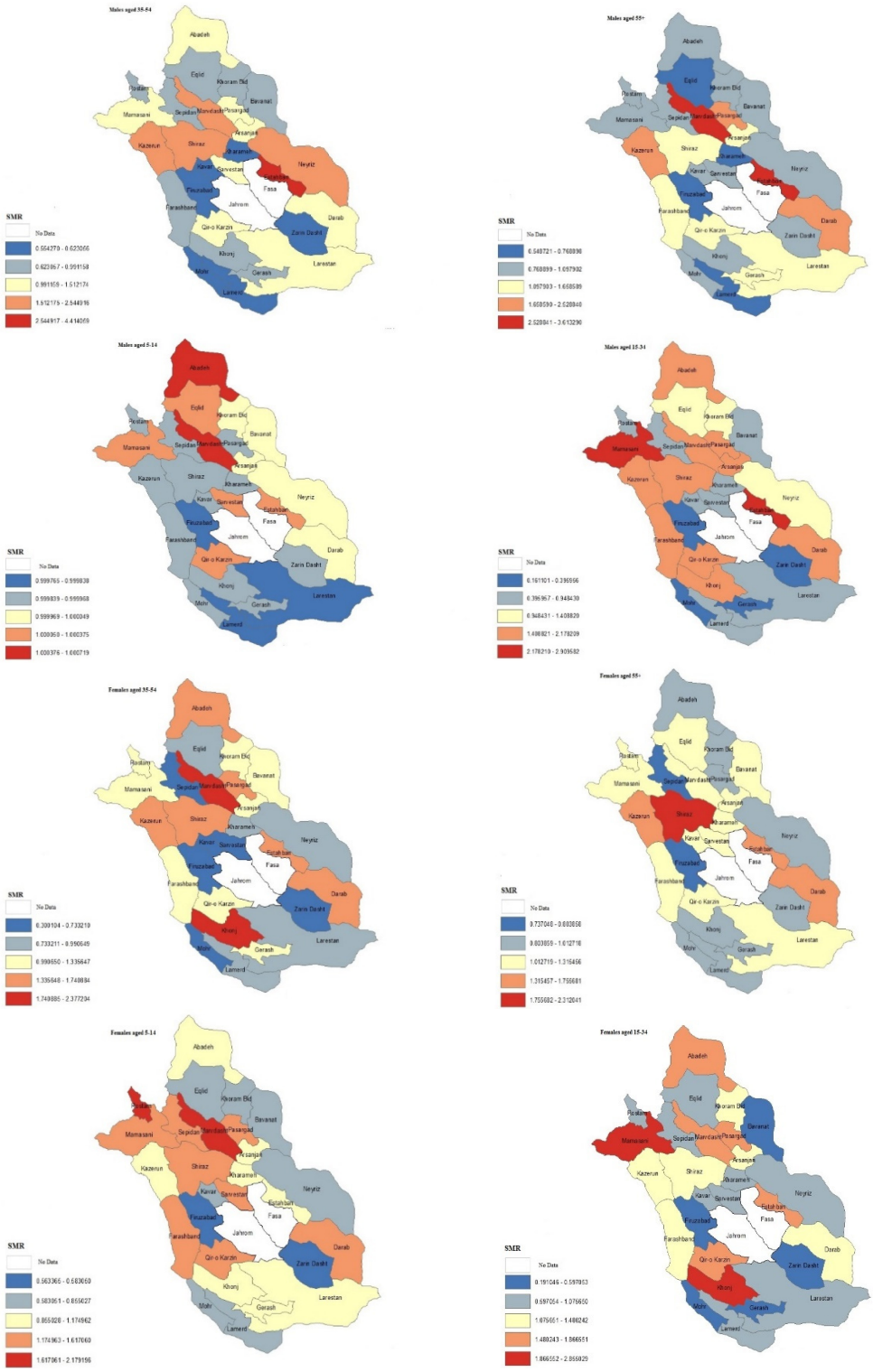
(Map 1). This spatial pattern was better displayed in the smoothed SMR map (Map B) compared to the unsmoothed SMR map (Map A).

On the other hand, Map 2 illustrates the geographical distribution of unsmoothed and smoothed SMRs of suicide attempts in all age and gender groups. The unsmoothed SMR of suicide attempts (A) ranged between 0.111015 and 1.899865, while the smoothed SMR range (B) increased from 0.161717 to 2.535528. Mamasani, Estahban, and Khonj townships accounted for the highest SMR values and Firuzabad, Mohr, Zarindasht, and Gerāsh accounted for the lowest values (Map 2). The statistical indicator of Moran's I=-0.04 depicted a lack of spatial correlation with the value of p=0.866.

Spatial Patterns of Suicide and Suicide Attempt in Terms of Age and Sex Groups

Map 3 displays the smoothed SMRs of suicide by age-

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Map 4. Maps of smoothed SMRs of suicide attempts separately for men and women of 5-14, 15-34, 35-54, and 55+ years old in 27 townships of Fars Province

sex groups of 15-34, 35-54, and 55 years and older.

The smoothed SMR of suicide ranged between 0.699481 and 2.384369 for women aged 15-34 years of (a difference of 3.41 times), while this range was between 0.551229 and 3.933177 for men aged 15-34 years (a difference of 7.13 times). The smoothed SMRs for the men and women of 35-54 years old were within the ranges of 0.9996473 to 1.000600184 (a difference of 1.0009) and 0.999883 to 1.000364 (a difference of 1.0005), respectively, and 0.999960004 to 1.00023887 (a difference of 1.0003) and

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Table 1. The adjusted and unadjusted RRs of the relationship between socioeconomic factors and suicide

Variables	Adjusted RR			Unadjusted RR		
	RR	Confidence interval of 95%	P-value	RR	Confidence interval of 95%	P-value
Marriage rate (per 1000)	0.9714	0.8474-1.1137	0.6777	0.9806	0.8799-1.0928	0.7225
Divorce rate (per 1000)	1.1400	0.5117-2.5396	0.7485	0.9521	0.6447-1.4059	0.8049
Crude birth rate (per 1000)	0.6801	0.0860-5.3763	0.7148	0.8533	0.6984-1.0426	0.1207
Dependency ratio (%)	0.9692	0.6143-1.5291	0.8929	0.9533	0.8503-1.0688	0.4122
General fertility rate (per 1000)	1.0362	0.5877-1.8270	0.9021	0.9540	0.9025-1.0038	0.0957
Percentage of the age group over 65 years (%)	0.6819	0.3109-1.4957	0.3394	0.9701	0.7825-1.3580	0.8288
Urbanization rate (%)	1.0084	0.9599-1.0594	0.7390	0.9946	0.9709-1.0188	06596
Mortality rate under 1 year of age (per 1000)	1.1184	0.8598-1.4547	0.4042	0.9979	0.8798-1.1436	0.9764
Literacy rate (%)	0.8756	0.5910-1.2974	0.5080	0.9189	0.7996-1.0560	0.2330
Disability rate (%)	0.5318	0.0057-49.6054	0.7849	1.3933	0.1892-10.2625	0.7447
Unemployment rate (%)	0.93839	0.14598449-1.	0.8353	1.0332	0.9679-1.1031	0.3264
Economic participation rate (%)	0.8945	0.6466-1.2374	0.5007	0.8826	0.7145-1.0904	0.2469
Household size (persons)	0.5660	0.0165-19.4530	0.7525	1.3210	0.2535-6.8840	0.7410

0.999969 to 1.0003752 (a difference of 1.0004) for men and women over 55 years, respectively (Map 3).

No clusters were observed between the age and sex groups of suicide in the townships of the province:

Moran's I statistic indicator reached its peak in the age group of 15-34 years: 0.0075 (p= 0.2384) (men) and -0.0152 (P=0.5492) (women), -0.0200 (p=0.6822) (men) and 0.0023 (p= 0.3026) (women) for the age group of 35-54 years and -0.0210 (p=0.6674) (men) and -0.0466 (p=0.7125) (women) for the group of over 55 years.

On the other hand, the smoothed SMR of suicide attempts for women of 5-14 years old ranged from 0.56336 to 2.17919 (a difference of 3.87 times), while this range varied from 0.99976 to 1.00071 (a difference of 1.0009) for the men aged 5-14 years. The smoothed SMRs in men and women of 15-34, 35-54, and over 55 years old fell within the ranges of 0.16110 to 2.90958 (a difference of 18.06 times) and 0.191045 to 2.85502 (a difference of 14.94 times), 0.55427 to 4.41405 (a difference of 7.96 times), and 0.30010 to 2.37720 (a difference of 7.92 times), and 0.54872 to 3.61329 (a difference of 6.58 times) and 0.73704 to 2.31204 (a difference of 3.14 times), respectively (Map 4).

Also, no clusters were observed between the age and sex groups of attempted suicide in the townships of the province:

Moran's I statistic indicator reached its peak in the age group of over 55 years: 0.0082 (p=0.2458) (men) and -0.0279 (p=0.8391) (women), -0.0235 (p=0.7104) (men) and -0.0516 (p=0.6788) (women) for the age group of 35-54 years, and -0.0239 (p=0.7615) (men) and -0.0440 (p=0.8258) (women) for the age group of 15-34 years.

The Correlation Between Socio-economic Characteristics of the Regions and the Rates of Suicide and Attempted Suicide

Tables 1 and 2 summarize the results of adjusted and unadjusted Rate Ratio (RR) concerning the relationship between SMR of suicide and attempted suicide and socio-economic characteristics of the areas separately for the study variables. It should be noted that in an unadjusted mode, the mentioned results are indicative of the effect of each variable without affecting or controlling the effects

Table 2. The adjusted and unadjusted RRs of the relationship between socioeconomic factors and suicide attempts

Variables	Adjusted RR	Unadjusted RR				
	RR	Confidence interval of 95%	P-value	RR	Confidence interval of 95%	P-value
Marriage rate (per 1000)	1.0226	0.8917-1.1726	0.7497	1.0190	0.9103-1.1407	0.7438
Divorce rate (per 1000)	1.0154	0.4631-2.2267	0.9694	1.0090	0.6856-1.4848	0.9637
Crude birth rate (per 1000)	1.0787	0.1813-6.4192	0.9336	0.9296	0.7623-1.1335	0.4704
Dependency ratio (%)	0.8623	0.5711-1.3017	0.4807	0.9475	0.8444-1.0632	0.3592
General fertility rate (per 1000)	0.9825	0.6040-1.5981	0.9432	0.9761	0.9242-1.0309	0.3854
Percentage of the age group over 65 years (%)	1.0015	0.4800-2.0899	0.9967	1.0396	0.7880-1.3715	0.7837
Urbanization rate (%)	1.0211	0.9682-1.0768	0.4416	1.0038	0.9801-1.0282	0.7535
Mortality rate under 1 year of age (per 1000)	1.0139	0.7819-1.3147	0.9172	0.9935	0.8642-1.1421	0.9274
Literacy rate (%)	0.9206	0.6182-1.3709	0.6840	1.0006	0.8741-1.1455	0.9929
Disability rate (%)	0.7045	0.0133-37.2555	0.8627	1.9682	0.2712-14.8663	0.4950
Unemployment rate (%)	0.9456	0.8108-1.1029	0.4761	1.00333	0.9321-1.0798	0.9309
Economic participation rate (%)	0.9383	0.6929-1.2706	0.6807	0.9843	0.8005-1.2103	0.8809
Household size (persons)	0.7079	0.0265-18.9291	0.8368	0.7074	0.1173-4.2665	0.7057

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of other variables, i.e. how much each variable alone increases or decreases the risk of suicide or suicide attempt without having any effects. However, in an adjusted mode, the results mentioned for each variable are in the case that the effects of other variables are held constant and under control.

The results of the study revealed that there was no correlation between the socioeconomic characteristics of the regions and the rates of suicide and attempted suicide in the 27 townships of Fars province.

Discussion

This study assessed the spatial patterns of risks for suicide and suicide attempts in the 27 townships of Fars province by using a series of data related to suicide and attempted suicide.

The Spatial Pattern of Suicide and Attempted Suicide According to Age and Sex Groups

The general map of suicide representing SMR distribution of suicide (combined of all ages) in the townships of the province was indicative of the greatest risk of suicide in Farashband and Firuzabad townships in the southwest and Marvdasht township at the north of the province, while the lowest risk for suicide was related to Kavar, Gerash, and Abadeh, respectively. In contrast, Mamasani, Estahban, and Khonj townships accounted for the highest levels of SMR of suicide attempts and Firuzabad, Mohr, Zarindasht, and Gerash had the lowest values of SMR of suicide attempts.

The various specific age-sex trends in suicide rates might indicate the different effects of socio-economic factors or totally the diverse social processes among different age-gender groups [29].

Generally, the most important spatial characteristics of suicide in Fars province were observed, for example in the north and southwest with the highest rates and in Kavar, Gerash, and Abadeh townships with the lowest rates in all the age and sex groups though the youngest age group depicted the most geographical variations (SMR range). Likewise, during a study conducted in Taiwan, the youngest age group demonstrated the most geographical changes [22]. In addition, it has been reported that the spatial distribution of suicide has shown some common patterns in all different age and gender groups in England and Wales [29]. The higher degree of both spatial diversity and clusters in young people in some of the areas might be due to an increase in the variety of variables associated with high suicide rates in those areas in the youth (for example: the ratios of single-person households, divorce, and single adults) against the variable related to high suicide rates of the areas in old people (i.e., the ratio of single people) [22].

Also, it can be noted in this regard that the teenagers and young adults who are at risk for suicidal behaviors are probably involved in some stressful events that they cannot manage and control. These stressful events as predisposing factors usually play a major role in suicide attempts [30]. Thus, it is necessary to hold classes on stress management training and problem solving for the groups at risk in order to take an effective step to reduce this phenomenon in this age group.

The Correlation Between Socio-economic Characteristics of the Areas and Rates of Suicide and Suicide Attempts

Generally, the results of the current research on an ecological level showed that the rates of suicide and attempted suicide in the townships of Fars province have not been under the influence of any of the socioeconomic factors. Of course, this does not show that the phenomenon of suicide and attempted suicide at the individual level has any relations with the mentioned socio-economic variables or not.

This lack of correlation observed between the rates of suicide and attempted suicide and socio-economic variables may be real or caused by some possible reasons mentioned as follows.

If in the most studies conducted, there has been found a link between the rates of suicide and some socio-economic indices such as literacy [31-32], disability [33-37], family size [38-39], rate of unemployment [40], economic hardship [41-42], urbanization [43], marriage [44-46], and divorce [45-46], it is for the reason that the mentioned socio-economic indices have been available according to gender in those studies. Whilst in the present study, the socio-economic indices were not accessible based on gender on the township level during the study years and thus the census data of 2011 were inevitably utilized. Temporally, the information of suicide and attempted suicide was different from socio-economic indices. This means that to calculate the SMR for suicide and suicide attempts in terms of age and sex groups, the demographic data of age and sex groups were not available and thus the data of age and gender groups of the 2011 census were inevitably used, which may have affected the results of this study to some extent. In this study, the phenomenon of suicide and attempted suicide and socioeconomic factors at the level of townships was investigated. It would be better to separately study urban and rural populations for the analysis of the correlation between the variables and suicide and attempted suicide, as well as identification of the areas with the greatest risk of suicide. Unfortunately, no necessary demographic and socio-economic information was available in this field.

Limitations

Although suicide is an individual activity, in this study, changes in the rates of suicide and suicide attempts, as well as socioeconomic factors were investigated on a township level instead of suicide risks at the individual level. Since the design of our study was of an ecological type, the present analyses could have been more likely influenced by ecological fallacy or bias [49]. Therefore, for further investigation, some studies at the individual level associated with the mentioned socio-economic variables at the provincial level must be conducted.

As it was mentioned, the unavailability of population based data on age and sex groups during the study years

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accounted for one of the limitations of the present study to calculate the required parameters. In addition, the inaccessibility of some socio-economic indices such as the rates of literacy, disability, and unemployment, household size, and economic participation according to sex at the twonship level during the study years was another limitation to the current study so that the data of 2011 census was employed to deal with it.

The results of the research showed that none of the study factors was related to the rates of suicide and attempted suicide and it is possible that some other socio-economic indices such as poverty, income, population density, migration, alcohol and drug consumption, and the prevalence of mental disorders have played a role in the occurrence of this problem in this part of the country according to sex. Unfortunately, since such information was not available, performing their analyses was not possible in this study.

Conclusion

The geographical patterns of suicide in all age and gender groups in the province were indicative of the highest suicide rates in the north and southwest of the province and the lowest rates in Kavār, Gerāsh, and Ābādehtownships. Further studies on the causes andindividual's motivations for suicide, as well as prevention planning for the high-risk areas throughout the province are essential.

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Conflict of Interest

The Authors have declared no conflict of interest for this study.

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