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Analysis of suicides in the catchment area of the Institute of Forensic Medicine, University of Zurich Switzerland

A retrospective cohort study of sex differences, suicide methods and trends over time

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Abstract

Background and objective: Suicide has a profound impact on both the affected families and society at large. Among young adults it even ranks as the fourth leading cause of death. Therefore, analysis of suicides is crucial for enhancing prevention strategies. This study aims to (I) investigate sex and age differences, (II) differences in methods and (III) locations (urban vs. rural) among those who committed suicide over a time period of 10 years in the catchment area of the Institute of Forensic Medicine, University of Zurich.

Material and methods: The archive of the Institute of Forensic Medicine, University of Zurich was searched for postmortem examinations and autopsy reports from completed suicides over a time period of 10 years. All relevant data were extracted from the written reports and five age groups were defined (group I ≤ 30 years, group II 31–44 years, group III 45–54 years, group IV 55–64 years and group V > 64 years). Nonparametric Kruskal-Wallis one-way variance analysis by rank was used for the statistical analysis on each criterion.

Results: Of the 1174 individuals included in the study, 72% were male, and 28% were female, with a mean age of approximately 52 years at the time of suicide. No relevant change was observed in the male-to-female ratio over the 10 years; however, women showed a trend toward a lower age at suicide. In terms of suicide methods, men had a higher rate of shooting (21.2% vs. 3.6%, $p < 0.1$) and hanging (24.4% vs. 16.4%, $p < 0.1$), whereas women had a higher rate of intoxication (21.6% vs. 9.0%, $p < 0.1$). The choice of suicide method also varied across age groups. Regarding location, completed suicides declined in urban regions but increased in rural regions.

Conclusion: Prevention plans should be reviewed, especially given the trend toward younger women completing suicide. Suicide prevention remains a major sociopolitical challenge that demands continuous review and the adaptation of suicide prevention strategies.

Keywords
Suicide · Suicide methods · Suicide prevention · Location · Age groups

Supplementary Information

The online version of this article (https://doi.org/10.1007/s00194-023-00676-3) contains figure 4 with a visualization.

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Introduction

According to the World Health Organization (WHO) over 700,000 people die from suicide annually worldwide [1]. Thus, on average, one completed suicide occurs every 45 s. The number of suicides in general is higher than deaths in traffic [2]. Among children and adolescents, suicide is regarded as 2nd–4th leading cause of death [1, 3]. Needless to say, every suicide impacts not only the committing person but also their families and related persons to a large extent and society in a broader sense [1].

Switzerland has one of the highest suicide rates in the world [4]. According to the Swiss Health Observatory approximately 1000 people died from suicide in 2020 (11.4 per 100,000 inhabitants) [5]. The most frequent method was hanging (31.3%), followed by the use of firearms (18.1%), poisoning (13.0%), falls from a height (11.2%), trains (11.7%) and drowning (4.3%) [5]. The highest rate of suicide was reached in the early 1980s and subsequently declined toward the end of the millennium [6].

Previous worldwide studies have demonstrated that suicide rates, methods and reasons vary across age groups and among sexes [4, 7]. For example, the suicide rate is 2.3 times higher in men than in women worldwide [8]. The different preferences in suicide methods between men and women are considered to be a primary reason for this finding; women prefer "softer" and potentially less lethal suicide methods, while men tend toward more violent techniques [9]. It has also been demonstrated that over 90% of people who die by suicide experience mental illness [6]. Additionally, a rural-urban discrepancy is found with a higher suicide incidence in rural areas [6].

This study aimed to (I) investigate sex and age differences, (II) differences in methods and (III) locations (urban vs. rural) among those who completed suicide over 10 years in the catchment area of the Institute of Forensic Medicine, University of Zurich.

Material and methods

Study group

We retrospectively searched all postmortem examinations and autopsy reports on completed suicide over 10 consecutive years (2012–2021) in the archives of the Institute of Forensic Medicine, University of Zurich ($n = 5344$). We excluded duplicates ($n = 497$), cases of assisted suicides[1] [10] ($n = 3200$), and cases in which the manner of death could not be clearly defined, such as fatal intoxication cases in which a clear distinction between suicide and accidental overdose could not be made ($n = 473$). Our final study group comprised 1174 cases. Sex, age, postcode, date of death, suicide method, and detailed case circumstances were extracted from the written reports and pseudonymized. Age groups were defined (group I ≤ 30 years, group II 31–44 years, group III 45–54 years, group IV 55–64 and group V > 64 years) for the subsequent statistical analysis.

The catchment area of the Institute of Forensic Medicine University of Zurich has a mixed rural-urban population. To examine the location-specific differences, we classified areas based on their postal codes and population size, grouping them into 3 categories: city (≥ 100,000 residents), 2nd tier city (≥ 10,000 and < 100,000 residents) and 3rd tier city (< 10,000 residents). Suicide cases involving rare methods such as by car, electricity, drowning, or explosion were grouped as "others" due to their low frequency. The suicide method "gas inhalation" included inhalation of helium, nitrogen, butane gas, propane, carbon monoxide, carbon dioxide, nitrous oxide and argon.

[1] Assisted suicides are legal in Switzerland, as long as certain requirements are met, e.g., that the capacity of judgment of the patient is proven beforehand by a physician and a self-interest from the assisting person(s)/organization can be excluded. Organizations such as Exit or Dignitas help those who wish to end their own life with the necessary preparations and administrative procedures. Ultimately, the necessary medication (usually a drinkable barbiturate) has to be taken by the individual himself/herself completely independent from others.

Due to the small case number ($n < 20$) no analysis of homicide-suicides or double suicides was made.

Usual procedure in cases of suspected non-natural death in Switzerland

In cases of suspected non-natural death in Switzerland, an "AgT" (*außergewöhnlicher Todesfall* [extraordinary death]) has to be reported to the police. Police, public prosecutor and a forensic pathologist (or forensically trained public health officer, a so-called *Amtsarzt*) are then called to the scene. The physician performs an external examination of the deceased on site. The findings and the interpretations are then reported to the public prosecutor, who then decides to either order further investigations (such as an autopsy, toxicological analysis, etc.) or to release the body.

In cases in which a public health officer performed the examination on site and the body was released on site, the Institute of Forensic Medicine University of Zurich was not involved and therefore has no case information. Against this background, it means that our study consists of only those cases in which a forensic pathologist from the Institute of Forensic Medicine University of Zurich performed the examination on site and/or an autopsy was performed at the Institute of Forensic Medicine University of Zurich. In concrete terms, of the 6195 suicide cases (assisted suicides included) that have been recorded in the catchment area of the Institute of Forensic Medicine University of Zurich between 2012–2021 according to the Swiss Health Observatory [5], 4847 suicide cases (after exclusion of duplicates) were included in our study group (ca. 78%).

Statistics

The following criteria were considered: sex (male vs. female), age (groups I–V as defined in the previous section), location (rural vs. urban), whether there were previous suicide attempts (one or more), and what method, e.g., fall from a height, thermal (fire), gas inhalation, hanging, shooting, intoxication, sharp force, train and others, the person used.

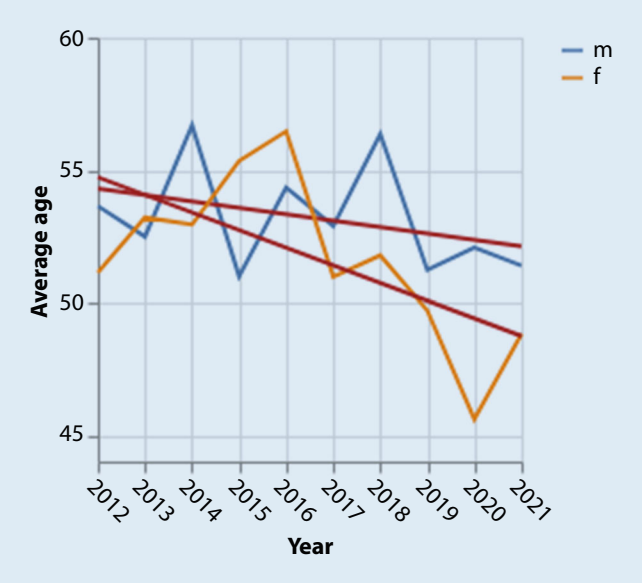

Fig. 1 ◄ Average age (years) at the time of suicide, in men (*blue line*) vs. women (*orange line*) and trends (*red line*)

We performed a nonparametric Kruskal-Wallis one-way analysis of variance by rank (H-test) per criterion. The data were organized and visualized in Excel (Version 16.70 for Mac, Microsoft). We conducted the analysis with an online calculator (available at www.socscistatistics.com). The significance was double-checked with a custom-made script written in *R* [R Core Team (2022)] [11] using the statistical package rstatix [12]. In a few cases, small numerical variations in the *p*-values (less than 2%) between the online calculator and R script can be attributed to numerical approximations in each program. No contradictions were observed between the results obtained using the online calculator and the R script.

Results

Study group

The final study group consisted of 1174 cases. Between 2012 and 2021 there were 174 suicides in age group I, 225 in age group II, 238 in age group III, 204 in age group IV, and 333 in age group V. No female suicides occurred in 2019 in age group IV. The number of cases fluctuated annually with a minimum of 76 male suicides in 2013 and a maximum of 103 in 2019 and a minimum of 27 female suicides in 2019 and a maximum of 39 in 2016.

Sex

The study group exhibited a significant sex difference, with a male:female ratio of approximately 2.5 (men = 72% vs. women = 28%; $n = 845$ vs. $n = 329$). This sex ratio remained consistent across the years studied (group I mean = 2.4, SD = 1.1; group II mean = 2.7, SD = 1.1; group III mean = 2.6, SD = 0.5; group IV mean = 2.9, SD = 1.2 and group V mean = 2.8, SD = 0.6).

Age

The average age at the time of suicide among women (51.78 years, standard deviation (SD) ± 19.03 years) and men (53.21 years, SD ± 18.85) is shown in **Fig. 1**. No significant change in the average age at the time of suicide was observed over the 10 years; however, a trend toward a lower age could be seen among women.

Suicide methods

Regarding the preference for specific suicide methods, no significant change was observed over the 10 years.

In terms of sex, there was a significant difference in the use of hanging (men 24.4% vs. women 16.4%, $p < 0.1$), shooting (men 21.2% vs. women 3.6%, $p < 0.1$), and intoxication (women 21.6% vs. men 9.0%, $p < 0.1$) (**Fig. 2**). There was also a significant sex difference in the use of sharp force (men 4.9% vs. women 3.0%, $p < 0.5$). There was no significant sex difference observed for the other methods.

The suicide method preference varied across the different age groups (**Fig. 3a–e**). Men in age groups I and II most often committed suicide by hanging (group I 29%, group II 28%), followed by train (group I 18%, group II 14%), shooting (group I 13%, group II 10%), fall from a height (group I 8%, group II 13%) and intoxication (group I 12%, group II 9%). Men in age groups III and IV used shooting more frequently (age group III 18%, group IV 23%), shooting even being the most commonly used suicide method in the age group V in males (35%), followed by fall from height (18%) and hanging (14%). Women in age group I most often committed suicide by train (26%), followed by intoxication (20%) and hanging (20%). In age group II the preferred suicide methods in women were hanging (27%) and intoxication (23%), followed by train (11%) and fall from a height (11%). For age groups III, IV and V, women most often used intoxication as a suicide method (group III 22%, group IV 25%, group V 19%).

Locality of suicide

There was a declining trend of completed suicides in urban regions, whereas an increasing trend could be seen in rural regions. The number of suicides in the city group vs. the 2nd tier city group was significantly higher ($p < 0.05$); however, there was no significant difference between the city group vs. the 3rd tier city group or between the 2nd tier city group and the 3rd tier city group ($p < 0.05$) (Supplement Visualization Fig. 4: number of suicides and suicide methods over 10 years in the catchment area of the Institute of Forensic Medicine, University of Zurich).

Farewell letter, suicide reason and previous suicide attempts

Documentation of the presence of a farewell letter, the suicide reasons and whether there were previous suicide attempts in the person's history was inconsistent in the forensic reports. A farewell letter was described in 43.9% of the female suicide cases and in only 32.2% of the male cases.

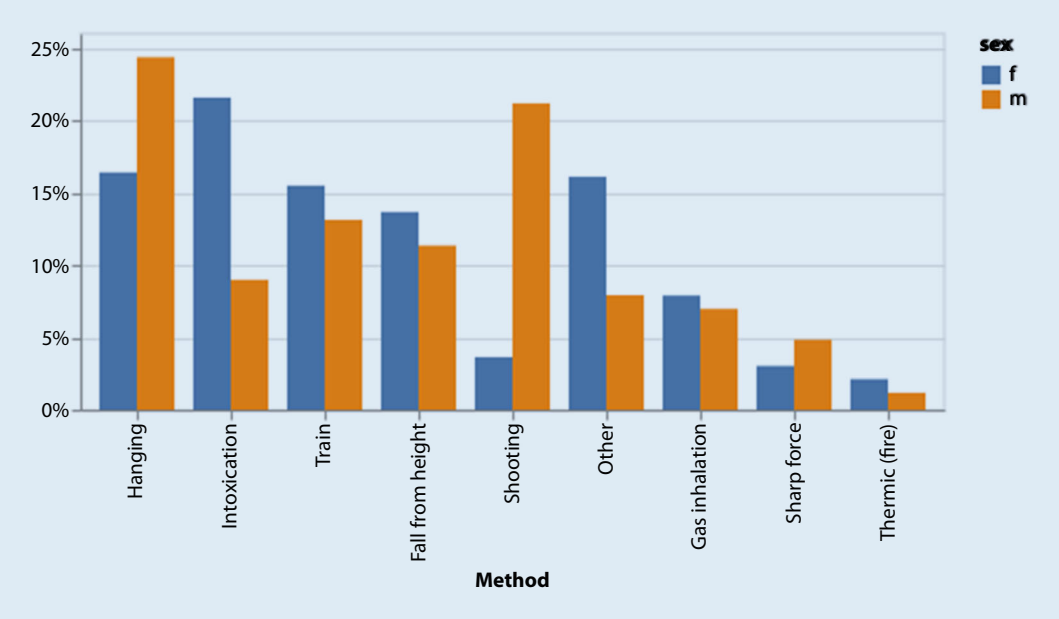

Fig. 2 ◄ Suicide methods in men vs. women over 10 years

The documented suicide attempt rate in women was over twice as high as that among men (women 23.5% vs. men 10.9%). The number of documented suicide attempts among women increased up to the age of 65 years (group I, 20%; group II, 25%; group III, 27%; group IV, 30%); however, after that the rate of documented attempted suicides decreased (group V, 18%). Men under 30 years of age demonstrated the highest rate of documented suicide attempts (group I, 19% vs. other age groups, 8–11%).

Discussion

The first aim of our study was to investigate whether there was an overall sex and age difference in completed suicides. We found that significantly more men committed suicide (male:female ratio approximately 2.5). In contrast, the percentage of documented suicide attempts in women was more than twice as high as that among men in our study groups. This finding confirms an apparent sex paradox described in prior studies in which male predominance was observed in completed suicides, while a female predominance was observed in attempted suicides [13, 14]. There are multiple potential explanations for this sex paradox, such as cultural expectations related to gender, social norms, and differences in suicidal behavior [13]. Sex differences in psychiatric diseases and help-seeking behavior might also impact suicide [13]. Psychiatric illnesses account for most suicides [4]. Depression may be underdiagnosed in men as they express their suffering differently from women and the suicidal process in men is shorter than in women [15]. In our study group men also tended to use relatively brutal, "hard" suicide methods (such as shooting, hanging and sharp force) that might per se be more successful suicide methods. In contrast, women showed a comparatively high incidence of relatively "soft" suicide methods (such as intoxication), which might fail more easily [16].

Although there was no statistically significant difference in the average age of completed suicide in women vs. men over the 10 years (52 vs. 53 years), a trend in women was observed with suicide occurring at younger ages over time. This is consistent with the report from the Swiss Federal Statistical Office in 2020, describing a decline of the overall number of completed suicides in 2020, but a moderate increase in young women under 25 years [17]. In this respect, it is also important to acknowledge the close correlation of suicide with psychiatric disorders and/or substance abuse in adolescents [3]. Also in our study group, younger women (age groups I and II) used "harder" suicide methods more frequently, such as hanging and suicide by train, compared to middle-aged or older women (age groups III–V). It could be hypothesized if this trend of female suicide age becoming younger over time might be linked to the changing gender roles and perceptions of young women. Ultimately, we do not yet have a comprehensive explanation for this development necessitating further investigation to address and counteract it effectively.

As a second aim, we conducted a comprehensive analysis of the differences in suicide methods. Men used shooting significantly more often than women. Additionally, incidence of suicide by shooting increased with male age. This male predominance in suicide by shooting might be due to certain specifics in Swiss military affairs. First, military service is compulsory only for men and provides familiarization with firearms. In addition, every person discharged from military service can take the assault rifle home in Switzerland. Prior studies have demonstrated that the availability of firearms at home correlates with firearm suicides [18, 19]. With a reduction in availability of firearms, both shooting suicides and total suicides decrease without an impact on non-shooting suicides [18]. This finding highlights the importance of restricting the availability of firearms as part of the prevention strategies.

As a third aim, we assessed whether there was a difference in suicides in urban vs. rural areas. Over the 10 years, there was a declining trend of completed suicides

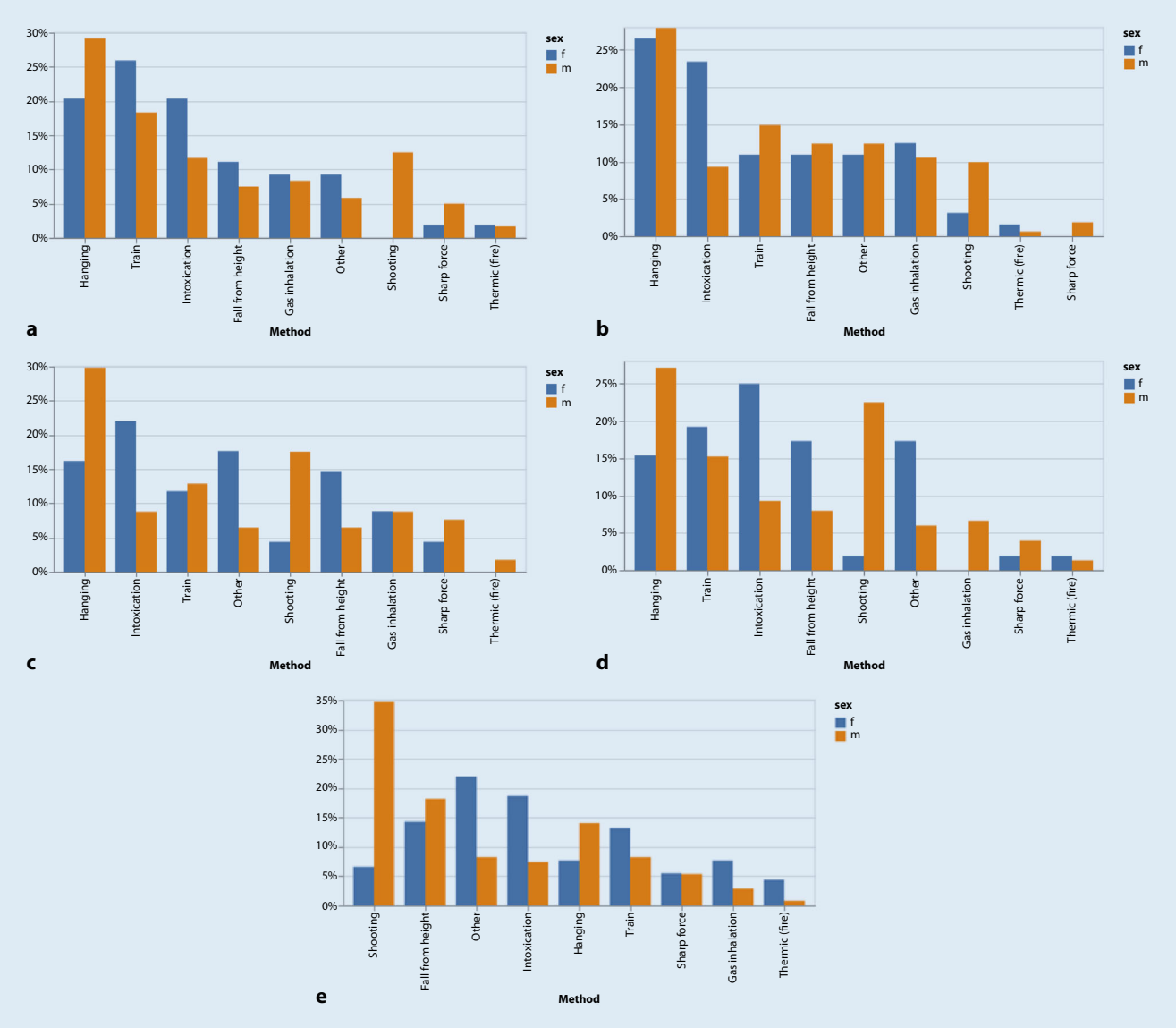

Fig. 3 ▲ Suicide methods in men vs. women classified into age groups I–V. **a** Age group I (< 30 years). **b** Age group II (31–44 years). **c** Age group III (45–54 years). **d** Age group IV (55–64 years). **e** Age group V (> 64 years)

in urban regions, whereas an increasing trend was seen in rural regions, paralleling the results of a US suicide study in which suicide rates were found to be highest in rural and lowest in urban counties [20]. Additionally, a Canadian and an Australian study showed similar results with higher suicide rates in rural than urban regions [21, 22]. There are many possible reasons for this rural predominance in suicides. In rural communities, access to mental health services is poorer, and rural men are less likely to seek professional help or social support for mental health problems, which is also influenced by the concept of rural masculinity [21]. Occupational and economic factors might also play a role [21]. A possible reason for less distinctive differences between rural and urban regions in our study group is the close proximity of these regions in Switzerland.

Limitations

Unfortunately, the data related to farewell letters and the reasons for suicide were not consistently recorded in our study group, which precluded further analysis. Switzerland is a highly diverse country, with 39% of its population (aged 15 years and above) having a migration background [23]. Because suicide methods vary significantly across different countries and regions [4] it would be intriguing to explore whether the origins of the individuals influence the characteristics of completed suicides. Unfortunately, this aspect could not be examined as ancestry was not recorded.

Also, not all cases of suicide in the catchment area of the Institute of Forensic Medicine University of Zurich could be included in our study. In cases that were examined on site by a public health officer and the body was released on site, the Institute of Forensic Medicine University of Zurich was not involved, and we therefore had no data to assess (see above).

Our analysis is based on data from the catchment area of the Institute of Forensic Medicine, University of Zurich. Although our study population may be similar to other European regions, the results might not represent countries with different socioeconomic conditions and cultures. Additionally, many other factors that might influence suicides, aside from socioeconomic status, psychiatric diseases and somatic diseases, were limitedly documented in our study group and could not be considered in our analysis.

Conclusion

Suicide prevention strategies must be re-evaluated in response to the concerning trend of decreasing age in female suicides. Also, access to suicide methods should be restricted to enhance suicide prevention efforts. In particular, stricter regulations pertaining to firearms access are recommended as shooting is one of the most frequently used suicide methods among (especially older) men. Addressing suicide prevention remains a major sociopolitical challenge that requires continuous review and incorporation of research findings to continually enhance suicide prevention strategies.

Key points.

- Suicide prevention strategies must be re-evaluated in response to the concerning trend of decreasing age in female suicides.
- We recommend stricter regulations to firearms access as shooting is one of the most frequently used suicide methods among men.
- Suicide prevention remains a major sociopolitical challenge that requires continuous review and incorporation of research findings to continually enhance suicide prevention strategies.

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Zusammenfassung

Analyse der Suizide im Einzugsgebiet des Instituts für Rechtsmedizin der Universität Zürich, Schweiz. Eine retrospektive Kohortenstudie bezüglich Geschlechtsunterschieden, Suizidmethoden und Trends im Zeitverlauf

Hintergrund und Ziel: Suizide wirken sich weitreichend auf die betroffenen Familien und die Gesellschaft im Allgemeinen aus. Bei jungen Erwachsenen machen sie sogar die vierthäufigste Todesursache aus. Eine dezidierte Analyse von Suiziden ist entscheidend, um Präventionsstrategien zu verbessern. In dieser Studie wurde Folgendes untersucht: (I) Geschlechts- und Altersunterschiede bei vollendetem Suizid, (II) Unterschiede in den Suizidmethoden und (III) Unterschiede in ländlichen vs. städtischen Gegenden.
Material und Methode: Das Archiv des Instituts für Rechtsmedizin der Universität Zürich wurde nach Legalinspektionsberichten und Obduktionsgutachten sämtlicher Suizide über 10 Jahre (2012–2021) durchsucht. Alle relevanten Informationen wurden aus den schriftlichen Berichten erfasst. Zur weiteren Analyse wurden Altersgruppen definiert (Gruppe I ≤ 30 Jahre, Gruppe II 31–44 Jahre, Gruppe III 45–54 Jahre, Gruppe IV 55–64 Jahre, Gruppe V > 64 Jahre). Die statistische Analyse erfolgte mittels Kruskal-Wallis-Test (H-Test).
Ergebnisse: Von den 1174 Fällen, die in die Studie eingeschlossen wurden, waren 72 % männlich und 28 % weiblich, wobei das Durchschnittsalter etwa 52 Jahre betrug. Diese Geschlechtsverteilung blieb über den beobachteten Zeitraum von 10 Jahren konstant. Bei den Frauen wurde jedoch im Zeitverlauf ein Trend zu einem jüngeren Alter beobachtet. Bezüglich Suizidmethode verwendeten mehr Männer als Frauen eine Schusswaffe (21,2 % vs. 3,6 %; $p < 0.1$) oder erhängten sich (24,4 % vs. 16,4 %; $p < 0.1$), während Frauen sich eher vergifteten (21,6 % vs. 9,0 %; $p < 0.1$). Die Wahl der Suizidmethode variierte auch zwischen den Altersgruppen. Des Weiteren wurde ein geringer Rückgang der Suizide in städtischen Regionen und eine geringe Zunahme der Suizide in ländlichen Regionen beobachtet.
Schlussfolgerung: Die Suizid-Präventionsmaßnahmen müssen kontinuierlich analysiert und überarbeitet werden, insbesondere aufgrund eines Trends bei Frauen, die sich in einem immer jüngeren Alter das Leben nehmen.

Schlüsselwörter
Suizid · Suizidmethode · Suizidprävention · Örtlichkeit · Altersgruppen

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Data availability. The data cannot be made available due to legal restrictions.

Declarations

Conflict of interest. L. Gübelin, A. Dobay, R. Golomingi, M. Thali, L. Ebert and S. Franckenberg declare that they have no competing interests.
Ethical standards. For this article no studies with human participants or animals were performed by any of the authors. All studies mentioned were in accordance with the ethical standards indicated in each case.
This research project does not fall within the scope of the Human Research Act (HRA). Therefore, authorization from the ethics committee is not required (KEK ZH-Nr. 15–0686).

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