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Research report

Preference of lethal methods is not the only cause for higher suicide rates in males

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ABSTRACT

Background: In most countries worldwide suicide rates are higher for males whereas attempted suicide rates are higher for females. The aim is to investigate if the choice of more lethal methods by males explains gender differences in suicide rates.
Methods: Data on completed and attempted suicides were collected (n = 3235, Nuremberg and Wuerzburg, years 2000–2004). The research question was analyzed by comparing the method-specific case fatality (= completed suicides / completed + attempted suicides) for males and females.
Results: Among the events captured, men chose high-risk methods like hanging significantly more often than women ($\varphi = -0.27$; $p < 0.001$). However, except for drowning, case fatalities were higher for males than for females within each method. This was most apparent in "hanging" (men 83.5%, women 55.3%; $\varphi = -0.28$; $p < 0.001$) and "poisoning by drugs" (men 7.2%, women 3.4%; $\varphi = -0.09$; $p < 0.001$).
Limitations: The sample size (n = 3235) was not enough for comparing method and gender specific case fatalities with a fine-meshed stratification regarding age.
Conclusions: Higher suicide rates in males not only result from the choice of more lethal methods. Other factors have to be considered.

1. Introduction

Approximately 1 million people worldwide die of suicide every year and the number of attempted suicides is estimated to be 10 to 20 times higher (World Health Organization, 2003). In Europe and most countries rates of completed suicides differ profoundly by gender with a global average male/female ratio of 2.9:1 (Värnik et al., 2008). Opposite to the rate of completed suicides, females outnumber males with respect to the number of attempted suicides. Results from the WHO/EURO Multicentre Study on parasuicide show a male/female ratio for non-fatal suicide acts of 1:1.5 (Schmidtke et al., 1996). Given the high numbers of annual suicides, prevention has been an important issue worldwide. In Western countries, high male suicide rates are of specific concern. Thus, an essential matter for improving suicide prevention is to find out more about the reasons for gender differences in suicide and especially about suicide patterns in males.

Several reasons for gender differences in suicidal behavior have been discussed. Depression as a major cause of suicidality (Bertolote and Fleischmann, 2002; Lönnqvist and Koskenvuo, 1988) has about half the prevalence in males compared to females. This could be a contributing factor to the lower rates of suicidal acts in total (completed + attempted suicides) in

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males, but does not explain why more males have higher completed-suicide rates. Further factors possibly contributing to the high male suicide rate are psychosocial factors: men are more reluctant to seek professional help compared to women when feeling depressed, hopeless or suicidal (Houle et al., 2008; Möller-Leimkühler, 2003), they often have less social support than women (Houle et al., 2005, 2008), unemployment seems to be a major threat especially to males (Andres et al., 2010; Stuckler et al., 2009), and a strong link between alcohol dependence and depression in men increases their suicide risk (Houle et al., 2008; Möller-Leimkühler, 2003). Furthermore, the choice of more or less lethal methods appears to be an important factor. While males in total carry out less suicidal acts, they choose more high-risk methods than women as shown by various studies (Hawton, 2000; Houle et al., 2008; Large and Nielssen, 2010; Schrijvers et al., 2011). High-risk methods have been defined as being more violent and immediately lethal in comparison to low-risk methods (Denning et al., 2000). Methods with the highest case fatality are firearms and hanging. In a recent study analyzing 16 European countries, Värnik et al. (2008) have shown that males are at greater risk of choosing highly lethal suicide methods such as hanging and firearms whereas females are at less risk with mostly choosing self-poisoning.

Additionally, age patterns seem to play an important role in suicidal behavior. In Germany, suicide rates follow the so-called Hungarian pattern, with higher numbers of completed suicides within the elderly, specifically males (Schmidtke et al., 2008). However, in other parts of Europe, e.g. in Scandinavian countries and Poland, suicide rates are highest between the ages of 45–55 years (Lester, 1982). Importantly, the age at which a suicidal act is carried out influences case fatality. For instance, self-poisoning with psychotropic drugs might be survived by a young person, but can be lethal at an older age. Thus, age needs to be taken into account when disentangling the factors explaining gender differences in suicidality.

If the preference for certain methods is the dominant factor explaining gender differences in suicide rates, then within the same method case fatalities should be similar in males and females, even after accounting for age effects (highest rates of attempted suicides in young females, highest rates of completed suicides in old males). If case fatalities differ by gender, other factors beyond the choice of method must be considered to explain higher male suicide rates.

We wanted to investigate why completed suicides occur more frequently in males although the number of suicidal acts in total is higher in females. Thus, we analyzed whether the choice of methods fully explains higher rates of completed suicide in males answering the following questions: 1. Are there gender differences in case fatality within the same suicide method? 2. Can possible gender differences in case fatality be explained by the influence of age?

2. Methods

Data used in the present study were assessed during a suicide prevention project, the “Nuremberg Alliance Against Depression”, “a 2-year, four-level, multifaceted, community-based intervention with evaluation with respect to both a baseline year and a control region” (Hegerl et al., 2006; p. 1230). The data on completed and attempted suicides from 2000 to 2004 were collected in the city of Nuremberg (480,000 inhabitants) and the region of Wuerzburg (260,000 inhabitants) in Bavaria, Germany. This study aimed at a stable data assessment over the time in order to discover changes in rates of attempted suicides. It was not the aim of the project to achieve a complete coverage of suicide data (Hegerl et al., 2006).

In the course of this project, Nuremberg was selected as the intervention region since size and infrastructure of this city appeared adequate and large central hospitals as well as active and cooperative practice networks could help facilitate the assessment of suicidal acts. Wuerzburg was selected as a control region because this region is characterized by a good infrastructure for the assessment of suicide attempts and participated in the WHO/EURO Multicentre Study on Suicidal Behaviour (Schmidtke et al., 1996). Furthermore, the baseline suicide rate in Wuerzburg (20.22 per 100,000) in 2000 was comparable to the baseline suicide rate in Nuremberg (20.48 per 100,000).

For the present study, the corresponding data from these two areas have been aggregated in order to obtain a sufficiently high number of analyzable suicidal acts. Regarding attempted and completed suicides, this study represents a prospective longitudinal cohort study of routine data collected from two urban regions. Due to anonymization of data concerning attempted and completed suicides, the study addresses selected cases and not individuals.

2.1. Case definition: completed suicides

Data on completed suicides including suicide method as coded by ICD-10 (International statistical classification of diseases; tenth revision), gender and age-group were received from the Bavarian State Office for Statistics and Data Processing. Completed suicide cases with minimum age 18 years (age limit for adulthood in Germany) were selected for the study. For reasons of data protection no personal identifiers were included. Suicide reporting is subject to federal authorities in Germany. Post mortem examinations in Germany have to be performed by a physician. The physician determines the cause of death and lists it according to the X-codes in ICD-10 on the death certificate. In case of evidence for unnatural deaths due to external impact or unexplained causes of death the police have to be informed. All death certificates are administered by the local health authorities. The corresponding data are forwarded to the State Offices for Statistics and Data Processing for further analysis, assigning ICD-10 X codes (see section ‘Method classification’) and the place of residence of the dead person. Thus, only cases with a residential address in the State are registered, excluding e.g. illegal migrants. In the end, the data are transmitted to the German Office for Statistics and Data Processing.

How many suicides in Bavaria were actually recorded as ‘undetermined’ by mistake has not been investigated so far by other studies. However, in order to control this possible confounding factor, we examined whether suicide mortality in Bavaria (between 2000 and 2004) was influenced by the number of undetermined deaths in this time interval (see Table 1).

Time trends in the observation period from 2000 and 2004 for suicides and undetermined deaths (ICD-10 codes: Y10–Y34) were analyzed using Poisson regression models

Table 1
Death-case related suicide rates (SR), undetermined death rates (UDR) and total rates (SR + UDR) from 2000 to 2004 in Bavaria.

	2000	2001	2002	2003	2004
Total number of death cases in Bavaria	118,846	117,930	119,755	121,778	116,460
Suicides[a] (%)	1959	1904	1870	1822	1841
(95% C.I.)	(1.65)	(1.61)	(1.56)	(1.50)	(1.58%)
	(1.58–1.72)	(1.54–1.69)	(1.49–1.63)	(1.43–1.57)	(1.51–1.65)
Undetermined death cases[b] (%)	79	144	169	133	129
(95% C.I.)	(0.07)	(0.12)	(0.14)	(0.11)	(0.11)
	(0.05–0.08)	(0.10–0.14)	(0.12–0.16)	(0.09–0.13)	(0.09–0.13)
Suicides + undetermined death cases (%)	2038	2048	2039	1955	1970
(95% C.I.)	(1.71)	(1.74)	(1.70%)	(1.61%)	(1.69%)
	(1.64–1.79)	(1.66–1.81)	(1.63–1.78)	(1.54–1.68)	(1.62–1.77)

Notes: 95% C.I. = 95% confidence interval.
[a] Definition according to the ICD-10 codes X60–X84.
[b] Definition according to the ICD-10 codes Y10–Y34.

with the death-case related event rates for suicides or undetermined deaths as outcome variables. Based on the regression equation

$$\text{Log}(\text{event rate}) = \alpha + \beta * Year + \varepsilon$$

(with Year as the year of the event in the sense of a linear term) the average annual percentage change (AAPC) of the event rate was calculated according to the formula

$$AAPC = [\exp(\beta) - 1] + 100$$

(Baumert et al., 2005).

Using Poisson regression, it was next tested whether the AAPC value significantly differed from zero.

The trend for suicides revealed a statistical tendency for decreases of the rates between 2000 and 2004 (AAPC = −1.57; p = 0.07). Overall, a slight decline was also apparent for suicide rates + undetermined deaths, albeit not being significant (AAPC = −1.00; p = 0.14). Thus, time trends of the suicide rates and the total rates (suicide rates + undetermined deaths) were similar over a 5-year time period (2000–2004) and it is unlikely that the assessment of suicide mortality in Nuremberg and Wuerzburg was influenced by the number of undetermined deaths.

2.2. Case definition: attempted suicides

Attempted suicides were defined according to the WHO definition of parasuicide as "an act with a nonfatal outcome, in which an individual deliberately initiates a non-habitual behavior that, without intervention from others, will cause self-harm, or deliberately ingests a substance in excess of the prescribed or generally realized therapeutic dosage, and which is aimed at realizing changes which the subject desired via the actual or expected physical consequences" (Bille-Brahe et al., 1997). Assessment was performed in cooperation with all institutions where individuals were treated after the suicide attempt. Mainly, data on attempted suicides were collected in all local hospitals in the study area including psychiatric wards. Further data were collected from existing crisis intervention and health centers and from a sample of psychiatric practices (approximately 40% of the practices were willing to cooperate). Overall, 26% of recorded attempted suicides were identified in Emergency Rooms, 32% in Psychiatric Hospitals and their acute day wards, 24% in crises intervention centers, 12% in psychiatric practices, 4% in local health care centers and 2% in both Emergency rooms and local health services.

This assessment makes no claim to be complete, rather to be a stable assessment over time and to represent an extract of the public health services structure. This type of data collection is limited to individuals seeking medical or psychological treatment after a suicide attempt. Although medical care is widely accessible in Germany, a certain number of suicide attempters are assumed not to seek medical attention and therefore do not appear in the statistics.

Data were collected during routine clinical work-ups of suicide survivors using an adapted version of the monitoring form of the WHO/EURO Multicentre Study on Parasuicide (Schmidtke et al., 1996). Physicians and nurses in general hospital emergency rooms, general practices, crisis intervention centers and health centers as well as employees in other public sectors (like police officers) participated in the data collection. The monitoring form for each suicide attempt included a pseudonymized code in order to impede double count of cases. To ensure reliability in data collection, the number of participating institutions was kept constant, data assessment was continuously supervised and the informants received detailed instructions for the data collection. Classification of undetermined intention cases was based on observations made by medical personnel and not only on the self-report of study subjects. Besides using WHO criteria of parasuicide, records of attempted suicides were based on medical impression, such that a case could be selected as attempted suicide if all aspects were suggesting so even when the study subject denied intent. The few unclear cases were marked as undetermined intention cases and excluded from the study population.

The annual incidence rates for suicides and attempted suicides in the study population are presented in Table 2.

Suicide incidence rates tended to decrease (average annual percentage change = −4.96; p = 0.09) and incidence rates for attempted suicides decreased significantly from 2000 to 2004 (average annual percentage change = −10.79; p < 0.001). These results can, in part, be explained by earlier work with an intervention in the Nuremberg area with demonstrable reduction in suicidal acts (Hegerl et al., 2010). The findings of this earlier study also demonstrate that the variation in rates

Table 2
Annual incidence rates for suicides and attempted suicides in the study population (city of Nuremberg; city and region of Wuerzburg) from 2000 to 2004.

	2000	2001	2002	2003	2004
Study population (N)	732,612	738,230	743,320	745,495	749,037
Suicides[a] (‰[b])	158	117	129	130	122
(95% C.I.)	(0.22)	(0.16)	(0.17)	(0.17)	(0.16)
	(0.18–0.25)	(0.13–0.19)	(0.15–0.21)	(0.15–0.21)	(0.14–0.19)
Attempted suicides (‰[b])	621	558	527	498	372
(95% C.I.)	(0.85)	(0.76)	(0.71)	(0.67)	(0.50)
	(0.78–0.92)	(0.69–0.82)	(0.65–0.77)	(0.61–0.73)	(0.45–0.55)

Notes: 95% C.I. = 95% confidence interval.
[a] Definition according to the ICD-10 codes X60–X84.
[b] Population standardized rate.

of suicide and suicidal acts is not explained by cyclical variation in the data.

2.3. Method classification

Data on completed and attempted suicides were coded according to the ICD-10 X-diagnoses. We classified different types of methods of self-harm according to ICD-10 terms and according to the specification of other studies (Elnour and Harrison, 2008; Värnik et al., 2008). Suicide methods were re-categorized by nine groups: poisoning by drugs (X60–X64), poisoning by other means (X65–X69), hanging (X70), drowning (X71), firearms (X72–X74), cutting by sharp objects (X78), jumping from high places (X80), lying in front of a moving object (X81) and other methods (X75–X77, X79, X82–X84).

The average risk of death within a certain suicide method will be referred to in this paper as case fatality. The case fatality for each suicide method was estimated by dividing the number of completed suicides for a given method by the sum of completed and attempted suicides for that method.

For comparison of men and women in their tendency to use lethal or less lethal methods, we generated two groups of methods by using the median as a cut-off point: "high-risk" and "low-risk" methods. The median of all method-specific case fatalities in this study is 50.0% (high-risk ≥50%, low-risk <50%). Hence, poisoning by drugs, poisoning by other means, cutting with sharp objects and other methods were defined as low-risk-methods and firearms, hanging, drowning, lying in front of a moving object and jumping are defined as high-risk-methods.

2.4. Statistics

To compare methods by gender, cross tables were created depicting associations between completed and attempted suicides. Differences in the proportion of completed and attempted suicides were tested for significance by the non-parametric χ^2-test. The corresponding effect sizes were phi coefficients (φ). In order to find significant predictors of case fatality, a multivariate binary logistic regression analysis was computed. Independent variables were age (in 5 year age bands), gender (reference category: female), year of the suicidal act (2000–2004; reference category: 2000), city (Nuremberg/Wuerzburg; reference category: Wuerzburg), suicide methods (reference category: poisoning by drugs), the interaction of "age" and "gender" and the interaction of the factors "year" and "risk of suicide methods" (high versus low). This interaction was implemented in the regression analysis given the fact that reports of high-risk suicide attempt methods decreased by 47% and reports of low-risk suicide attempt methods by only 15% (Hegerl et al., 2006). Whether these changes over time had an impact on case fatalities was also investigated. To answer whether a possible age-dependency of gender differences in case fatalities was associated with suicidal acts, the interaction of the three factors "age", "gender" and "suicide method" was inserted into this multivariate model. The case fatality in the sense of a binary classification of suicidal acts (completed suicide versus attempted suicide) was used as dependent variable.

Statistical analysis was performed using SPSS 15.0 for Windows (SPSS Inc.; Chicago, Illinois, USA). Alpha was set at 0.05.

2.5. Ethics review

The study was approved by the ethics committee of the Ludwig-Maximilians-University of Munich and is in accordance with the guidelines laid down in the 1964 Declaration of Helsinki.

3. Results

In Nuremberg and Wuerzburg 3235 cases of suicidal acts occurred during the study time, 656 completed suicides and 2579 attempted suicides. In total, there were 1766 women and 1469 men. Similar to national data and data of previous studies, men had higher rates of completed suicides (n = 478, 72.9%, 95% C.I.: 69.3%–76.2%) than women (n = 178, 27.1%, 95% C.I.: 23.8%–30.7%). Females had higher rates of attempted suicides (n = 1588, 61.6%, 95% C.I.: 59.7%–63.5%) than males (n = 991, 38.4%, 95% C.I.: 36.5%–40.3%).

3.1. Case fatality of suicide methods

The number of methods used and their case fatality are described in Table 3. Firearms and hanging were the most lethal methods with a case fatality over 77%. Least lethal methods were poisoning by drugs and cutting with a sharp object. In proportion to the total number of cases, highly lethal methods accounted for a small percentage of suicidal acts, but for a high percentage of completed suicides.

Table 3
Case fatality for each suicide method.

Suicide method	Completed suicides	Attempted suicides	Total number	Percentage of total cases	Case fatality (in %)
Poisoning by drugs (X60–X64[a])	85 (12.9%)	1736 (67.7%)	1821	56.6%	4.7
Poisoning by other means (X65–X69)	29 (4.4%)	116 (4.5%)	145	4.5%	20.0
Hanging (X70)	259 (39.5%)	77 (3.0%)	336	10.4%	77.1
Drowning (X71)	32 (4.9%)	18 (0.7%)	50	1.6%	64.0
Firearms (X72–X74)	53 (8.1%)	15 (0.6%)	68	2.1%	77.9
Sharp object (X78)	25 (3.8%)	408 (15.9%)	433	13.4%	5.8
Jumping (X80)	117 (17.8%)	117 (4.6%)	234	7.3%	50.0
Moving object (X81)	39 (5.9%)	24 (0.9%)	63	2.0%	61.9
Other methods	17 (2.6%)	53 (2.1%)	70	2.1%	24.3
Total	656	2564	3220	100%	20.4

[a] Definition according to ICD-10.

3.2. Gender differences in choice of methods and case fatality

Men chose high-risk methods significantly more often compared to women (70% vs. 30%) and low-risk methods less frequently (30% vs. 70%; $\varphi = -0.27$; $\chi^2 = 230$, df = 1; $p < 0.001$).

Next, gender-specific case fatalities per method were analyzed.

Overall, the case fatality in men (32.5% (478/1469)) was significantly higher than in women (10.1% (178/1766)) ($\varphi = -0.28$; $\chi^2 = 250.23$, df = 1; $p < 0.0001$).

The case fatality was numerically lower for females in every method except for drowning (see Table 4). For five suicide methods this difference was statistically significant: hanging: men: 83.5%; women: 55.3% ($\chi^2 = 26.47$, df = 1; $p < 0.001$), poisoning by drugs: men: 7.2%; women: 3.4% ($\chi^2 = 13.36$, df = 1; $p < 0.001$), poisoning by other means: men: 28.2%; women: 12.2% ($\chi^2 = 5.80$, df = 1; $p = 0.02$), using sharp methods: men: 8.6%; women: 2.5% ($\chi^2 = 7.45$, df = 1; $p = 0.006$) and moving objects: men: 70.8%; women: 33.3% ($\chi^2 = 6.82$, df = 1; $p = 0.009$). No statistically significant differences were found for drowning: men: 61.1%; women: 65.6% ($\chi^2 = 0.10$, df = 1; $p = 0.75$).

Table 4
Gender differences in case-fatality per method of suicidal acts.

Suicide method[a]	Case-fatality (ratio completed suicides/total episodes)			
	Men	Women	φ	χ^2 test p
Poisoning by drugs (X60–X64)	7.2 (44/610)	3.4 (41/1211)	−0.09	0.0003
Poisoning by other means (X65–X69)	28.2 (20/71)	12.2 (9/74)	−0.20	0.016
Hanging (X70)	83.5 (217/260)	55.3 (42/76)	−0.28	<0.0001
Drowning (X71)	61.1 (11/18)	65.6 (21/32)	0.05	0.752
Firearms (X72–X74)	78.8 (52/66)	50.0 (1/2)	−0.12	0.349[b]
Sharp object (X78)	8.6 (20/232)	2.5 (5/201)	−0.13	0.0063
Jumping (X80)	55.0 (72/131)	43.7 (45/103)	−0.11	0.0869
Moving object (X81)	70.8 (34/48)	33.3 (5/15)	−0.33	0.0091
Other methods	28.6 (8/28)	21.4 (9/42)	−0.08	0.493

Notes: χ^2 test: statistic from χ^2 tests based on two-by-two tables (gender (male/female) × suicide (yes/no)). φ: phi coefficient.
[a] Definition according to ICD-10.
[b] Based on Fisher's exact test (two-sided).

3.3. Results of regression analysis

A multivariate binary logistic regression analysis was computed to identify significant predictors of case fatality rate. In the model, sociodemographic variables and suicide methods explained 57% of variance in case fatality rate ($R^2 = 0.57$; $p < 0.001$). Higher age, male gender and the control region (Wuerzburg) were significant predictors for case fatality rate of a suicidal act (see Table 5). While the case fatality rate was 24.8% in Wuerzburg, it was only 18.6% in

Table 5
Predictors of case fatality of suicidal acts according to the results of a multivariate binary logistic regression analysis.

Independent variables	p	Odds ratio (OR)	95% C.I. OR	
			Lower limit	Upper limit
Age	<0.001	1.17	1.12	1.23
Sex (ref = female)	<0.001	2.55	1.57	4.15
Age * sex	0.90	–	–	–
Age * sex * suicide method	0.38	–	–	–
City (ref = Wuerzburg)	<0.001	0.61	0.47	0.80
Year of the suicidal act (ref = 2000)	0.07	–	–	–
2001	0.80	1.07	0.63	1.84
2002	0.97	0.99	0.56	1.75
2003	0.33	1.31	0.76	2.24
2004	0.01	1.98	1.15	3.42
Year * risk of suicide methods (high/low)	0.44	–	–	–
2001 by risk (reference = low)	0.24	1.59	0.74	3.41
2002 by risk (reference = low)	0.99	1.00	0.48	2.09
2003 by risk (reference = low)	0.75	1.13	0.53	2.38
2004 by risk (reference = low)	0.39	0.72	0.34	1.54
Suicide method (ref = poisoning by drugs)	<0.001	–	–	–
Poisoning by other means	<0.001	3.46	1.72	6.92
Firearms	<0.001	12.45	2.84	54.54
Hanging	<0.001	46.25	24.15	88.55
Drowning	<0.001	29.63	12.12	72.42
Cutting by sharp objects	0.40	0.73	0.35	1.51
Jumping from high places	<0.001	17.32	9.22	32.54
Lying in front of a moving object	<0.001	23.76	9.11	62.02
Other methods	<0.001	5.86	2.58	13.31

Notes: CI: confidence interval. The dependent variable is the case fatality, an individual-level variable and the independent variables are also individual-level variables.

Nuremberg ($\chi^2 = 15.17$, df = 1; $p < 0.001$). Compared to poisoning with drugs as a reference category, all other suicide methods (besides cuts and stabs) were associated with significantly higher case fatality rate of suicidal acts. A non-significant trend with time on case fatality rates was observed (Wald statistic = 8.61; df = 4; p = 0.07).

4. Discussion

4.1. Main findings

Consistent with prior studies (Denning et al., 2000; Elnour and Harrison, 2008; Kposowa and McElvain, 2006), suicidal acts were associated with higher lethality in males than in females. Since underlying reasons are only partly understood, gender differences in case fatality with respect to different methods were analyzed. It was found that for all suicide methods except for drowning case fatality was higher in men. This was most apparent for methods like hanging (men: 83.5%; women: 55.3%) and lying in front of moving objects (men: 70.8%; women: 33.3%). Even the low-risk method "poisoning by drugs" was significantly more lethal for men (7.2%) than for women (3.4%). It can be speculated that the real case fatalities in women were even lower than reported here since low-risk suicide attempt methods dominate in this subgroup and are often overseen. If males use less lethal methods like poisoning more lethally than females, there is a higher likelihood of a male self-poisoning attempt being reported than a female one. Thus, the male excess of females in case fatality of low lethal methods can be assumed to be actually higher than estimated.

Since in Germany and other countries males perform suicidal acts at an older age than females (Schmidtke et al., 2008) it could be argued that the decreasing physical robustness in older people can be expected to lead to a higher probability of a lethal outcome. Indeed, age had a significant effect on case fatality in our study. Further analyses, however, showed that gender differences were independent from age, as revealed by a non-significant interaction of the factors "age" and "gender" in predicting case fatality. Moreover, the interaction of the factors "age", "gender" and "suicide method" was also not significant in the model, indicating that age did not have a significant influence on gender differences in case fatalities, regardless of suicide method used. Thus, frailty alone does not explain the higher case fatalities of suicidal methods in men.

It has to be acknowledged that due to the reducing effect of the 4-level intervention on suicidal acts using high risk methods in Nuremberg (Hegerl et al., 2006), direct effects on case fatalities within high risk methods are conceivable. We considered this in the conducted regression analysis. As the analysis did not show a significant interaction between year and risk of method, it can be assumed that these effects are too small to impact our findings. Further, the extent to which completed suicides may have been missed by excluding undetermined deaths had to be controlled. Our analysis demonstrated that time trends of suicide rates and total rates (suicide rates + undetermined deaths) were similar over a 5-year period (2000–2004) in Bavaria, making it unlikely that the assessment of suicide mortality in Bavaria was influenced by the number of undetermined deaths. However, there might have been a bias in categorizing suicides versus undetermined deaths in our study.

Regarding attempted suicides, the determination of suicidal intent was made on the basis of medical observation and self-report. Previous studies have demonstrated that suicidal males are more likely to deny intent during treatment of injury (Houle et al., 2005). Hence, we included information beyond self-report to prevent misclassification of male attempted suicides as accidental.

Importantly, the double count of attempted suicide cases was impeded but there was no subject-based interpretation of attempted suicides. Thus, we cannot exclude that some patients appear more than once in the study dataset due to experiencing multiple attempted suicides during the study. In this case, a subject based interpretation would have let to less attempted suicide cases than our event based interpretation. For future research, it needs to be discussed whether a subject or an event based interpretation is more plausible.

Our results are comparable to those previously reported by a few studies including both attempted and completed suicides for assessment of method-specific case fatalities (Elnour and Harrison, 2008; Miller et al., 2004; Shenassa et al., 2003; Spicer and Miller, 2000). These studies were conducted in the United States and in Australia using administrative hospital discharge data as information sources for attempted suicides. Elnour and Harrison (2008) have shown higher case fatalities for different suicide methods in males and older age groups in their study. Differences in gender were found to be significant except for jumping/lying before a moving object. Others have demonstrated similar results. Miller et al. (2004) underlined however that the choice of method is an important factor, because highly lethal methods like firearms and hanging have a higher probability of resulting in death. Regarding the choice of method, Spicer and Miller (2000) confirmed gender differences in case fatality after stratification by method and also Shenassa et al. (2003) found significant differences in case fatality between males and females.

Summarizing, our results and those of the few previous studies can be seen as similar and continuous over different sample sizes and research locations. This finding confirms that beyond the choice of method (Large and Nielssen, 2010), the modus operandi of a method is crucial for the result of a suicidal act. Accordingly, identification of factors that contribute to higher case fatalities among men is crucial to further elucidate the underlying reasons of higher male suicide rates.

Possible reasons for higher lethal behavior in males may be a stronger intent to die, a higher threshold for help-seeking, a possible social isolation resulting in a lower chance to be rescued, more aggressive, impulsive personality traits, the involvement of alcohol and the role of unemployment. Some studies have provided evidence that a high level of suicidal intent is an important predictor of completed suicide, of which males are at risk, underpinning the impact of the intention to die on case fatality (Suominen et al., 2004). Less help-seeking behavior in men may also influence their attendance to psychiatric services. Up to 90% of suicides occur in the context of a psychiatric disorder (mainly depression, schizophrenia and substance-related disorders) (Hawton and van Heeringen, 2009; Lönnqvist and Koskenvuo, 1988). Untreated psychiatric disorders could amplify the intent to die and

subsequently affect case fatalities (Murphy, 1998). Other studies further show that the traditional masculine gender role increases risk of suicide in males, as the typical role performance reduces help-seeking behavior (Möller-Leimkühler, 2003). Thus, not only the chance for help before suicide is attempted is lower in men, but also the chance of being found and saved after the suicide attempt (Houle et al., 2008; Möller-Leimkühler, 2003). Additionally, studies have shown a strong relationship between aggression and case fatality in males (Baca-Garcia et al., 2006), often modified by the influence of alcohol. Alcohol fosters emotional disinhibition which can lead to more lethal suicidal behavior (Möller-Leimkühler, 2003). Also, unemployment and other economic factors could play a more life threatening role in males than in females. As shown in several countries, suicide and unemployment are highly correlated (Stuckler et al., 2009). Nevertheless, it remains unclear whether the association of unemployment and suicide in men is stronger compared to women (Andres et al., 2010; Stuckler et al., 2009). Even if these reasons do plausibly contribute to the explanation of gender differences, our results may as well reflect gender differences in the capacity to successfully implement particular methods varying in between gender. It is noteworthy that for two methods that require little in the way of technical skills (drowning and jumping from a height), gender differences in case fatality are slight. On the other hand, this assumption does not explain the significant difference in case fatalities within the method poisoning. Lacking data about the influence of technical skills, studies indicate the importance of accessibility to methods (Kanchan et al., 2009).

4.2. Limitations and strengths

A limitation of our study is the sample size (n = 3235) which is not enough for comparing method and gender specific case fatalities with a fine-meshed stratification regarding age. Case fatalities were calculated from attempted suicides assessed within the project Nuremberg Alliance Against Depression. This project aimed at a stable and representative, but not complete assessment of suicide attempts over time. While all major institutions where patients were treated after a suicide attempt cooperated closely, a number of attempted suicides occurred outside of this cooperation network. This leads to the relatively low number of suicide attempts, with a ratio of attempted to completed suicides of approximately 4:1. Most studies indicate a ratio of 10:1 or even more. Still, the assessed attempted suicides show comparable patterns to other data concerning attempted suicides. As in other samples, e.g. women are at higher number, choose less lethal methods like poisoning and are younger compared to samples regarding completed suicides.

Another limiting factor could be the higher threshold of males in seeking help, e.g. men might be less likely to present to hospital after a suicide attempt. We cannot exclude the possibility that more attempted suicides of males remained undetected which could have led to an overestimation of male case fatalities. Also, suicide attempters were mainly identified in hospitals, crisis intervention centers and other local health services and thus could have led to a bias.

Furthermore, anonymization of completed suicide data was impeding the probability to identify suicide completers who had previously attempted suicide during the study period. Overlapping of the two cohorts can be assumed, as suicide attempts increase the risk for suicide completion.

The strength of this study is the pre-post and naturalistic study design. A further strength is that data assessment was continuously monitored over the time period. Moreover, standardized interviews were conducted for the identification of attempted suicides instead of solely using computerized hospital data. The conclusion that higher male suicide rates are not only caused by men using more high-risk methods, but also by a higher case fatality compared to females within a certain method, is an important step in suicide research. To date, only a few studies addressed this issue.

This paper contributes to the understanding of gender differences in means used to take one's life. Our data support the notion that other factors like the intent to die, less help seeking behavior or the influence of alcohol seem to be stronger in males who engage in suicidal behavior than in females. The higher suicide rates of men are not only subject to the use of high-risk methods, but also by a higher case fatality compared to females within a certain method. This finding is not only explained by older age and frailty of males at the date of a suicidal act.

We conclude that restraining the access to lethal methods is important but not sufficient to reduce male suicide rates. This study shows that the next step to prevent higher male suicide rates should be a more detailed assessment of attempted and completed suicides, including data about intent to die and other factors mentioned above. As the choice of suicide method is only one factor, more background information about different motives standing behind higher male case fatalities has to be collected in order to develop new prevention strategies.

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Conflict of interest

The authors have no relevant financial relationships to disclose.

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The corresponding author confirms that he had full access to all data in the study, and takes responsibility for the integrity of the data and the accuracy of the data analysis.

All authors have made substantial contribution to conception and design, or analysis and interpretation of data, drafting the article or revising it critically for important intellectual content and final approval of the version to be published. There is no one else who fulfills these criteria, but has not been included as an author.

References

Andres, A.R., Collings, S., Qin, P., 2010. Sex-specific impact of socio-economic factors on suicide risk: a population-based case-control study in Denmark. European Journal of Public Health 20 (3), 265–270.

Baca-Garcia, E., Oquendo, M.A., Saiz-Ruiz, J., Mann, J.J., de Leon, J., 2006. A pilot study on differences in aggression in New York City and Madrid, Spain, and their possible impact on suicidal behavior. The Journal of Clinical Psychiatry 67 (3), 375–380.

Baumert, J.J., Erazo, N., Ladwig, K.H., 2005. Sex- and age-specific trends in mortality from suicide and undetermined death in Germany 1991–2002. BMC Public Health 5, 61.

Bertolote, J.M., Fleischmann, A., 2002. Suicide and psychiatric diagnosis: a worldwide perspective. World Psychiatry 1 (3), 181–185.

Bille-Brahe, U., Kerkhof, A., De Leo, D., Schmidtke, A., Crepet, P., Lonnqvist, J., Michel, K., Salander-Renberg, E., Stiles, T.C., Wasserman, D., Aagaard, B., Egebo, H., Jensen, B., 1997. A repetition-prediction study of European parasuicide populations: a summary of the first report from part II of the WHO/EURO Multicentre Study on Parasuicide in co-operation with the EC concerted action on attempted suicide. Acta Psychiatrica Scandinavica 95 (2), 81–86.

Denning, D.G., Conwell, Y., King, D., Cox, C., 2000. Method choice, intent, and gender in completed suicide. Suicide & Life-Threatening Behavior 30 (3), 282–288.

Elnour, A.A., Harrison, J., 2008. Lethality of suicide methods. Injury Prevention 14 (1), 39–45.

Hawton, K., 2000. Sex and suicide. Gender differences in suicidal behaviour. The British Journal of Psychiatry 177, 484–485.

Hawton, K., van Heeringen, K., 2009. Suicide. Lancet 373 (9672), 1372–1381.

Hegerl, U., Althaus, D., Schmidtke, A., Niklewski, G., 2006. The alliance against depression: 2-year evaluation of a community-based intervention to reduce suicidality. Psychological Medicine 36 (9), 1225–1233.

Hegerl, U., Mergl, R., Havers, I., Schmidtke, A., Lehfeld, H., Niklewski, G., Althaus, D., 2010. Sustainable effects on suicidality were found for the Nuremberg alliance against depression. European Archives of Psychiatry and Clinical Neuroscience 260 (5), 401–406.

Houle, J., Mishara, B.L., Chagnon, F., 2005. Can social support help prevent men from suicide attempt? Santé Mentale au Québec 30 (2), 61–83.

Houle, J., Mishara, B.L., Chagnon, F., 2008. An empirical test of a mediation model of the impact of the traditional male gender role on suicidal behavior in men. Journal of Affective Disorders 107 (1–3), 37–43.

Kanchan, T., Menon, A., Menezes, R.G., 2009. Methods of choice in completed suicides: gender differences and review of literature. Journal of Forensic Sciences 54 (4), 938–942.

Kposowa, A.J., McElvain, J.P., 2006. Gender, place, and method of suicide. Social Psychiatry and Psychiatric Epidemiology 41 (6), 435–443.

Large, M.M., Nielssen, O.B., 2010. Suicide in Australia: meta-analysis of rates and methods of suicide between 1988 and 2007. The Medical Journal of Australia 192 (8), 432–437.

Lester, D., 1982. The distribution of sex and age among completed suicides: a cross-national study. The International Journal of Social Psychiatry 28 (4), 256–260.

Lönnqvist, J., Koskenvuo, M., 1988. Mortality in depressive disorders; a 3-year prospective follow-up study in Finland. In: Helgason, T.D.R., Daly, R.J. (Eds.), Depressive Illness: Prediction of Course and Outcome. Springer, Berlin, pp. 126–130.

Miller, M., Azrael, D., Hemenway, D., 2004. The epidemiology of case fatality rates for suicide in the northeast. Annals of Emergency Medicine 43 (6), 723–730.

Möller-Leimkühler, A.M., 2003. The gender gap in suicide and premature death or: why are men so vulnerable? European Archives of Psychiatry and Clinical Neuroscience 253 (1), 1–8.

Murphy, G.E., 1998. Why women are less likely than men to commit suicide. Comprehensive Psychiatry 39 (4), 165–175.

Schmidtke, A., Bille Brahe, U., DeLeo, D., Kerkhof, A., Bjerke, T., Crepet, P., Haring, C., Hawton, K., Lonnqvist, J., Michel, K., Pommereau, X., Querejeta, I., Phillipe, I., Salander Renberg, E., Temesvary, B., Wasserman, D., Fricke, S., Weinacker, B., Sampaio Faria, J.G., 1996. Attempted suicide in Europe: rates, trends and sociodemographic characteristics of suicide attempters during the period 1989–1992. Results of the WHO/EURO Multicentre Study on Parasuicide. Acta Psychiatrica Scandinavica 93 (5), 327–338.

Schmidtke, A., Sell, R., Lohr, C., 2008. Epidemiology of suicide in older persons. Zeitschrift für Gerontologie und Geriatrie 41 (1), 3–13.

Schrijvers, D.L., Bollen, J., Sabbe, B.G., 2011. The gender paradox in suicidal behavior and its impact on the suicidal process. Journal of Affective Disorders, doi:10.1016/j.jad.2011.03.050.

Shenassa, E.D., Catlin, S.N., Buka, S.L., 2003. Lethality of firearms relative to other suicide methods: a population based study. Journal of Epidemiology and Community Health 57 (2), 120–124.

Spicer, R.S., Miller, T.R., 2000. Suicide acts in 8 states: incidence and case fatality rates by demographics and method. American Journal of Public Health 90 (12), 1885–1891.

Stuckler, D., Basu, S., Suhrcke, M., Coutts, A., McKee, M., 2009. The public health effect of economic crises and alternative policy responses in Europe: an empirical analysis. Lancet 374 (9686), 315–323.

Suominen, K., Isometsa, E., Ostamo, A., Lonnqvist, J., 2004. Level of suicidal intent predicts overall mortality and suicide after attempted suicide: a 12-year follow-up study. BMC Psychiatry 4, 11.

Värnik, A., Kõlves, K., van der Feltz-Cornelis, C.M., Marusic, A., Oskarsson, H., Palmer, A., Reisch, T., Scheerder, G., Arensman, E., Aromaa, E., Giupponi, G., Gusmao, R., Maxwell, M., Pull, C., Szekely, A., Sola, V.P., Hegerl, U., 2008. Suicide methods in Europe: a gender-specific analysis of countries participating in the "European Alliance Against Depression". Journal of Epidemiology and Community Health 62 (6), 545–551.

World Health Organization, 2003. The World Health Report 2003: Shaping the Future. World Health Organization, Geneva.