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ORIGINAL PAPER

Risk factors for suicide in rural Italy: a case–control study

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Abstract

Purpose Increased frequency of suicide in rural areas of Tuscany has been described since the 1970s. A case–control study was conducted in 2014 and 2015. The objective of this study was to identify major individual risk factors related to suicides in six rural districts of Tuscany.

Methods Cases were identified as all 128 suicides occurred in six rural districts between 2009 and 2013. Controls (three for each case) were matched for age, sex, and general practice. Information was collected from GPs using a structured questionnaire. Univariate and multivariate analyses were carried out to investigate the association between individual risk factors and suicide.

Results Informants for 91 cases of the 128 identified cases were successfully interviewed (response rate 71.1%). About 40.5–65.9% suicide cases and 11.4–20.0% of controls had some psychiatric pathology, accordingly to different definitions. Univariate conditional regression analysis showed that living in isolated houses (OR 2.48), living alone (OR 2.97), not being married (OR 2.63), low income (OR 2.73), psychiatric pathology (OR 9.70), psychotropic medication (OR 5.58), problems with relatives (OR 14.78), psychiatric family history (OR 5.67), and suicidal ideation (OR 15.61) were all risk factors. Practising religion (OR 0.27) was the only protective factor identified. Multivariate regression identified two independently and significantly associated variables namely, psychiatric pathology (OR 8.87) and living alone (OR 2.30).

Conclusions Results of this study showed, similarly to recent research, that not all suicide events are the results of psychiatric pathology. Prevention strategies should, therefore, target both socio-economic and clinical risk factors.

Keywords Suicide/statistics numerical data · Italy/epidemiology · Case–control studies · Risk factors · Rural population/statistics numerical data

Introduction

Suicide is an important public health problem which accounts for about 800,000 deaths worldwide each year [1]. Suicide occurs throughout the lifespan and is the second leading cause of death among 15–29 year olds globally. It is the consequence of a complex interaction of psychological, biological and social factors at both individual and environmental levels; this is reflected in large spatial and temporal variations in suicide occurrence, with up to tenfold differences in rates across countries [2].

Differences in suicide rates are also evident in Italy with a clear north–south gradient superimposed on higher rates in rural areas [3]. Tuscany, a region of central Italy, presents rates that are intermediate between those of the northern and southern regions and very similar to the national average (standardized rate in Italy 2009: 6.7; Tuscany 2009–2013; 6.7), with a male/female ratio of about 4/1 (male 11.9;

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female 2.6) [4]. However, even within a small geographical area such as Tuscany, wide variations in rates have been described. Increased risks for men in the rural areas of the region, particularly in southern Tuscany, have been noted since the 1970s [5, 6]. Southern Tuscany is an area of small medieval towns, hilltop villages and idyllic countryside with a chiefly agricultural economy; while the ancient mines of mercury on the extinct volcano of Mount Amiata and pyrite in Colline Metallifere (= Metalliferous Hills) were closed in the 1980s.

A suicide prevention project named "Montagna in Salute" (= Healthy Mountain) was promoted by the regional health department in collaboration with the UNCEM (Union of municipalities and local authorities of mountainous areas) in six rural districts between 2008 and 2015. The project included the institution of a regional as well as local committees to improve the care path of patients at high risk, a suicide crisis line (for the entire region with follow-up of people at high risk by local committees in the case of the six districts), a GP awareness campaign in the six districts (as general practitioners are often the first port of call for mental health problems), and a case–control study.

Case–control studies of suicide have usually used the method of the psychological autopsy interview with next of kin or other informants to identify differences in terms of risk factors between cases of suicides and appropriate controls [7–9]. Studies at individual level have highlighted that psychiatric illness, particularly a major mood disorder, is a leading risk factor for suicide [10, 11]; although most person with mental illness never attempt suicide. Other frequently reported clinical risk factors include alcohol use [12, 13], family problems [14], death of parents in childhood [15], divorce of parents in childhood [16], psychiatric family history [17], family history of suicide [18], previous attempt [19], suicidal ideation [20].

The objective of this study was to identify major individual risk factors related to suicides in six rural districts of Tuscany. More specifically, it tested the hypothesis that geographical isolation is related to suicide in rural areas.

Methods

Setting

The case–control study was conducted between August 2014 and December 2015 in six health districts of Tuscany (Amiata Grossetana, Amiata-Val d'Orcia, Casentino, Colline Metallifere, Lunigiana, Valdichiana Senese). A health district consists of an aggregation of neighbouring municipalities and is a subdivision of the local health board. Health districts are fairly homogeneous socio-economic areas, although there is considerable variation in their number of inhabitants. The six selected districts were all rural areas (i.e. low density of population) of the region and included 4 districts at high risk for suicide (highest quartile in 1997–2005: Amiata Grossetana, Amiata-Val d'Orcia, Colline Metallifere, Valdichiana Senese), one at average risk (second lowest quartile: Casentino), and one at low risk (lowest quartile: Lunigiana). The six districts were selected because either included in the mining area of Southern Tuscany at historical high risk (Amiata Grossetana, Amiata-Val d'Orcia, Colline Metallifere) or because local public health departments (Casentino, Lunigiana, Valdichiana Senese) asked to be involved in the project.

In each of the six districts, a project coordinator from the local health department was responsible to coordinate the data collection.

Sample size

Sample size calculations were based on a level of significativity of 95%, power of 80%, a minimum OR to detect of 2.0/1 and an exposure of 17% in the control group for psychiatric pathology, accordingly to a pilot test of the questionnaire in one district. More controls than cases were recruited (3:1 control to case ratio for the total sample) to maximise statistical power given the small number of cases in the catchment area that could be accrued over the study period. The intended sample size was determined in 121 cases and 363 controls. About 124 cases (and 372 controls) were estimated accordingly to mortality data over the previous 5-year period between 2009 and 2013.

Selection of cases and controls

Cases were identified as all 128 individuals whose cause of death was recorded as suicide (ICD-9: E950–E959) in the period between 1 January 2009 and 31 December 2013 among all legal residents of the six selected districts. People whose cause of death was undetermined (ICD-9: E980–E989) were not included. Data on the suicide episode (including method of suicide) were retrieved from the death certificate.

Controls were matched for age (year of birth ± 2), gender, and general practice. For each individual who died by suicide (and informants accepted to be interviewed), three living controls were selected as the next three suitable individuals from the alphabetic list of all patients of the same general practitioner starting from the next first letter of surname (to minimise relatives). There were eight controls who were not known to their GP and were substituted with the next suitable individual. One GP agreed to be interviewed for one case of suicide but then withdraw his availability to complete the interview also for the three controls identified in the practice list. These controls were not substituted.

Controls who had been eliminated from the GP practice list were excluded. Controls who had died for any reasons at the time of the interview with their GP were excluded as they were present in the lists only when they had not been promptly removed.

Interview techniques

The case–control study was based on the psychological autopsy method, which is a detailed retrospective collection of information about suicide victims through interviewing of key informants [21]. General practitioners were interviewed face-to-face by specifically trained staff (total number = 11) using a structured questionnaire for both cases and controls. Interviewers were not blind as to whether the interview related to a case or control. Informants were asked to refer to last 30 days before the episode for cases and to last 30 days before interview for controls.

The questionnaire included questions on two main domains: demographic and socio-economic characteristics (date of birth, sex, GP practice, place of birth, locality of residence, living arrangement, marital status, employment, income, and religion), and clinical factors (contact with GP previous 30 days, psychiatric pathology, use of psychotropic medication, alcohol use, problems with relatives, psychiatric family history, family history of suicide, death of parents when < 14 year old, divorce of parents when < 14 year old, previous attempt, suicidal ideation).

Data analysis

Frequencies were computed to assess the distribution of all variables in suicide and control groups, respectively. Each item was then dichotomised to facilitate the interpretation of results and calculate odds ratio. All analyses took account of a matched-pair design using data from cases and controls as matched pairs.

Univariate analysis was conducted by computing unadjusted matched odds ratio (OR) and their 95% confidence interval (95% CI) to compare the cases and controls with respect to different risk factors. The dependent variable was the case or control status and the independent variables were the hypothesized risk factors. Chi-squared test was used to test whether there was a significant difference between cases and controls. Yates correction was used in case of variables with a value of less than 5 in one or more cells.

Variables found to differ significantly between cases and controls (two-tailed $p < 0.05$, uncorrected for multiple controls) in the univariate analysis were then included in multivariate conditional logistic regression using forwards elimination procedures to identify risk factors independently associated with suicide. Explanatory variables with less than ten subjects in one or more cells were not fitted in these models, including the final model (Table 3), to avoid model instability [8].

All analyses were carried out using EpiInfo 7 software package (Centers for Disease Control and Prevention, 2014).

Sensitivity analysis

Mixing measures obtained from male and female and from the three districts of the mining area of Southern Tuscany at historical high risk (Amiata Grossettana, Amiata-Val d'Orcia, Colline Metallifere) with three other rural districts non-randomly selected (Casentino, Lunigiana, Valdichiana Senese) raised the risk of selection and information bias. Univariate analysis was then refitted by restricting the data to only the male cases and their matched controls in the three districts of the mining area of Southern Tuscany.

Results

Causes of death

Analysis of the death certificates showed that the most common methods of suicide were hanging or strangulation (43.8%), use of firearms (20.5%), jumping from height (15.1%), poisoning by solid or liquid substances (6.9%), drowning (1.4%), other injury, including sharp object (12.3%).

Recruitment

During the study period, a total of 72 informants for 91 cases of the 128 identified cases were interviewed (response rate: 71.1%). In total, 37 cases were lost because of reasons related to both cases (unknown to GP as registered but never attended: 3) or more commonly to informants (GP not consented or not available: 26; GP retired: 4; GP moved out of area: 1). It is important to notice that the response rate was higher than 66% in all districts except in Valdichiana (46.5%) were questionnaires were completed for only 20 of the 43 identified cases. This was due to delay of data collection into the winter season with limited time available by General Practitioners but possibly also because some GP in this district only formally joined the Project.

Description of cases and controls

Of the 91 cases, 73 (80.2%) were males and 18 (19.8%) were female with a gender ratio of 4.1–1. Distribution by age for cases and controls (Table 1) shows that 57.1% of cases and controls were 65 years of age or older. Table 2 shows distribution for case and control by age group of treated psychiatric disorder, psychiatric pathology according to their GP, psychiatric pathology and/or alcohol use according to their GP.

Table 1 Description of sample by age and sex

Age group	Male				Female				Total			
	Cases		Controls		Cases		Controls		Cases		Controls	
	N	%	*N*	%	*N*	%	*N*	%	*N*	%	*N*	%
25–34 years	1	1.4	3	1.4	2	11.1	6	11.3	3	3.3	9	3.3
35–44 years	5	6.9	21	9.7	3	16.7	8	15.1	8	8.8	29	10.7
45–54 years	13	17.8	29	13.4	3	16.7	9	17.0	16	17.6	38	14.1
55–64 years	10	13.7	34	15.7	2	11.1	6	11.3	12	13.2	40	14.8
65–74 years	15	20.6	39	17.9	1	5.6	5	9.4	16	17.6	44	16.3
75–84 years	19	26.0	59	27.2	2	11.1	5	9.4	21	23.1	64	23.7
85 years and over	10	13.7	32	14.8	5	27.8	14	26.4	15	16.5	46	17.1
Total	73	100.0	217	100.0	18	100.0	53	100.0	91	100.0	270	100.0

Table 2 Description of psychiatric pathology by age and sex

Age group	Sex	Psychotropic medication (except benzodiazepines and sleeping tablets)				Psychiatric pathology accordingly to their GP				Psychiatric pathology and/or alcohol misuse accordingly to their GP			
		Cases		Controls		Cases		Controls		Cases		Controls	
		N/Tot*	%	*N*/Tot*	%	*N*/Tot*	%	*N*/Tot*	%	*N*/Tot*	%	*N*/Tot*	%
25–64 years	Male	11/27	40.7	4/77	5.2	16/28	57.1	7/83	8.4	16/27	59.3	9/76	11.8
	Female	7/9	77.8	5/26	19.2	9/9	100.0	6/28	21.4	9/9	100.0	6/27	22.2
	Total	18/36	50.0	9/103	8.7	25/37	67.6	13/111	11.7	25/36	69.4	15/103	14.6
65 years and older	Male	12/42	28.6	12/126	9.5	21/43	48.8	17/129	13.2	23/39	59.0	26/124	21.0
	Female	4/6	66.7	8/24	33.3	6/7	85.7	9/24	37.5	6/7	85.7	9/22	40.9
	Total	16/48	33.3	20/150	13.3	27/50	54.0	26/153	17.0	29/46	63.0	35/146	24.0
Total	Male	23/69	33.3	16/204	7.8	37/71	52.1	24/213	11.3	39/66	59.9	35/201	17.4
	Female	11/15	73.3	13/50	26.0	15/16	93.8	15/52	28.9	15/16	93.8	15/49	30.6
	Total	34/84	40.5	29/254	11.4	52/87	59.8	39/265	14.7	54/82	65.9	50/250	20.0

*Excluded missing data

Univariate analysis

The univariate regression analysis of potential risk factors (Table 3) showed that living in isolated houses (OR 2.48), living alone (OR 2.97), not being married (OR 2.63), having low income (OR 2.73), being on psychotropic medication (OR 5.58), having problems with relatives (OR 14.78), psychiatric family history (OR 5.67), and suicidal ideation (OR 15.61) were all risk factors statistically significantly associated with suicide. Practising religion (OR 0.27) was the only protective factor identified.

Multivariate analysis

A final 'best fit' model (Table 4) identified two independently and significantly associated variables namely, psychiatric pathology (OR 8.87) and living alone (OR 2.30).

Sensitivity analysis

When restricting the analysis to only the 37 male cases and 111 male controls of the three districts of the mining area (Amiata Grossetana, Amiata-Val d'Orcia, Colline Metallifere), the patterns of association were similar (Table 1S); although with the restricted data, as expected, the observed odds ratios tended to be larger at the point that differences between cases and controls were not statistically significant for locality of residence, income, and psychotropic medication.

Discussion

This study is the first case–control study of suicides using the psychological autopsy method in Tuscany, while similar studies have recently been conducted in other areas of Italy [9, 22].

Table 3 Univariate conditional logistic regression analysis

Variable	Cases	Cases %	Controls	Controls %	OR (95% CI)	*p* value
Place of birth						
Outside Tuscany or Province of La Spezia	15	16.5	41	15.3	1.06 (0.56–2.01)	0.8482
Tuscany or Province of La Spezia	76	83.5	227	84.7		
Locality of residence						
Isolated houses	11	12.2	14	5.2	**2.48 (1.03–5.96)**	**0.0428**
Town, village or hamlet	79	87.8	253	94.8		
Living arrangement						
Living alone	25	29.1	32	12.3	**2.97 (1.61–5.49)**	**0.0005**
Living with other people	61	70.9	228	87.7		
Marital status						
Single, separated or divorced, widowed, living together as a couple	51	56.7	91	35.1	**2.63 (1.57–4.43)**	**0.0003**
Married	39	43.3	168	64.9		
Education						
Primary school or no education	36	45.0	83	35.9	2.45 (0.98–6.13)	0.0556
Secondary school or higher education	44	55.0	148	64.1		
Employment status						
Retired or unemployed	59	66.3	166	63.9	1.57 (0.72–3.41)	0.2552
Employed or student	30	33.7	94	36.1		
Income						
Low	26	43.3	61	27.4	**2.73 (1.29 5.77)**	**0.0088**
Medium–High	34	56.7	162	72.6		
Religion						
Practising	16	26.2	95	46.8	**0.27 (0.11–0.67)**	**0.0048**
Not practising or not religious	45	73.8	108	53.2		
Contact with GP in previous 30 days						
Yes	46	57.5	181	67.3	0.57 (0.31–1.06)	0.0769
No	34	42.5	88	32.7		
Psychiatric pathology						
Yes	52	59.8	39	14.7	**9.70 (4.99–18.33)**	**0.0000**
No	35	40.2	226	85.3		
Psychotropic medication (except benzodiazepines and sleeping tablets)						
Yes	34	40.5	29	11.4	**5.58 (2.76–11.30)**	**0.0000**
No	50	59.5	225	88.6		
Alcohol misuse						
4 or more unit/day	8	10.8	15	6.1	2.32 (0.80–6.79)	0.1233
3 or less unit/day	66	89.2	233	93.9		
Problems with relatives						
Yes	21	29.6	8	3.4	**14.78 (4.32–50.53)**	**0.0000**
No	50	70.4	227	96.6		
Death of parents when < 14 year old						
Yes	1	2.1	9	5.6	1.50 (0.14–16.54)	0.7406
No	46	97.9	151	94.4		
Divorce of parents when < 14 year old						
Yes	1	1.8	2	1.1	1.41 (0.09–23.57)	0.8092
No	55	98.2	174	98.9		
Psychiatric family history						
Yes	10	17.5	7	3.4	**5.67 (1.75–18.41)**	**0.0039**
No	47	82.5	199	96.6		

Table 3 (continued)

Variable	Cases	Cases %	Controls	Controls %	OR (95% CI)	*p* value
Family history of suicide						
Yes	4	7.4	0	0.0	2039451.21 (0.00–>1.0E12)	0.9577
No	50	92.6	204	100.0		
Previous attempt						
Yes	3	3.9	1	0.4	9.00 (0.94–86.46)	0.0570
No	73	96.1	248	99.6		
Suicidal ideation						
Yes	11	14.5	2	**0.8**	**15.61 (3.46–70.56)**	0.0004
No	65	85.5	247	**99.2**		

Statistically significant results are in bold

Table 4 Multivariate conditional logistic regression

Term	Odds ratio	95% CI		Coefficient	S. E.	Z-statistic	*p* value
Psychiatric pathology	8.87	4.46	17.64	2.1824	0.3509	6.2189	0.0000
Living alone	2.30	1.36	5.75	1.0280	0.3685	2.7897	0.0016

It is also one of the few studies that have been conducted exclusively in rural areas [23, 24], and to our knowledge the first that has used general practitioners as informants.

The psychological autopsy method has been widely used in previous studies and despite many methodological problems, it remains one of the most direct and effective methods for studying suicides [21].

The results of the study are consistent with previous psychology autopsy studies and showed that a number of socio-economic and clinical risk factors were associated with suicide in rural areas of Tuscany.

Locality of residence

Living in isolated houses (rather than in town, villages or hamlets) was an identified risk factor and seems to indicate a gradient of increased risk from towns to villages to isolated houses. A previous descriptive study using mortality data in Tuscany in 1988–2002 showed an increased risk for men (SMR = 132, $p < 0.05$) in municipalities with < 49 inhabitants/Km2 [6]. While, a subsequent multiple regression analysis of socio-economic correlates at level of the 34 health districts in 1997–2015 showed that isolated house was one of the variables included in the final model for men (along with low income and single person household) [25]. It was speculated that isolated houses represented a proxy measure of geographical isolation and remoteness which grasped not only the isolation due to living in municipalities with low density of population (as testified by its high simple correlation with this variable), but also the aspect of further remoteness of living in isolated houses within rural municipalities. The results of this case–control study seem to confirm this hypothesis.

There are a number of explanations for the excess of male suicides in rural Tuscany such as exposure to risk factors (e.g. alcohol), access to lethal suicide methods, availability of mental health services, as well as the role of cultural norms in rural and urban areas and the social fragmentation following the agricultural decline and the closure of the local mines [6].

Numerous different studies from various cultural contexts have similarly reported increased risk, for males in rural areas [26].

On the other hand, in case of female, previous research has shown an inverse increased risk in urban areas [6, 27].

Living arrangement

Living alone was a significant risk factor in the univariate analysis and one of the two risk factors in the multivariate model. It seems to reflect the large number of suicide of elderly men living alone in our sample. The association between living arrangement and suicide, particularly for the elderly, has been reported by other case–control studies [28–30] but others have not [8, 9, 31]. The mixed findings can be explained with the fact that living arrangements reflect local population density, housing prices and other local economic indicators.

Marital status

Not being married is a significant risk factor, which has been consistently reported [7, 28, 30, 32–34]. It has been

suggested that the association between living alone or not being married and suicide can be explained in terms of social isolation, cultural norms and stigma towards help-seeking as well as unemployment, and alcohol use [35].

Socio-economic status

Low income was significantly associated with suicide, while employment status and education were not significant probably because of the large proportion of retired people with low education in our sample. There is previous large evidence that suicide is highest in those groups most disadvantaged in society at both individual [28, 36, 37], and aggregate levels [27].

Religion

Practising religion was the only protective factor identified by the study. Similar results have been shown by other case–control studies [8], even after controlling for psychiatric pathology and socio-economic status [28] as well as by numerous studies at aggregate levels since the first famous study of Durkheim in 1897 [38]. It is accepted that religions with stronger affiliations may offer greater protection against suicide [27].

Psychiatric pathology and psychotropic medication

Among those who died by suicide, about 59.8% had some psychiatric pathology accordingly to their GP, and 40.5% had an established psychiatric diagnosis and were in treatment with psychotropic medication. On the other hand, only 14.7% of controls had some psychiatric pathology accordingly to their GP, and 11.4% were in treatment. The larger proportion of untreated psychiatric pathology (i.e. people considered to have a psychiatric pathology by their GP but not treated) among cases (32.3%) compared to controls (22.5%) might be indicative of some recall bias.

If we include in the definition of any mental disorders also our definition of alcohol misuse (4 or more unit/day) then about 65.9% of cases and 20.0% of controls had psychiatric disorders, alcohol misuse or both. It is worth noting that for the alcohol variable there were 17 missing value for cases (about 18.7% of all cases) and 23 missing values for controls (about 8.4% of all controls) which might point to same protection of the reputation of cases. Nevertheless, about 1/3 of all suicide cases in our sample did not have neither psychiatric pathology nor alcohol use.

Psychiatric pathology has been consistently reported as the most important risk factor in psychology autopsy studies since the first study in 1959 [39], which showed that more than 90% of suicide cases were determined to be mentally ill at the time of death. A systematic review of all 54 case series and 22 case–control studies carried out up to 2000 showed that 91% of suicide cases have psychiatric pathology in the case series; while for case–control studies the figure was 90% in cases and 27% in controls [40].

However, a more recent systematic review of psychological autopsy studies carried out between 2000 and 2010 found instead that only 33.3–62.9% of suicide cases had any form of psychiatric disorders diagnosis [41]. However, a considerable variation between countries was noticed with a higher proportion of suicide cases without mental disorders in India and China, particularly in rural areas. It was suggested that these differences between countries could be explained with increased socio-economic stressors, permissive cultural attitudes and effect of stigma on reporting of mental problems in Asian countries, particularly in rural areas. The only two studies in the western world reported in the review with a proportion of at least 30% suicide cases without a diagnosable mental disorders, were a study in the city of Budapest and the surrounding county of Pest (Hungary) [8], and a study in a mostly suburban area of Emilia-Romagna (Italy) [22]. Whilst, this proportion was 5–20% in other studies conducted in Europe and North America. Caution was, therefore, indicated in extrapolating the results of this most recent review to the western context and that further research from other areas was needed. Results of this study seem to suggest that the proportion of suicide cases without mental disorder is higher than 10% as previously suggested also in Europe, and particularly in rural areas.

Other clinical variables

Problems with relatives, psychiatric family history and suicide ideation were the only statistically significant factors among a number of variables regarding recent stressors, past psychiatric history, previous self-harm, family history and personal history (such death or divorce of parents when <14 year old). Only 17.5% of cases compared to 3.4% of controls had a known family history and only 14.5% of cases had expressed suicidal ideation compared to 0.8% of controls. These figures, which might have partially been inflated by the recall bias, highlight the difficulty to develop a suicide risk assessment tool based on clinical indicators.

Limitations

Results should be considered in the light of several limitations, particularly regarding both selection of cases (selection bias) and information gathered from informants (information bias).

There were a number of potential sources of selection bias in the study such as the non-random selection of the six districts, the exclusion of non-legal residents (because

usually not registered with a GP), the potential under-reporting of cases (but the inclusion of undetermined deaths didn't seem justified) [42], the response rate of 71.1% (and potentially that those excluded differed systematically from those included). Regarding the selection of controls, living controls were used in this study as in majority of similar studies. However, the exclusion of the most unwell potential controls might have resulted in wider differences between cases and controls. Selection of control, as described above, was not completely random; however, the strata where the three suitable controls were selected were very small of about 5–10 people and it was considered more important to promptly exclude family member with same surname in order of reducing possible overmatching. Similarly, systematic but not fully random selection of controls has been used in previous studies [7].

Regarding sources of potential information bias, proxy interviews were obtained with only one informant rather than two informants as recommended because of resources available [21]. However, it is the type of informant rather than the number of informants that is important [43]. It is generally assumed that the closer the key informant's relationship to the subject, the better is the quality of subjects' personal details. It should be noted that in Italy, there is usually a general practitioner for about 800–1000 people and particularly in rural areas, patient have been registered for as long as 20–30 years with the same GP, who often represents the only confident of elderly people, particularly of those living alone. Recall bias, which is the difference in recollection regarding past facts and events for cases and controls, is the most common problem with case–control studies. To partially overcome recall bias, we asked the GP to refer to 30 days before the event for cases and to 30 days before the last GP visit for controls; therefore, this time was generally closer to the time of interview for controls. It is also evident from Table 2 that there are missing values on almost every variable which highlight the fact that not always GPs were able to answer all questions (and potentially not the best informant in this type of study). Moreover, interviewers were not blind as it was very difficult in practice to disguise if the interview was about a case or a control. It is recommended that more than one interviewer should interview the same informant [21], but this was not possible due to lack of resources.

Another potential problem in case–control studies is that of overmatching. Cases and controls were matched on gender, age and area of residence. Some variables such as religion, ethnicity and socio-economic status are correlated with the area of residence. Hence matching on residence may have resulted in 'over-controlling', leading to a tendency to underestimate the strength of potential associations for those variables that are correlated with residence.

Finally, the study seems to be underpowered for those rarer risk factors (such as previously reported clinical factors or alcohol use, which is a culturally undervalued risk factor in the Italian context, even by GPs) or where the difference between cases and controls is less marked (possibly being born outside of the region).

Conclusions

There are two main domains of suicide risk factors: socio-economic (e.g. living alone) and clinical (psychiatric pathology).

This study showed an increased risk of suicide for people living in isolated houses and for people living alone, which suggests, in light of previous research, that social fragmentation with geographical and social isolation is an important aspect to explain the occurrence of suicide in rural Tuscany.

About 1/3 of all suicide cases did not have any psychiatric pathology and/or alcohol use at the time of the event. This finding is consistent with most recent research that at least 1/3 of suicide victims did not have psychiatric pathology and in contrast with the previous view that all or almost all (i.e. 90%) suicides are due to mental disorders. This study seems to confirm that also in Europe, particularly in rural areas, as much as about 30% of suicide cases have no psychiatric disorder at time of death. A concept of predicament suicide as an escape from unsustainable position with intolerable psychological pain either due to mental disorder and/or to socio-economic stressors has been recently developed to account for this new view [44]. Likewise, WHO has recently listed the assumption that "only people with mental disorder are suicidal" as one of the myths of suicide [1].

In conclusion, results of this study support prevention strategies of suicide that targets both socio-economic and clinical risk factors in a comprehensive and multilevel approach [45].

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Author contributions GB, MM and GC took a leading role in the conception and design of the study. GB, GC and DL organised the study, including obtaining ethics approval, and coordinated the data collection. MM completed the data entry, performed statistical analysis and interpretation of results, and wrote the initial draft of the manuscript. GC and DL contributed to the critical review of the manuscript. Authors read and approved the final manuscript.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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