

# Trends in suicide methods in Switzerland from 1969 to 2018: an observational study

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## Summary

**BACKGROUND:** Suicide is a serious societal and health problem. We examined changes in rates of completed suicides in Switzerland between 1969–2018 with particular regard to different methods of suicide used in different subgroups of the resident population.

**METHODS:** We used data of the Swiss cause of death statistics and Poisson regression models to analyse annual incidence rates and calendar time trends of specific suicide methods used in population subgroups by sex (men vs women), age (10–29, 30–64, >64 years), and nationality (Swiss vs other citizenship).

**RESULTS:** There were 64,996 registered suicides between 1969 and 2018. Across these 5 decades, the overall suicide rate was higher in men than in women (incidence rate ratio [IRR] 2.62, 95% confidence interval [CI] 2.58–2.67), in Swiss citizens than in foreigners (IRR 2.02; 95% CI 1.97–2.07), and in older residents (>64 years) than in the age groups 30–64 years (IRR 1.35, 95% CI 1.32–1.37) and 10–29 years (IRR 2.37, 95% CI 2.32–2.43). After peaking in the 1980s, the overall suicide rate had declined in all of these population subgroups, with flattening trends over most recent years. The most common specific methods of suicide were hanging (accounting for 26.7% of all suicides) and firearms (23.6%). The rates of the specific suicide methods were usually higher in men, in Swiss citizens and in older residents, and they had typically declined over most recent decades in the population subgroups examined. However, some methods diverged from this general pattern, at least in some population subgroups. For instance, railway suicides most recently increased in younger and in male residents whereas suicides by gas and by drowning were only at a low level after rapid declines in the last millennium.

**CONCLUSIONS:** Restricting access to lethal means (e.g., detoxification of domestic gas), improvements in health care and media guidelines for responsible reporting of suicides are possible explanations for the generally declining suicide rates in Switzerland. Whereas some methods (e.g., poisoning by gases or drowning) had become rare, others continue to account for many suicides every year, at least in some population subgroups (e.g., firearms in older Swiss men or railway suicides in younger and in

male residents). As different methods of suicide are chosen by different people or subgroups of the population, preventive efforts should include differentiated strategies and targeted measures to further reduce suicides in Switzerland and elsewhere.

## Introduction

Suicide is a serious societal and public health problem [1]. Worldwide, more than 700,000 people die due to suicide every year, placing suicide among the twenty leading causes of death [1]. Suicide may occur over the whole lifespan and is the most frequent cause of death among 15–24-year-olds globally [2]. According to the diathesis-stress model, suicidal behaviour can be triggered by internal stressors (e.g., mental disorders) or by external stressors (e.g., life-events) if they come across with predisposing biological or psychological characteristics (e.g., heightened perception of emotional distress or greater propensity for emotion to influence decisions) [3, 4]. Due to the economic and human costs of suicidal behaviour to individuals, families, communities and society [5], the World Health Organization (WHO) has prioritised suicide prevention and declared the reduction of suicide mortality by one third until 2030 as a global target [1, 6, 7]. Accordingly, the suicide rate is a health indicator of the United Nations Sustainable Development Goals [1].

In Switzerland, the population-based suicide rate declined after reaching a peak in the 1980s [8]. Nevertheless, there are still approximately 1000 suicides every year [9], which is around five times the number road traffic fatalities [10].

International data showed age-, gender- and region-specific differences in the methods of suicide used [2, 11–13]. Different groups of people may have different access to lethal methods and/or they may be attracted by different means of suicide [14]. As the availability of lethal means was shown to affect the methods of suicide used [15–18], restricting access to lethal methods is an important suicide prevention strategy [3, 6, 19]. Knowledge of the most commonly used methods of suicide [1] and a better understanding of the dynamics over time of the suicide methods used [8] may inform targeted and adequate preventive and control measures [7].

In Switzerland, Hepp et al. [8] found diverging calendar time trends for different methods of suicide between 1969

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and 2005. The current study aimed to extend these descriptive analyses by including more recent years (up to 2018), the application of more sophisticated statistical methods (Poisson regression models for rate events in order to estimate the true rates of completed suicides behind the observed numbers), and by in-depth analyses of calendar time trends of specific suicide methods in population subgroups (age, gender and nationality subgroups). Specifically, we aimed at answering the following research questions: (1) Did the population-based rates of specific suicide methods used in Switzerland change over the latest five decades (1969–2018)? (2) Did these calendar time trends in the rates of the suicide methods used differ depending on age, sex and nationality (Swiss vs other citizenship)?

Based on previous findings [8], we expected diverging time trends for specific methods of suicide over the latest five decades. Likewise, we expected that at least some of these time trends differ depending on age, sex and/or nationality. However, subgroup analyses were exploratory and no specific hypotheses were formulated regarding the role of age, gender and nationality.

## Methods

We performed secondary analyses of the Swiss cause of death statistics [20] for the period 1969–2018. Incidence rates and calendar time trends of specific suicide methods were examined in population subgroups which were stratified according to sex (men vs women), age (10–29, 30–64, >64 years), and nationality (Swiss vs other citizenship).

### Data sources

The Swiss cause of death statistics, courtesy of the Federal Statistical Office (FSO), is a mandatory and comprehensive registration based on data from civil registries and on death certificates issued by physicians [20]. Data have been available in electronic form since 1969 and include the following information for all deceased persons in the permanent resident population of Switzerland: causes of death, age, sex, civil status, occupation (with low data quality), commune of residence (civil domicile) and nationality [20]. There is almost full data coverage on cause of death for all deceased persons (only about 2% missing data) [17]. Causes of death are coded according to the WHO's International Classification of Diseases (ICD) [21, 22]. Registration rules prescribe the highest priority to violent causes of death; therefore, suicides are usually registered as the main cause of death [8]. In Switzerland, suicides are routinely investigated by the police and by legal medicine because they are a violent cause of death; an autopsy is not performed in all cases, however [8]. In 1995, there was a revision of the Swiss cause of death statistics with transition from ICD-8 [22] to ICD-10 [21]. A separate ICD-10 code for assisted suicide (X61.8) was introduced in 1998 and allows for the analysis of assisted suicides since then [8].

Data on the permanent resident population to calculate annual suicide rates were based on the population statistics of the FSO [23] (see appendix, table S1).

### Data management

Methods of suicide were grouped into nine categories based on ICD-8 and ICD-10 codes, respectively [21, 22]: (1) poisoning by solid or liquid substances (exclusive of assisted suicides) (ICD-8: 950 / ICD-10: X60-X66.9); (2) poisoning by gases (952 / X67-X69.9); (3) hanging, strangulation or suffocation (953 / X70-X70.9); (4) drowning or submersion (954 / X71-X71.9); (5) firearms or explosives (955 / X72-X75.9); (6) cutting by sharp or blunt objects (956 / X78-X79.9), (7) jumping from high places (957 / X80-X80.9), (8) jumping or lying in front of moving object (particularly trains) (958.00 / X81.8); and (9) other means (951, 958 (exclusive of 958.00), 959 / other ICD-10 codes).

For the years 1970 and earlier, the FSO had no annual population data stratified according to age, sex and nationality [23]. We therefore substituted the number of inhabitants in population subgroups (e.g., Swiss men over 64 years) for the years 1969 and 1970 with the respective figures of 1971.

### Data analyses

We used Poisson regression models to analyse annual incidence rates and calendar time trends of specific suicide methods used in specific subpopulations in Switzerland between 1969–2018. Poisson regression is the standard approach to analyse incidence rates in prospective studies [24]. In Poisson regression models, the natural log ( $\ln$ ) of the incidence rate of events (e.g., the  $\ln$  of the suicide rate) is modelled as a linear function of the predictor variables (e.g., calendar time or nationality) [24]. The exposure time or the population denominator are included as an offset term in the regression equation for model estimation in statistical software [24], such as STATA version 16 [25] used in this study.

We first estimated smoothed curves for true annual incidence rates of specific suicide methods using a restricted (natural) cubic-spline model with knots set at 10-year intervals (1978, 1988, 1998, and 2008) [26]. Spline functions are piecewise polynomials used in curve fitting to model nonlinear relationships [27] through the transformation of an independent variable (e.g., calendar time) [28]. Cubic polynomials were found to have good ability to fit sharply curving shapes and they can be made to be smooth at the join points (knots) by forcing the first and second derivatives of the function to agree at the knots [27]. Since cubic spline functions can behave poorly (be unstable) at the tails, constraining the function to be linear before the first and after the last knot has been recommended (therefore called restricted or natural splines) [29]. It was shown that the location of the knots (which has to be specified in advance) is not very crucial in restricted cubic spline models in most situations; the model fit depends much more on the number of knots [30]. For many datasets,  $k = 4$  knots offers an adequate fit of the model and is a good compromise between flexibility and loss of precision caused by overfitting a small sample [27]. Following this recommendation, we used restricted cubic-spline models with  $k = 4$  knots (set at 1978, 1988, 1998, and 2008) to estimate calendar time trends of annual suicide rates in population subgroups which were stratified according to sex and age groups [26].

In addition, we estimated Poisson regression models with the predictors calendar-time period (1969–1978, 1979–1988, etc.) and nationality to examine the impact of these predictors on the (true) rates of specific suicide methods. These analyses were again stratified for sex and age groups, and results were reported in terms of incidence rate ratios (IRRs) between time periods and nationalities, respectively.

We considered two-sided  $p < 0.05$  to be statistically significant and we report 95% confidence intervals (CIs) of the modelled rates. Please note that the 95% CIs relate to the uncertainty of the estimated rates behind the observed numbers (and not to the observed rates, which were realised under the assumption of these true rates); that is, the 95% CIs do not represent prediction intervals for the observed rates.

Statistical analyses were performed with STATA version 16 [25] and the program "grc1leg2" (<http://digital.cgdev.org/doc/stata/MO/Misc>) to customise graphs. A study protocol has not been prepared and registered.

**Ethics approval**

The responsible ethics committee of the canton of Zurich declared that the study does not fall within the scope of the Swiss Human Research Act (HRA). Therefore, the approval of study protocols and the need of informed consent were waived by the ethics committee of the canton of Zurich (BASEC-Nr. Req-2021-01125).

**Results**

There were 64,996 suicides registered in Switzerland between 1969 and 2018 (table 1).

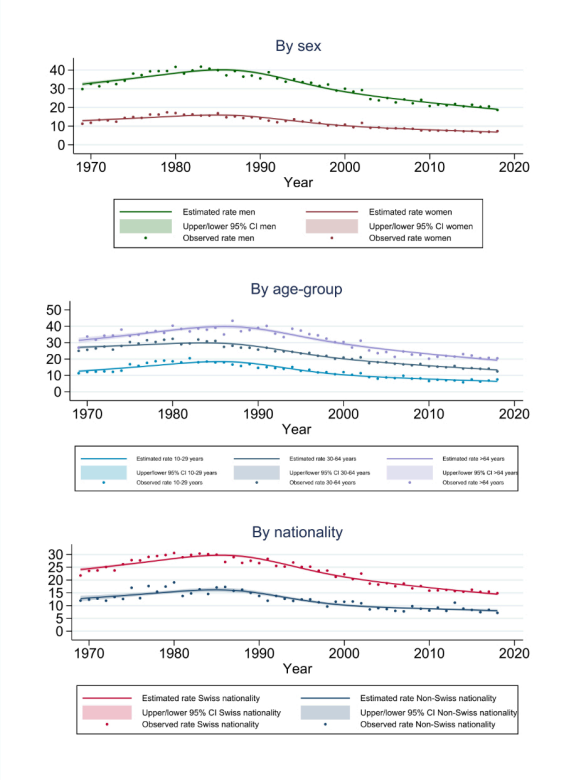
This figure resulted after excluding two suicides of 9-year-old boys and 8781 assisted suicides. After peaking in the 1980s, the population-based overall suicide rate declined over most recent decades in both sexes, in Swiss and foreign citizens, and in young (10–29 years), middle-aged (30–64 years) and older (>64 years) inhabitants (fig. 1). Across the five decades studied, the overall suicide rate was higher in men than in women (IRR 2.622, 95% CI 2.577–2.666), in Swiss citizens than in residents with foreign nationality (IRR 2.019, 95% CI 1.968–2.071), and in older inhabitants than in middle-aged (IRR 1.348, 95% CI 1.324–1.373) and younger inhabitants (IRR 2.374, 95% CI

2.319–2.431). Hanging accounted for most suicides over the 50-year study period (26.7%), followed by firearms (23.6%), poisoning by solid or liquid substances (12.7%) and jumping from high places (11.1%) (table 2).

Subsequently, the most common methods of suicide will be described with particular regard to deviations from these overall trends and patterns as well as regarding their relevance in population subgroups in most recent years.

Although most suicide methods were more often used by men than by women, the estimated population-based incidence rates for suicides by poisoning with solid or liquid substances developed on a rather similar level for both sexes between 1969 and 2018 (figures 2–4). In addition, the incidence rates were not consistently lower and sometimes

**Figure 1:** Suicide rates per 100,000 population (person-years). Note: estimated true rates and associated confidence intervals (CI) were derived from Poisson regressions using a restricted cubic-spline model.



**Table 1:** Number of suicides in Switzerland (1969–2018).

Age group	Sex	Nationality	Period					Total
			1969-1978	1979-1988	1989-1998	1999-2008	2009-2018	
10-29 years	Male	Swiss	1924	2433	1826	1114	820	8117
		Other	185	238	230	166	174	993
	Female	Swiss	539	701	400	352	262	2254
		Other	92	70	83	61	50	356
30-64 years	Male	Swiss	4685	5339	5088	4257	3533	22902
		Other	517	639	646	639	740	3181
	Female	Swiss	2064	2424	2'093	1693	1418	9692
		Other	193	236	198	212	253	1092
>64 years	Male	Swiss	1704	2179	2419	2034	2163	10499
		Other	81	107	124	137	204	653
	Female	Swiss	913	1216	1'200	885	746	4960
		Other	51	63	78	59	46	297
Total			12948	15645	14385	11609	10409	64996

even higher among foreigners than among Swiss citizens (tables 3 and 4). There was a downward trend in suicides by poisoning over more recent decades in all population subgroups (appendix, figures S1 and S2). This trend started with some delay in older people (>64 years), however (figures 2–4).

Suicides by poisoning with gas were rare among women (figures 2–4). In men, suicides by gas peaked in the 1980s and then declined rapidly. Except for older (>64 years) male and female inhabitants, the rates of gas suicides were higher in Swiss citizens than in foreigners (tables 3 and 4).

Hanging ranked second of all suicide methods in men (after firearms) and in women (after poisonings by solid or liquid substance) during the 50-year study period (table 2). Incidence rates typically declined since the 1980s, with flattening trends in more recent decades (figures 2–4). Between 2009–2018, hanging was the most common suicide method among men, except for older (>64 years) Swiss citizens who most often committed suicide by firearms (appendix, fig. S1). In women, hanging was also the most common suicide means up to 64 years, when jumping from heights became most frequent (appendix, fig. S2).

The incidence rate of suicides by drowning developed on a similar level in men and in women over the last 50 years (figures 2–4). Suicides by drowning were relatively common in earlier decades, particularly among older people, and declined in all age groups and in both sexes over recent decades. Interestingly, the rate of drownings was permanently higher in foreign than in Swiss young men (IRR 1.484, 95% CI 1.084–2.032) throughout the study period (table 3).

Rarely used by women, firearms accounted for most suicides among men between 1969–2018 (table 2). In young (10–29 years) and middle-aged (30–64 years) men, firearm suicides had the highest incidence rate of all methods until the early 2000s, when hanging became most frequent after a steep decline in firearms suicides (figures 2 and 3). In older Swiss men (>64 years), however, the rate of firearm suicides declined to a lesser extent and guns replaced hang-

ing as the most common suicide method since the 1990s (fig. 4 and appendix fig. S1). The IRR for suicides by firearms between foreign and Swiss men was the lowest of all suicide methods in each of the age groups (table 3).

Suicide by cutting with sharp or blunt objects accounted for only 2.1% of all suicides (table 2) and was rarely used in all subpopulations (appendix, figures S1 and S2).

The rate of suicides by falls declined since the late 1980s in all population subgroups (figures 2–4 and appendix, figures S1 and S2). However, in women, jumping from high places was among the most common suicide methods, and middle-aged women had similar incidence rates as their male contemporaries.

Suicides by jumping or lying in front of moving objects (almost exclusively trains) followed an increasing trend in men (all age groups) and in young women (10–29 years) during the latest decade (figures 2–4). In consequence, railway suicides most recently became one of the most common suicide means in young people (fig. 2 and appendix, figures S1 and S2).

Other suicide methods such as intentional self-harm by crashing a motor vehicle or by unspecified means were rare throughout our study period (figures 2–4).

## Discussion

We examined trends in Swiss suicide rates between 1969 and 2018 with a particular focus on different methods of suicide used in various subgroups of the resident population. This meets with the WHO recommendation to "conduct a situation analysis (for instance, rates of suicide and self-harm, specific populations at risk, common methods of suicide, [...]) to inform the planning of suicide prevention activities" [7]. Following this line of reasoning, our results may contribute to the Swiss national action plan on prevention of suicide, which was introduced in 2017 and which aims to reduce the rate of suicides by about 25% by 2030 as compared with 2013 [31].

**Table 2:**  
Methods of suicides used in Switzerland (1969–2018).

Suicide method	ICD-8 code	ICD-10 code	Men			Women			All		
			Absolute frequency	Relative frequency	Rate per 100000 person-years	Absolute frequency	Relative frequency	Rate per 100000 person-years	Absolute frequency	Relative frequency	Rate per 100000 person-years
Poisoning by solid or liquid substances <sup>1</sup>	950	X60-X66.9	3893	8.4%	2.56	4336	23.2%	2.70	8229	12.7%	2.63
Poisoning by gases	952	X67-X69.9	2882	6.2%	1.89	570	3.1%	0.36	3452	5.3%	1.10
Hanging, strangulation or suffocation	953	X70-X70.9	13486	29.1%	8.86	3849	20.6%	2.40	17335	26.7%	5.54
Drowning or submersion	954	X71-X71.9	2252	4.9%	1.48	2926	15.7%	1.82	5178	8.0%	1.66
Firearms or explosives	955	X72-X75.9	14615	31.5%	9.61	694	3.7%	0.43	15309	23.6%	4.90
Cutting by sharp or blunt objects	956	X78-X79.9	1020	2.2%	0.67	359	1.9%	0.22	1379	2.1%	0.44
Jumping from high places	957	X80-X80.9	3944	8.5%	2.59	3291	17.6%	2.05	7235	11.1%	2.31
Jumping or lying in front of moving object (particularly railway)	958.00	X81.8	3145	6.8%	2.07	1915	10.3%	1.19	5060	7.8%	1.62
Other			1108	2.4%	0.73	711	3.8%	0.44	1819	2.8%	0.58
All methods			46345	100.0%	30.46	18651	100.0%	11.62	64996	100.0%	20.79

<sup>1</sup> Exclusive of assisted suicides.

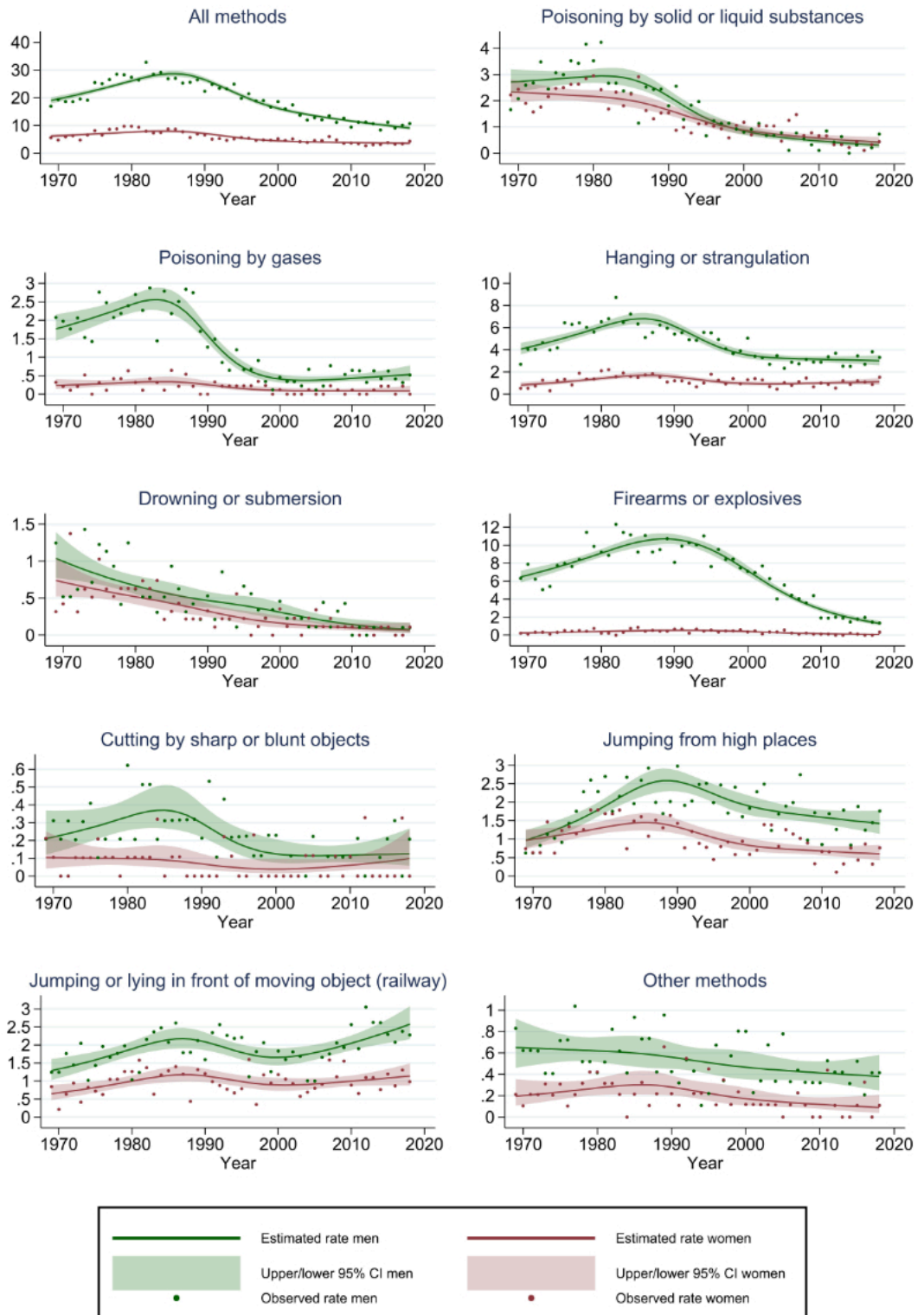
**Overall suicide rate**

Hepp et al. [8] had previously demonstrated that the overall suicide rate in Switzerland peaked in the 1980s and then declined up to 2005 in both sexes. We found that these declining trends also occurred in different age groups and in

Swiss as well as in foreign citizens. Furthermore, the declining trends in Swiss suicide rates went on up to 2018, even though they tended to attenuate in most recent years.

The decline in the overall Swiss suicide rate corresponds with declining trends in Europe and globally [32]. When

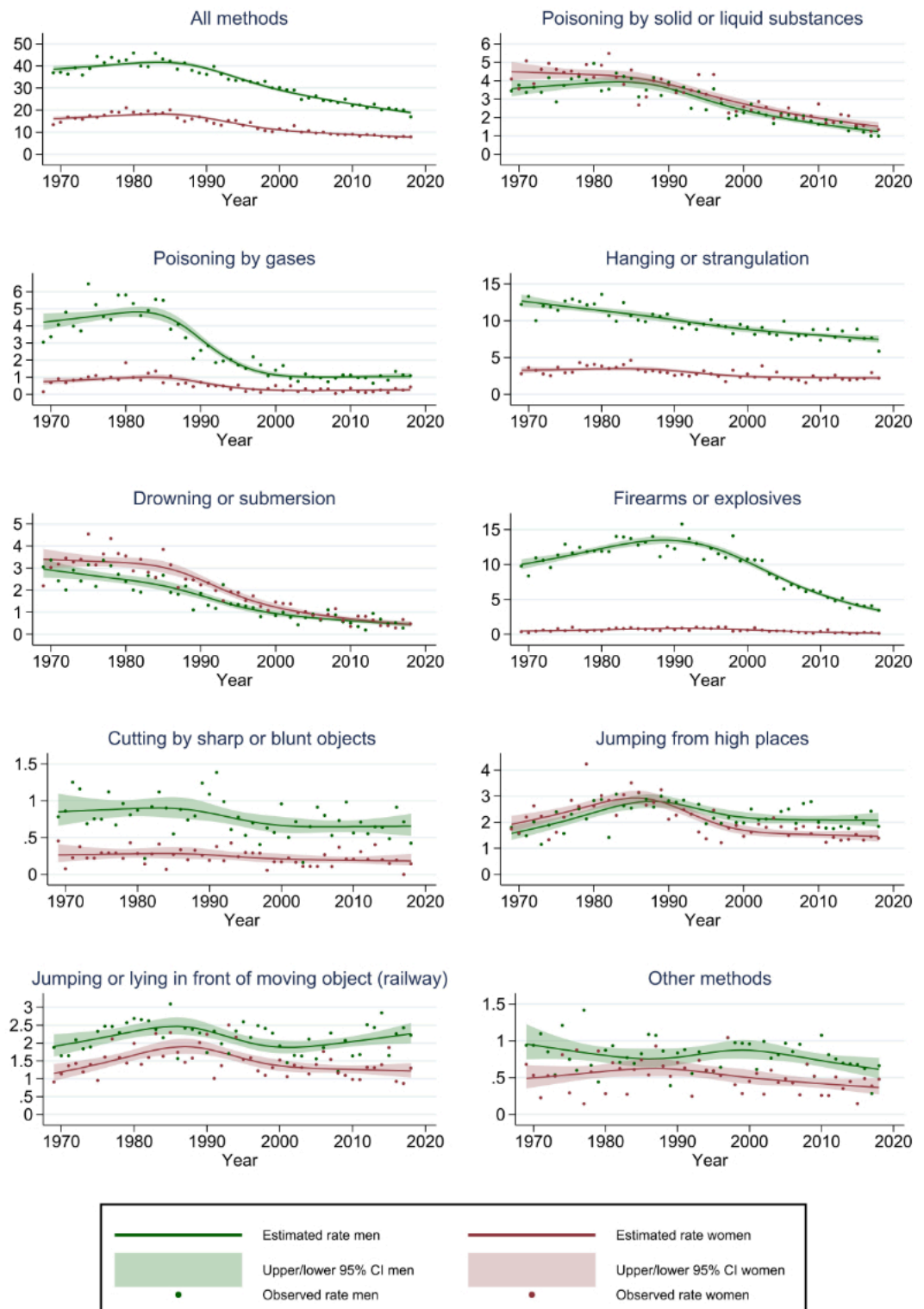
**Figure 2:** Rates of suicide methods per 100,000 population (person-years) in the age group 10–29 years. Note: estimated true rates and associated confidence intervals (CI) were derived from Poisson regressions using a restricted cubic-spline model.



compared with the European Union (EU), the decline in Switzerland was even more pronounced: after having been much higher in 1980 (24.9 vs 14.0 suicides per 100,000 population), most recently (2017), the age-standardised overall suicide rate in Switzerland (10.4) approached the EU rate (9.0) [33]. This sharp decline in Switzerland had

occurred despite the lack of a national suicide prevention strategy until 2017 [31]. However, public and private stakeholders had implemented a range of prevention measures already earlier. The stable economic situation and improvements in mental health care are further possible explanations for declining suicide rates in Switzerland [31].

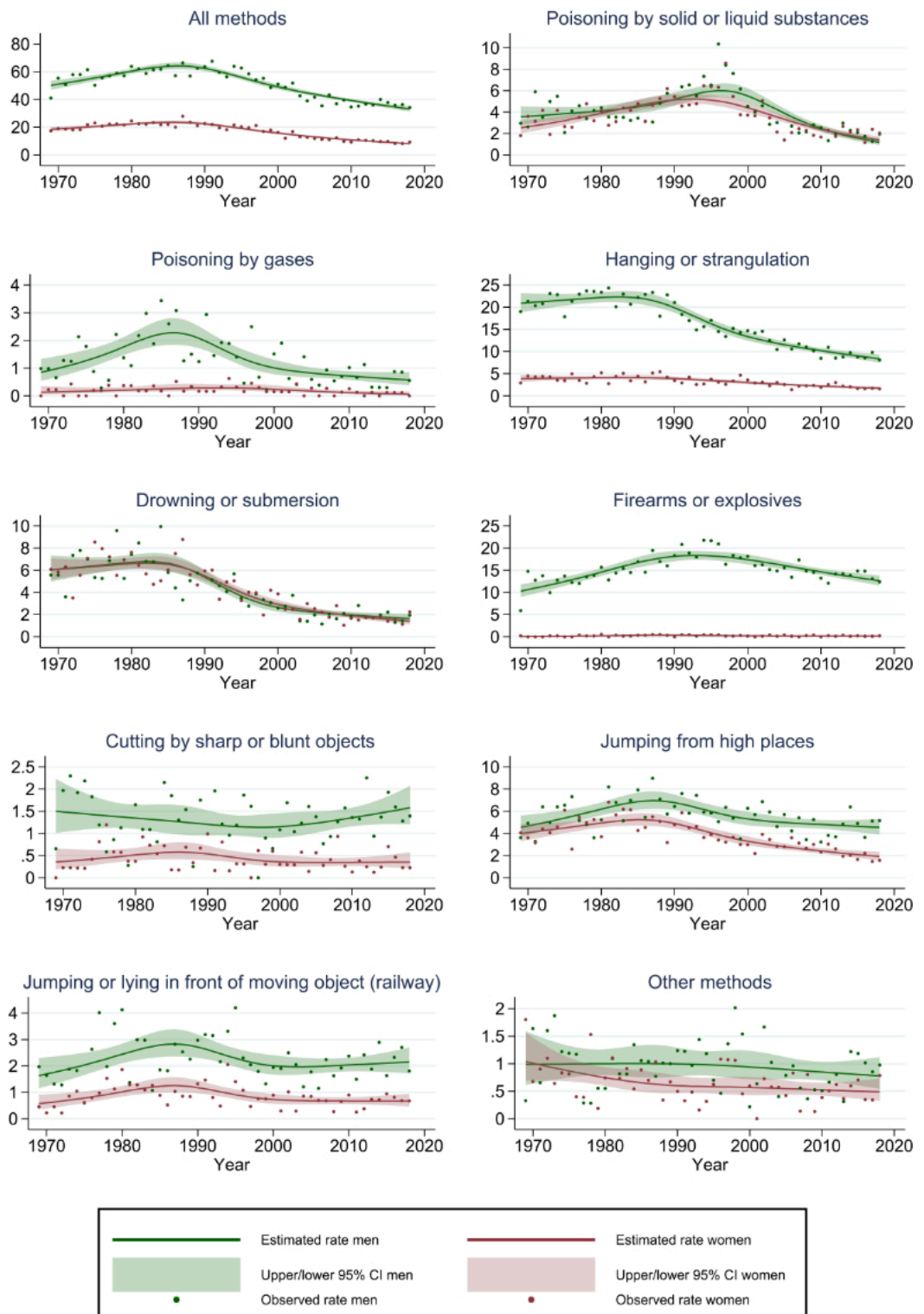
**Figure 3:** Rates of suicide methods per 100,000 population (person-years) in the age group 30–64 years. Note: estimated true rates and associated confidence intervals (CI) were derived from Poisson regressions using a restricted cubic-spline model.



Interestingly, even the 2007 financial crisis did not halt the declining trend of suicides in Switzerland, although the Swiss economy was hit hard by the crisis. This contrasts with increasing suicide rates in other European countries which were more severely struck by the crisis (e.g., Greece, the Netherlands or UK) [34]. Unemployment was

shown to be associated with increased suicide rates across nations [35]. The relatively low unemployment rate in Switzerland despite the financial crisis and the aforementioned overall political and socioeconomic stability as well as a well-functioning healthcare system might help to explain the declining trend in Swiss suicide rates.

**Figure 4:** Rates of suicide methods per 100,000 population (person-years) in the age group 65 or more years. Note: estimated true rates and associated confidence intervals (CI) were derived from Poisson regressions using a restricted cubic-spline model.



Up to 90% of people who commit suicide suffer from a mental disorder, most often affective disorders [36]. Adequate mental health care is therefore crucial to prevent suicides. Access to psychiatric and psychotherapeutic care

**Table 3:**  
Rate ratios of suicides in men.

Agegroup	Suicide method	Period vs reference period 1969–1978 (95% CI)				Foreigners vs Swiss citizens (95% CI)				
		Period 1979–1988	Period 1989–1998	Period 1999–2008	Period 2009–2018	Period 1969–1978	Period 1979–1988	Period 1989–1998	Period 1999–2008	Period 2009–2018
10–29 years	Poisoning	0.958 (0.800–1.148)	0.609 (0.492–0.753)	0.286 (0.215–0.381)	0.109 (0.071–0.167)	0.650 (0.445–0.950)	0.921 (0.656–1.293)	0.515 (0.314–0.842)	0.397 (0.181–0.869)	1.545 (0.769–3.104)
	Gas	1.211 (1.003–1.463)	0.500 (0.390–0.642)	0.173 (0.118–0.255)	0.263 (0.192–0.361)	0.427 (0.321–0.570)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Hanging	1.324 (1.175–1.493)	1.046 (0.920–1.189)	0.681 (0.589–0.788)	0.649 (0.561–0.751)	0.836 (0.746–0.937)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Drowning	0.689 (0.493–0.961)	0.439 (0.297–0.648)	0.285 (0.179–0.452)	0.115 (0.060–0.222)	1.484 (1.084–2.032)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	1.369 (1.243–1.507)	1.339 (1.213–1.479)	0.827 (0.739–0.927)	0.298 (0.254–0.349)	0.153 (0.126–0.184)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Cutting	1.487 (0.876–2.525)	1.063 (0.596–1.896)	0.427 (0.197–0.924)	0.534 (0.265–1.075)	0.937 (0.562–1.563)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.719 (1.382–2.138)	1.729 (1.386–2.156)	1.445 (1.148–1.820)	1.125 (0.884–1.432)	0.743 (0.618–0.893)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.250 (1.009–1.549)	1.334 (1.076–1.654)	1.039 (0.826–1.308)	1.585 (1.290–1.949)	0.601 (0.496–0.729)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	0.941 (0.660–1.343)	0.714 (0.483–1.055)	0.788 (0.537–1.156)	0.609 (0.406–0.915)	0.799 (0.569–1.123)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.271 (1.200–1.345)	1.061 (0.999–1.128)	0.685 (0.639–0.735)	0.504 (0.467–0.544)	0.516 (0.483–0.551)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
30–64 years	Poisoning	1.076 (0.953–1.215)	0.843 (0.744–0.956)	0.593 (0.519–0.677)	0.410 (0.354–0.474)	0.710 (0.637–0.792)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Gas	1.101 (0.981–1.235)	0.470 (0.408–0.541)	0.243 (0.205–0.289)	0.221 (0.185–0.264)	0.305 (0.223–0.418)	0.334 (0.254–0.440)	0.358 (0.250–0.513)	0.421 (0.272–0.650)	0.715 (0.518–0.987)
	Hanging	0.859 (0.797–0.925)	0.749 (0.695–0.808)	0.672 (0.623–0.724)	0.622 (0.576–0.671)	0.423 (0.359–0.499)	0.698 (0.609–0.800)	0.608 (0.530–0.698)	0.685 (0.602–0.780)	0.720 (0.641–0.809)
	Drowning	0.814 (0.702–0.945)	0.495 (0.420–0.585)	0.306 (0.254–0.370)	0.187 (0.150–0.233)	0.600 (0.510–0.705)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	1.171 (1.093–1.254)	1.188 (1.111–1.271)	0.803 (0.747–0.862)	0.469 (0.432–0.509)	0.189 (0.172–0.209)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Cutting	0.868 (0.670–1.124)	0.929 (0.726–1.189)	0.739 (0.573–0.953)	0.770 (0.601–0.986)	0.544 (0.435–0.681)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.393 (1.186–1.636)	1.327 (1.133–1.555)	1.221 (1.042–1.429)	1.135 (0.969–1.330)	0.543 (0.477–0.617)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.188 (1.014–1.392)	1.088 (0.929–1.273)	0.887 (0.755–1.042)	1.110 (0.954–1.292)	0.520 (0.454–0.595)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	0.922 (0.715–1.189)	0.833 (0.647–1.073)	0.967 (0.761–1.228)	0.786 (0.614–1.006)	0.552 (0.444–0.686)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.041 (1.001–1.082)	0.894 (0.859–0.930)	0.678 (0.651–0.707)	0.549 (0.526–0.574)	0.426 (0.389–0.467)	0.465 (0.428–0.505)	0.418 (0.385–0.453)	0.475 (0.437–0.516)	0.503 (0.464–0.544)
>64 years	Poisoning	0.941 (0.728–1.217)	1.890 (1.516–2.356)	0.888 (0.694–1.137)	0.564 (0.435–0.731)	2.900 (1.741–4.829)	2.563 (1.543–4.259)	1.410 (0.950–2.095)	1.185 (0.742–1.892)	1.128 (0.694–1.832)
	Gas	2.062 (1.389–3.061)	1.486 (0.987–2.236)	0.796 (0.508–1.248)	0.631 (0.403–0.986)	0.767 (0.462–1.274)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Hanging	1.036 (0.937–1.146)	0.796 (0.717–0.883)	0.601 (0.540–0.670)	0.441 (0.395–0.493)	0.635 (0.545–0.739)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Drowning	0.977 (0.811–1.177)	0.689 (0.566–0.840)	0.335 (0.266–0.423)	0.297 (0.238–0.372)	0.910 (0.695–1.193)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	1.274 (1.121–1.447)	1.587 (1.407–1.789)	1.354 (1.200–1.528)	1.186 (1.054–1.335)	0.368 (0.306–0.443)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Cutting	0.832 (0.553–1.252)	0.855 (0.576–1.269)	0.807 (0.549–1.187)	1.039 (0.732–1.474)	1.015 (0.681–1.511)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.221 (1.006–1.483)	1.142 (0.942–1.383)	0.951 (0.784–1.153)	0.852 (0.707–1.028)	1.130 (0.932–1.370)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.298 (0.943–1.786)	1.422 (1.046–1.933)	0.938 (0.679–1.297)	1.152 (0.855–1.553)	0.560 (0.374–0.839)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	0.895 (0.555–1.445)	1.146 (0.737–1.782)	0.790 (0.498–1.254)	0.804 (0.520–1.244)	1.085 (0.675–1.744)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.114 (1.046–1.187)	1.117 (1.050–1.188)	0.830 (0.779–0.886)	0.697 (0.654–0.743)	0.908 (0.727–1.135)	0.896 (0.738–1.088)	0.720 (0.601–0.863)	0.571 (0.480–0.678)	0.644 (0.558–0.743)

Note: Incidence rate ratios were derived from Poisson regression models and adjusted for the interaction of period\*nationality, if adding such interaction term statistically significantly improved the fit of the model as compared to the respective model without interaction term (log-likelihood ratio test).

<sup>1</sup> Adding the interaction period\*nationality did not statistically significantly improve the fit of the model when compared to a model without interaction term (log-likelihood ratio test).



**Table 4:**  
Rate ratios of suicides in women.

Age group	Suicide method	Period vs. reference period 1969–1978 (95% CI)				Foreigners vs. Swiss citizens (95% CI)				
		Period 1979–1988	Period 1989–1998	Period 1999–2008	Period 2009–2018	Period 1969–1978	Period 1979–1988	Period 1989–1998	Period 1999–2008	Period 2009–2018
10–29 years	Poisoning	1.109 (0.904–1.361)	0.505 (0.387–0.659)	0.527 (0.403–0.689)	0.198 (0.134–0.291)	1.085 (0.764–1.541)	0.424 (0.251–0.717)	0.764 (0.446–1.308)	0.384 (0.193–0.766)	0.931 (0.442–1.961)
	Gas	1.336 (0.795–2.247)	0.794 (0.433–1.455)	0.230 (0.088–0.601)	0.352 (0.159–0.780)	0.442 (0.213–0.914)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Hanging	1.728 (1.343–2.223)	1.159 (0.878–1.531)	1.058 (0.794–1.409)	0.995 (0.746–1.327)	0.826 (0.659–1.036)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Drowning	0.749 (0.510–1.101)	0.357 (0.215–0.591)	0.277 (0.158–0.488)	0.106 (0.046–0.245)	0.679 (0.419–1.100)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	1.372 (0.863–2.183)	1.561 (0.986–2.473)	1.072 (0.646–1.779)	0.318 (0.151–0.668)	0.479 (0.285–0.804)	– <sup>2</sup>	– <sup>2</sup>	– <sup>2</sup>	– <sup>2</sup>
	Cutting	0.913 (0.371–2.246)	0.548 (0.187–1.603)	0.342 (0.094–1.242)	0.761 (0.289–2.002)	0.559 (0.196–1.591)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.348 (1.045–1.739)	0.888 (0.667–1.183)	0.952 (0.717–1.265)	0.495 (0.351–0.697)	0.710 (0.547–0.920)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.577 (1.168–2.129)	1.369 (0.999–1.876)	1.395 (1.016–1.914)	1.490 (1.094–2.030)	0.453 (0.333–0.615)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	1.165 (0.649–2.093)	1.378 (0.779–2.438)	0.577 (0.278–1.198)	0.498 (0.234–1.060)	1.004 (0.599–1.683)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.308 (1.169–1.463)	0.841 (0.739–0.957)	0.782 (0.684–0.895)	0.561 (0.484–0.650)	0.853 (0.684–1.064)	0.544 (0.426–0.696)	0.773 (0.610–0.979)	0.569 (0.434–0.747)	0.592 (0.438–0.801)
30–64 years	Poisoning	0.944 (0.843–1.057)	0.806 (0.719–0.904)	0.544 (0.480–0.616)	0.433 (0.380–0.493)	0.606 (0.536–0.686)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Gas	1.232 (0.962–1.578)	0.500 (0.369–0.679)	0.369 (0.266–0.513)	0.305 (0.216–0.431)	0.392 (0.270–0.569)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Hanging	1.106 (0.975–1.254)	0.828 (0.725–0.944)	0.756 (0.662–0.862)	0.729 (0.639–0.832)	0.553 (0.485–0.632)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Drowning	0.886 (0.778–1.010)	0.556 (0.481–0.642)	0.329 (0.279–0.389)	0.171 (0.139–0.211)	0.501 (0.419–0.598)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	1.321 (0.981–1.777)	1.571 (1.185–2.083)	0.961 (0.707–1.305)	0.542 (0.381–0.770)	0.284 (0.191–0.422)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Cutting	1.025 (0.653–1.607)	0.994 (0.638–1.548)	0.700 (0.436–1.123)	0.805 (0.513–1.264)	0.443 (0.269–0.730)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.431 (1.232–1.662)	0.996 (0.851–1.166)	0.865 (0.737–1.014)	0.711 (0.603–0.838)	0.683 (0.591–0.789)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.266 (1.047–1.530)	1.235 (1.025–1.488)	1.033 (0.854–1.249)	0.953 (0.786–1.155)	0.378 (0.306–0.468)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	1.199 (0.878–1.637)	1.173 (0.863–1.593)	0.886 (0.644–1.220)	0.783 (0.566–1.083)	0.568 (0.418–0.773)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.087 (1.028–1.150)	0.842 (0.795–0.893)	0.640 (0.602–0.680)	0.529 (0.497–0.564)	0.538 (0.505–0.573)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
>64 years	Poisoning	1.198 (0.965–1.486)	1.811 (1.488–2.204)	0.944 (0.760–1.173)	0.677 (0.540–0.850)	1.909 (1.103–3.307)	2.403 (1.560–3.700)	1.939 (1.369–2.746)	1.179 (0.718–1.936)	0.578 (0.295–1.131)
	Gas	1.393 (0.577–3.361)	1.795 (0.786–4.101)	0.924 (0.371–2.297)	0.565 (0.212–1.507)	1.497 (0.597–3.751)	– <sup>2</sup>	– <sup>2</sup>	– <sup>2</sup>	– <sup>2</sup>
	Hanging	1.124 (0.928–1.362)	0.847 (0.695–1.034)	0.721 (0.590–0.883)	0.538 (0.436–0.663)	0.591 (0.423–0.824)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Drowning	1.006 (0.864–1.172)	0.672 (0.571–0.792)	0.421 (0.351–0.505)	0.251 (0.205–0.308)	0.627 (0.465–0.844)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Firearms	2.568 (1.020–6.470)	2.521 (1.012–6.278)	1.580 (0.607–4.111)	1.529 (0.598–3.910)	1.107 (0.445–2.750)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Cutting	1.091 (0.624–1.907)	0.928 (0.528–1.629)	0.946 (0.548–1.634)	0.641 (0.361–1.138)	1.523 (0.840–2.762)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Falls	1.230 (1.029–1.469)	0.940 (0.782–1.129)	0.708 (0.584–0.857)	0.500 (0.409–0.610)	1.034 (0.812–1.318)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Railway	1.513 (1.000–2.290)	1.449 (0.963–2.181)	0.902 (0.581–1.399)	0.941 (0.617–1.436)	0.477 (0.236–0.964)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	Other	0.798 (0.518–1.227)	0.703 (0.457–1.082)	0.562 (0.361–0.875)	0.524 (0.341–0.807)	1.542 (0.948–2.506)	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>	– <sup>1</sup>
	All methods	1.136 (1.042–1.238)	0.996 (0.914–1.085)	0.672 (0.613–0.737)	0.491 (0.446–0.541)	1.074 (0.810–1.424)	1.072 (0.832–1.380)	1.213 (0.965–1.526)	0.888 (0.682–1.155)	0.630 (0.467–0.848)

Note: Incidence rate ratios were derived from Poisson regression models and adjusted for the interaction of period\*nationality, if adding such interaction term statistically significantly improved the fit of the model as compared to the respective model without interaction term (log-likelihood ratio test).

<sup>1</sup> Adding the interaction period\*nationality did not statistically significantly improve the fit of the model when compared to a model without interaction term (log-likelihood ratio test).

<sup>2</sup> Model with interaction period\*nationality could not be estimated (non-convergence) due to very low suicide rates.

was facilitated in Switzerland with the 1996 introduction of mandatory health insurance for all residents. Together with efforts to destigmatise mental disorders, this resulted in a steadily increasing proportion of the Swiss population who used psychiatric services [37]. Further measures to improve mental health care in Switzerland (and elsewhere) involved education of non-psychiatric health professionals (e.g., primary care physicians) for better recognition and treatment of depression [38–41], greater awareness of the high suicide risk after discharge from psychiatric hospitals [3, 42, 43], and increased prescription of antidepressants, particularly selective serotonin reuptake inhibitors (SSRIs), which are easier to handle by general practitioners than other antidepressants [44–48]. These improvements in mental health care most probably contributed to declining suicide rates in Switzerland.

However, in other countries such as the USA, the suicide rate did not decline and was even increasing since the millennium [49], despite preventive developments such as increased prescription of antidepressants [50]. Although most suicide decedents suffer from mental disorders [36], most people with mental disorders do not commit suicide [51]. This suggests the importance of factors other than mental health which may place people at risk for suicide [2, 5]. Among these precipitating factors are stressful life events such as interpersonal conflicts [1, 52] or the availability of lethal means [3, 53], which seem to be particularly important for impulsive suicidal acts. The in-depth study of the use of different suicide methods in different population subgroups may help to better understand risk factors for suicide and inform targeted preventive measures.

### Specific methods of suicide

As the overall suicide rate, suicides by specific methods typically declined since the 1980s in both sexes, in all age groups, and in Swiss as well as in foreign citizens. Also consistent with suicides in general, the specific suicide methods were typically more often used by men, by older people and by Swiss citizens. However, the use of some specific suicide means diverged from this general pattern, at least in some subpopulations. Together with the most frequently used methods in recent years, this requires particular attention with respect to targeted suicide prevention measures.

#### *Poisoning with solid or liquid substances*

Suicides by poisoning with solid or liquid substances had declined in Switzerland over most recent decades. This corresponds with more cautious dispersion of potentially lethal drugs such as reduction of paracetamol package sizes to non-lethal doses [54, 55] or replacement of tricyclic antidepressants with less toxic SSRIs [8]. The decline in suicides by poisoning occurred with some delay and not until the late 1990s in older people (>64 years). However, this could be due to erroneous reporting of assisted suicides, which were not documented with an extra ICD-10 code until 1998. Assisted suicides most likely occur in older and physically ill people [56], and they were particularly prone to be miss-classified as "conventional" suicides by poisoning in the 1990s, when this phenomenon was new in Switzerland. Yet another explanation for the delayed decline among the elderly could be the higher

availability of potentially lethal drugs in their households. Due to relatively high incidence rates, prevention of suicides by poisoning with solid or liquid substances deserves particular attention in women and in foreigners, especially when taking into account the steadily increasing proportion of migrants in Switzerland [57].

#### *Poisoning with gases*

Suicides by poisoning with gas had already declined in Switzerland in the 1950s and 1960s when the domestic gas was detoxified [58]. During the 50 years studied here (1969–2018), suicides by gas were rare in women. In men, gasification remained a relatively common suicide means until the mid-1980s, when new legislation prescribed catalytic converters for new motor vehicles. As a result, the exhaust of new cars was no longer available as a lethal means [8] and gas suicides began to decline rapidly in all male age groups and across nationalities. The association between the introduction of catalytic converters and declining rates of gas suicides was observed in various countries, with no or only moderate shifts to suicides by other means [18, 59–61]. In Switzerland, some method substitution might have occurred among older men (>64 years), among whom suicides by poisonings with solid or liquid substances and firearm suicides had increased in the late 1980s and early 1990s. However, the overall suicide rate had decreased even in this age group. Our findings therefore underpin the potential of restricting access to lethal means as an evidence-based strategy for suicide prevention [19, 53], even though emission laws were introduced for environmental and not for suicide prevention purposes. Suicides by charcoal burning had most recently attained increasing popularity in some Asian countries [53] after extensive media reporting of a few cases [62]. So far, our data suggest no increase of poisonings with gases in Switzerland.

#### *Hanging, strangulation and suffocation*

Hanging accounted for most suicides in Switzerland between 1969–2018. Incidence rates had typically declined since the 1980s but trends then tended to level out more recently. In consequence, hanging had become the most common suicide means in younger and middle-aged people (<64 years). Maybe, other methods to which access was restricted (e.g., firearms or toxic substances) had been partially substituted with hanging, which is an easily available and highly lethal method [63]. Restricting access to ties and ligature points is difficult, especially in public places [64]. Some preventive evidence is available for infrastructural measures (e.g., "anti-suicide" shower heads) in controlled environments such as psychiatric hospitals or prisons [63, 65].

#### *Drowning*

Drowning used to be a common suicide method with similar incidence rates in men and women, but rates declined in all subpopulations over more recent decades. This might be explained by efforts to teach swimming at Swiss schools since the 1960s, when public and private swimming pools became popular in Switzerland [8]. Although swimming lessons were intended to prevent accidental drowning, they

apparently also had an impact on suicides. The delayed decline among older people and consistently higher rates in young foreign men (as compared with young Swiss men) might be due to the lower penetration of swimming lessons in older people and migrants.

#### *Firearms*

Firearms are a highly lethal suicide method [66], which is often used in impulsive suicidal acts [67]. The availability of guns in households was shown to be associated with firearms suicides [68, 69], whereas restricting access to firearms seems to reduce firearm suicides, with only modest method substitution [3, 19]. If suicides by firearms ranked second (after hanging) in Switzerland over the last 50 years, this corresponds with the quite liberal firearms legislation and the high availability of firearms in Swiss households [68, 69]. Further underpinning the relevance of availability, firearm suicides were particularly common in Swiss men, who usually have easy access to firearms. In Switzerland, all male citizens are obliged to serve in the militia army. Army weapons are usually stored at home between army trainings and they often go to private ownership after termination of military services for a small fee [70, 71]. In 2003, the personnel of the Swiss army was approximately halved and since 2007 ammunition is no longer stored at home by the militia soldiers [71]. These reforms reduced the availability of firearms and provide an explanation for the decline in firearm suicides. This decline was particularly pronounced in younger Swiss men. A previous study showed that this decline in young men was indeed due to reduced suicides by military firearms, whereas suicides with other guns did not decrease [70]. Further findings from Switzerland suggest only modest method substitution following the army reform [71], even though some shift to railway suicides might have occurred in younger men. Among older Swiss men, the decline in firearm suicides was less pronounced and firearms had even become the most common suicide means in most recent decades. However, these older generations had served in the army before the reforms and they often still stored weapons and ammunition at home. Assuming that the choice of suicide means not only depends on their availability but also on their cultural and societal acceptance [72], reduced public acceptance of private firearms possession could provide yet another explanation for decreasing firearms suicides in Switzerland.

#### *Cutting with sharp or blunt objects*

Suicides by cutting are hard to prevent by restricting access to widely available sharp or blunt objects. However, suicides by cutting are relatively rare in Switzerland (2.1% of all suicides) and we could not identify a subpopulation in which this method is of major relevance. Nevertheless, it should be kept in mind that cutting is a frequently used means for non-lethal self-injurious behaviour.

#### *Jumping from heights*

Suicides by falls had decreased less than other common methods of suicide (e.g., hanging or firearms in men or poisoning in women) over the last 50 years. Most recently, jumping from heights had even become one of the most

common suicide means in women and in older foreign men. Previous findings suggested that leap suicides often occur among people with severe mental illness (e.g., psychosis) [8, 67] and among inpatients who lack access to other means while being at hospital [73]. Therefore, safeguarding jumping sites at hospitals seems to be an important prevention strategy [74], as is the safeguarding of so-called "hotspots" in general. Leap suicides tend to accumulate at hotspots such as iconic bridges, towers or other high-rise buildings [73]. This suggests the role of imitation effects in leap suicides, which may be additionally inspired by media reports [75]. Restricting access by erecting barriers (e.g., fences or safety nets) at hotspots and installing signage offering help at popular jumping sites were shown to reduce leap suicides, with little evidence for major method substitution in Switzerland [76–78] and elsewhere [19, 79]. However, moving to another nearby jumping location may still occur [80] and securing hotspots by barriers can be hindered by high costs or aesthetic objections. This might explain the modest decline in leap suicides in Switzerland. Yet another explanation could be that other methods with declining trends (e.g., firearm suicides) were partially substituted with leap suicides.

#### *Railways*

Railway suicides were increasing in the current millennium, particularly in younger and in male subpopulations. Among younger people, railway suicides had even become the most common means in recent years aside from hanging [81]. Maybe reduced suicides by other methods (e.g., firearms) were partially substituted with railway suicides. Switzerland has a dense railway network, making trains readily available as a highly lethal means of suicide [14]. Correspondingly, railway suicides are more common in Switzerland than in other countries [82]. In 2013, the Swiss Federal Railways company started an action plan to prevent suicides [82]. However, measures such as training of staff, surveillance of hotspots and more cautious communication of railway suicides probably need some more time to unfold their full preventive effects. As railway suicides are highly prone to imitation, media guidelines for responsible reporting are yet another preventive strategy to limit the awareness of this easily available and highly lethal suicide method [83–85]. While physically securing all railways is impossible, barriers at hotspots (e.g., fences at railways near psychiatric hospitals) represent other promising strategies for railway suicide prevention [82, 86, 87].

#### *Other methods*

Suicides by other methods such as crashing a motor vehicle and suicides by other unspecified means were rare in Switzerland throughout the five decades. Thus, they are of minor relevance with regard to method-specific suicide prevention measures.

#### **Limitations**

Our study has some limitations. First, we discussed and interpreted changes in suicide rates in relation to changes in potentially explaining factors (e.g., availability of firearms) but we did not quantitatively correlate changes in suicide rates with changes in risk or protective factors. Our

explanations were discussed among experts from various disciplines, but they should be considered rather speculative, as the data and methods used in this study did not allow testing of the stated hypotheses. Second, there might be erroneous reporting of causes of death in the mortality statistics (e.g., misattribution of suicide to accidental deaths or, less likely, vice versa). However, it is unlikely that registration patterns had systematically changed during the study period. Effects of misreporting on time trends in suicide rates should therefore be tolerable. Last but not least, our analyses were restricted to completed suicides and did not take into account attempted suicides and suicidal ideation, which are much more prevalent than completed suicides [2, 6, 19], particularly in women [88].

## Conclusions

Suicides in total and suicides by specific methods generally declined in Switzerland over the latest three decades across sexes, ages and nationalities. Some methods (e.g., drowning or poisoning by gases) had become relatively rare, whereas other methods also declined but go on accounting for many suicides in Switzerland every year, at least in some subgroups of the resident population (e.g., firearms in older Swiss men or railway suicides in young residents). In summary, our results both corroborate previous findings that suicides are preventable [3, 19, 88] but they also refer to the need for further and targeted preventive efforts, if a 25% reduction of the Swiss suicide rate is to be achieved by 2030 as intended by the national action plan [31].

The decline in specific suicide methods such as firearms, drownings or poisonings was associated with changes in the availability of these lethal means in Switzerland. Suicide attempters usually have a preferred method [16, 89] and they often act impulsively [52, 90, 91]. If immediate access to the preferred means is restricted, brief suicidal crises with strong ambivalence may pass by [3]. And even if people switch to other means, restricting access to highly lethal methods increase chances that a less lethal method is chosen [8]. In this line of reasoning, our data also suggest no major method substitution after access to specific means was restricted. Aside from method restriction, further explanations for decreasing suicide rates in Switzerland are the development of media guidelines for more responsible reporting of suicide events (e.g., avoidance of explicit descriptions and speculation about reasons) [31] and improvements in health care, including easier access to health services (following the introduction of mandatory health insurance), measures to improve early identification and management of mental disorders [41] and changes in drug prescription (more SSRIs, less toxic drugs) [8].

Further efforts to reduce suicides in Switzerland and elsewhere require coordination and collaboration among multiple sectors of the society (e.g., health, education, justice, law, politics, media sector) [2, 19, 88]. Suicidal behaviour is a complex issue with many factors beyond mental disorders being involved [7]. A public health approach to prevention should therefore include combinations of evidence-based universal (e.g., means restriction), selective (e.g., early detection of mental disorders) and indicated (e.g., follow-up care after attempted suicide) strategies on both an individual and a population level [6, 19]. Our

analyses underpinned that different suicide methods are chosen by different people or subgroups of the population. Targeted prevention measures should take these findings into account and aim at differentiated prevention strategies for individuals or groups at high risk in order to further reduce suicides.

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## Potential competing interests

All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest was disclosed.

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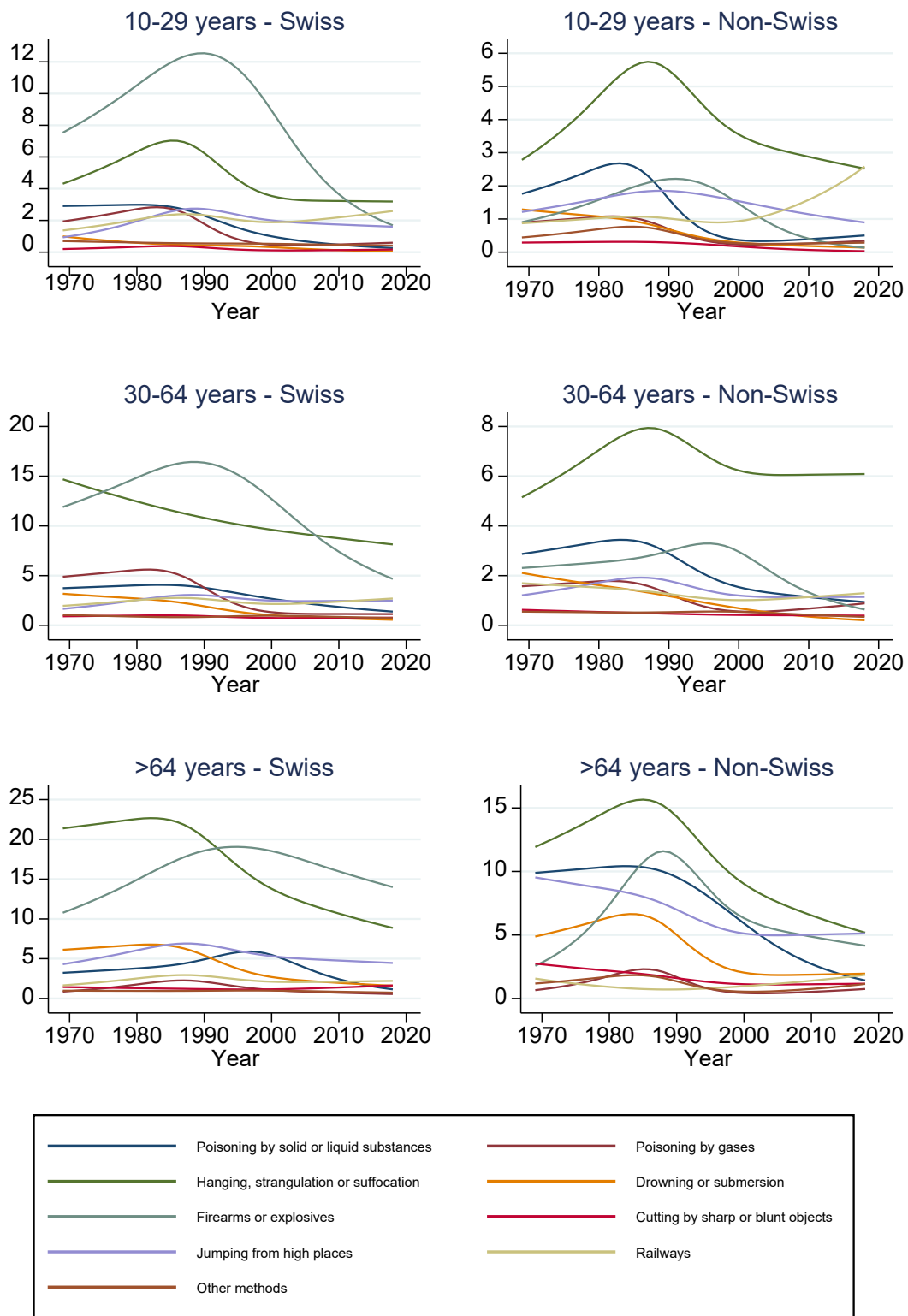
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# Appendix

**Table S1.** Resident population (annual mean) in Switzerland (1969–2018).

Age group	Sex	Nationality	Period				
			1969–1978	1979–1988	1989–1998	1999–2008	2009–2018
10–29 years	Male	Swiss	813463	813837	720898	684119	711814
		Other	155856	149247	193989	208230	240446
	Female	Swiss	797222	792811	703671	665385	691059
		Other	159515	145426	188994	202506	222698
30–64 years	Male	Swiss	1041577	1140394	1265025	1394888	1429523
		Other	269733	293548	384548	440686	595765
	Female	Swiss	1161064	1260012	1375283	1467075	1491068
		Other	186720	200327	269449	365561	509531
>64 years	Male	Swiss	309600	355392	393475	445040	563939
		Other	16207	19479	28003	52525	82635
	Female	Swiss	453172	531361	598180	653636	754312
		Other	23564	25690	32044	49089	73886
Total			5387694	5727525	6153559	6628739	7366676

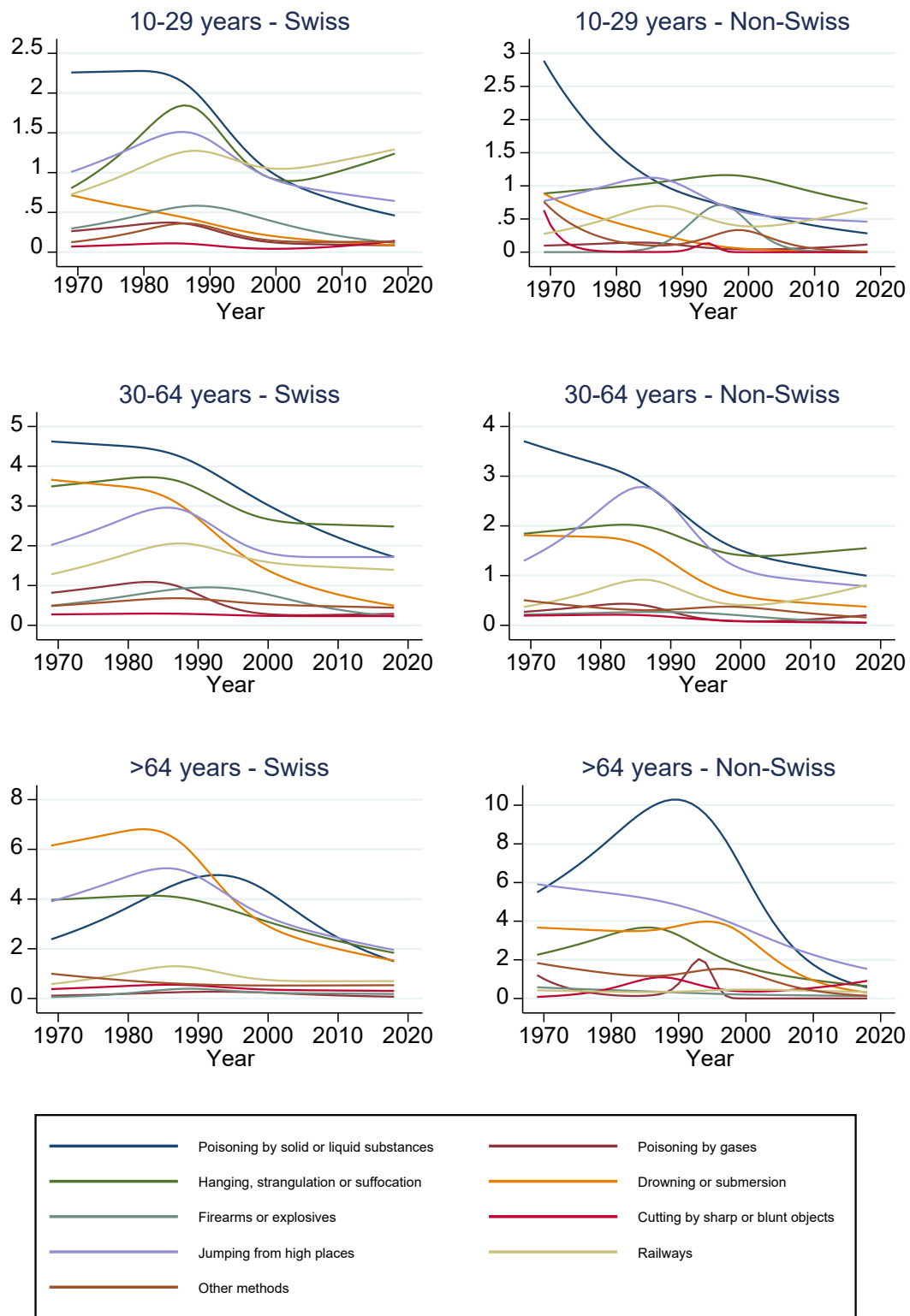
**Figure S1.** Rates of suicide methods per 100'000 population (person-years) in men.



Note: Estimated true rates were derived from Poisson regressions using a restricted cubic-spline model.



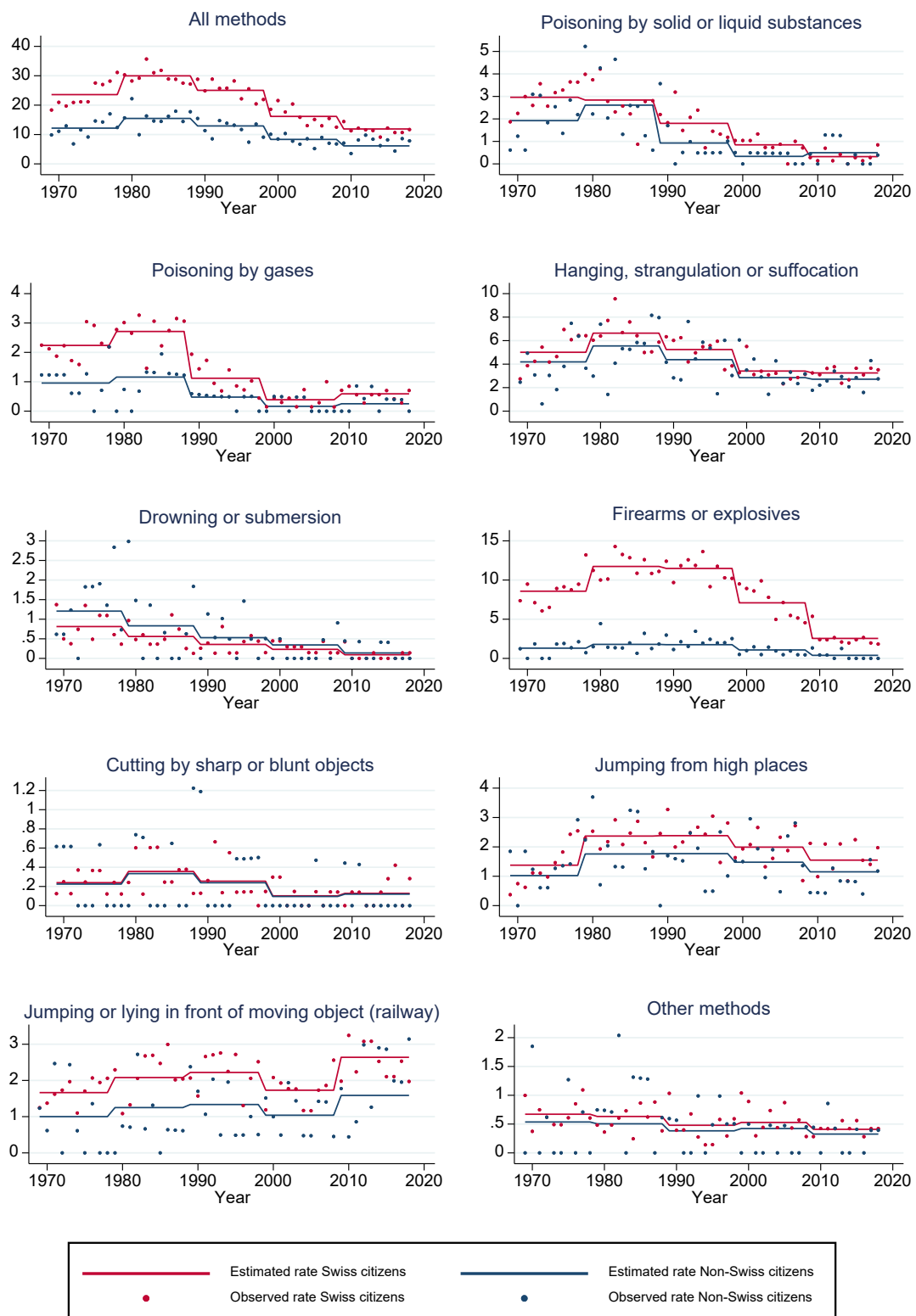
**Figure S2.** Rates of suicide methods per 100'000 population (person-years) in women.



Note:

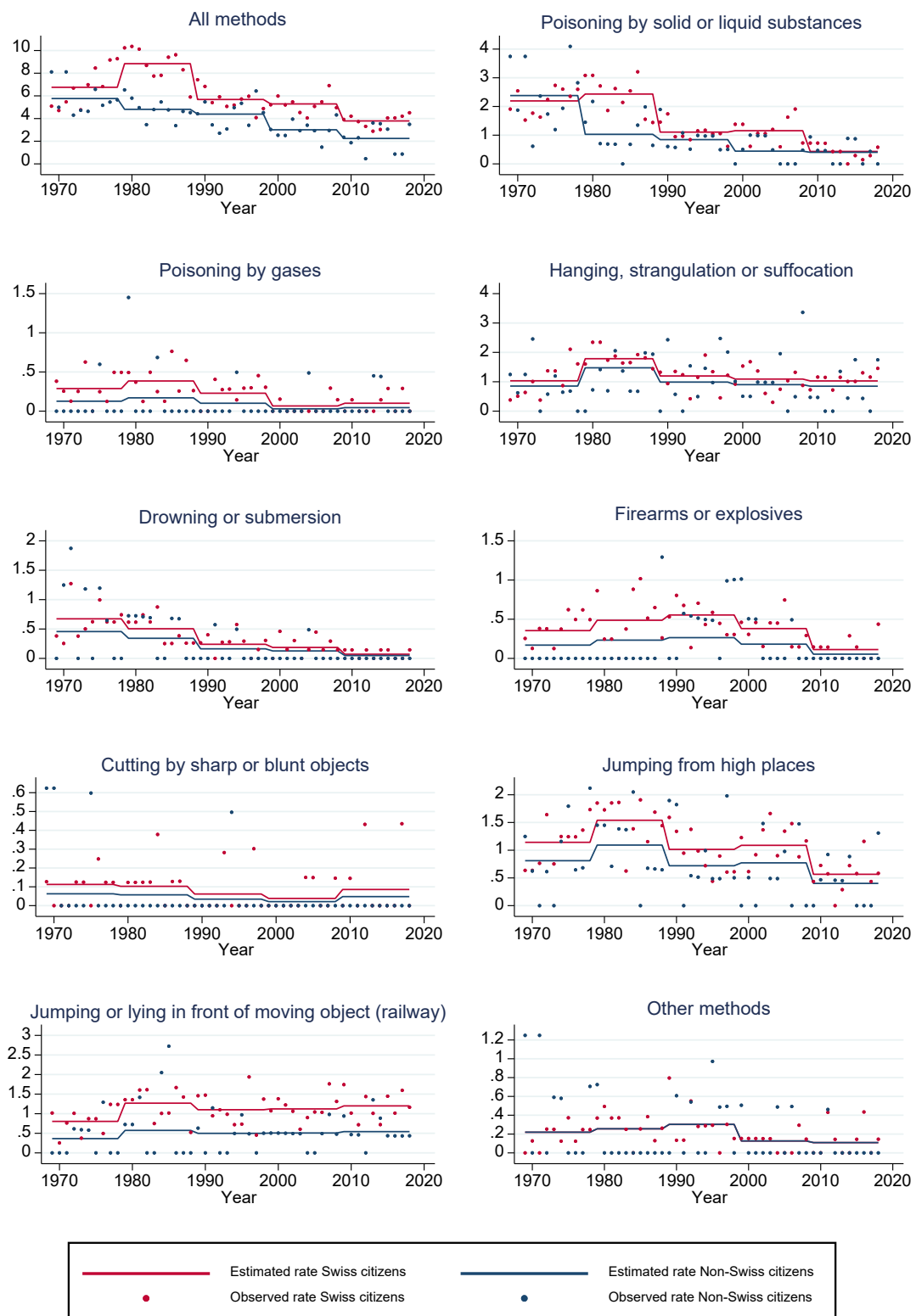
Estimated true rates were derived from Poisson regressions using a restricted cubic-spline model.

**Figure S3.** Rates of suicide methods per 100'000 population (person-years) in 10-29 years old men.



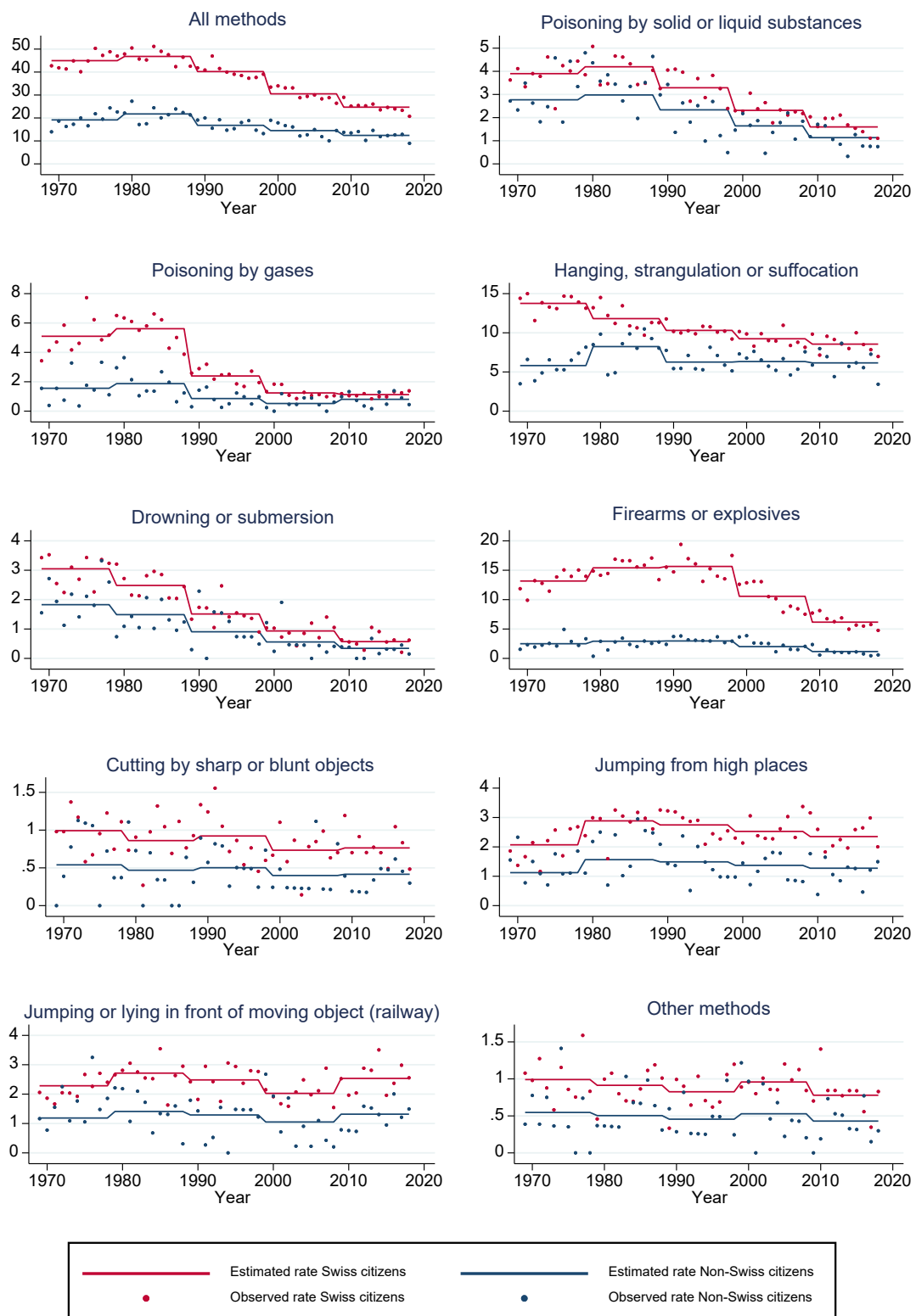
Note: Estimated true rates were derived from Poisson regression models.

**Figure S4.** Rates of suicide methods per 100'000 population (person-years) in 10-29 years old women.



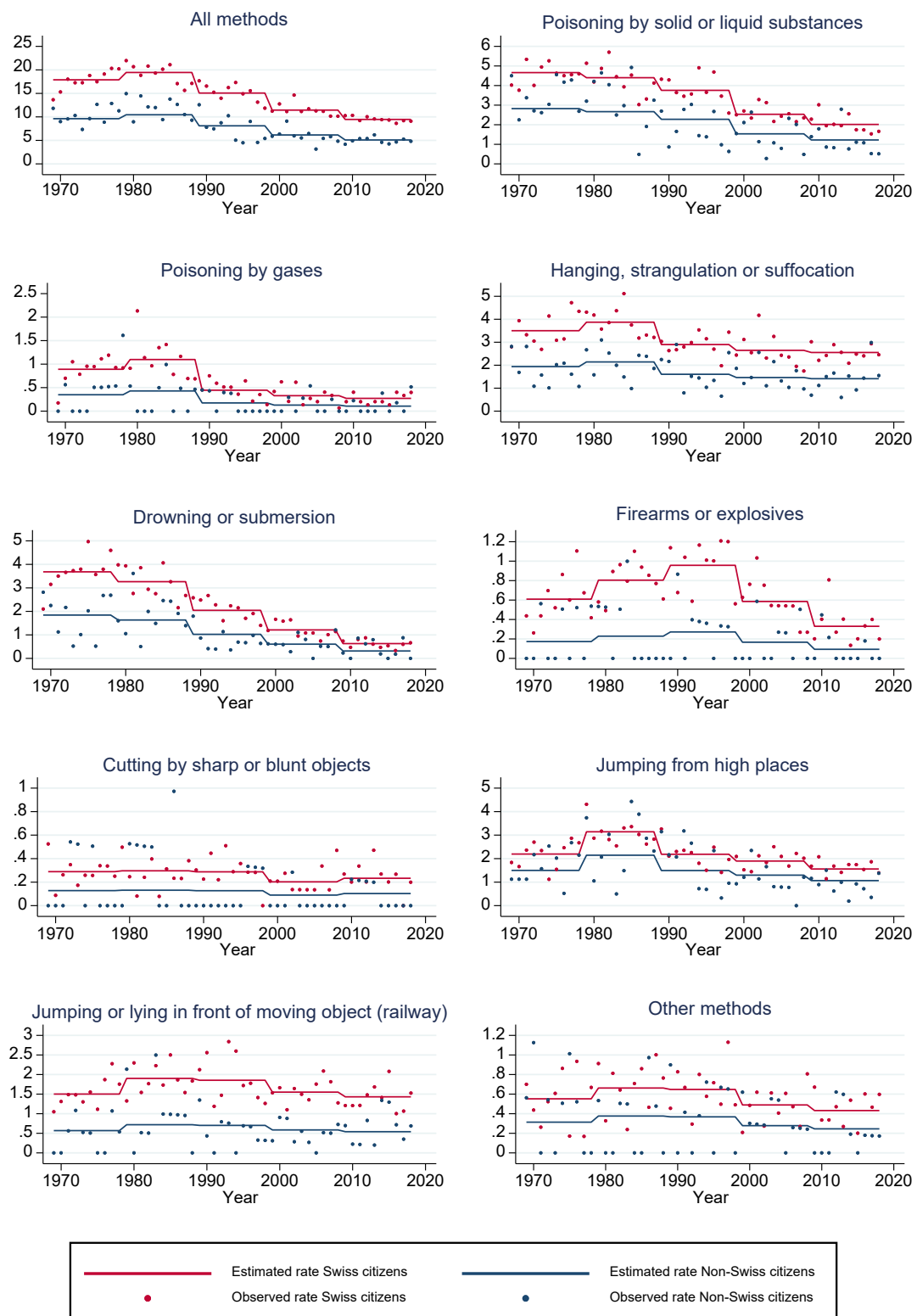
Note: Estimated true rates were derived from Poisson regression models.

**Figure S5.** Rates of suicide methods per 100'000 population (person-years) in 30-64 years old men.



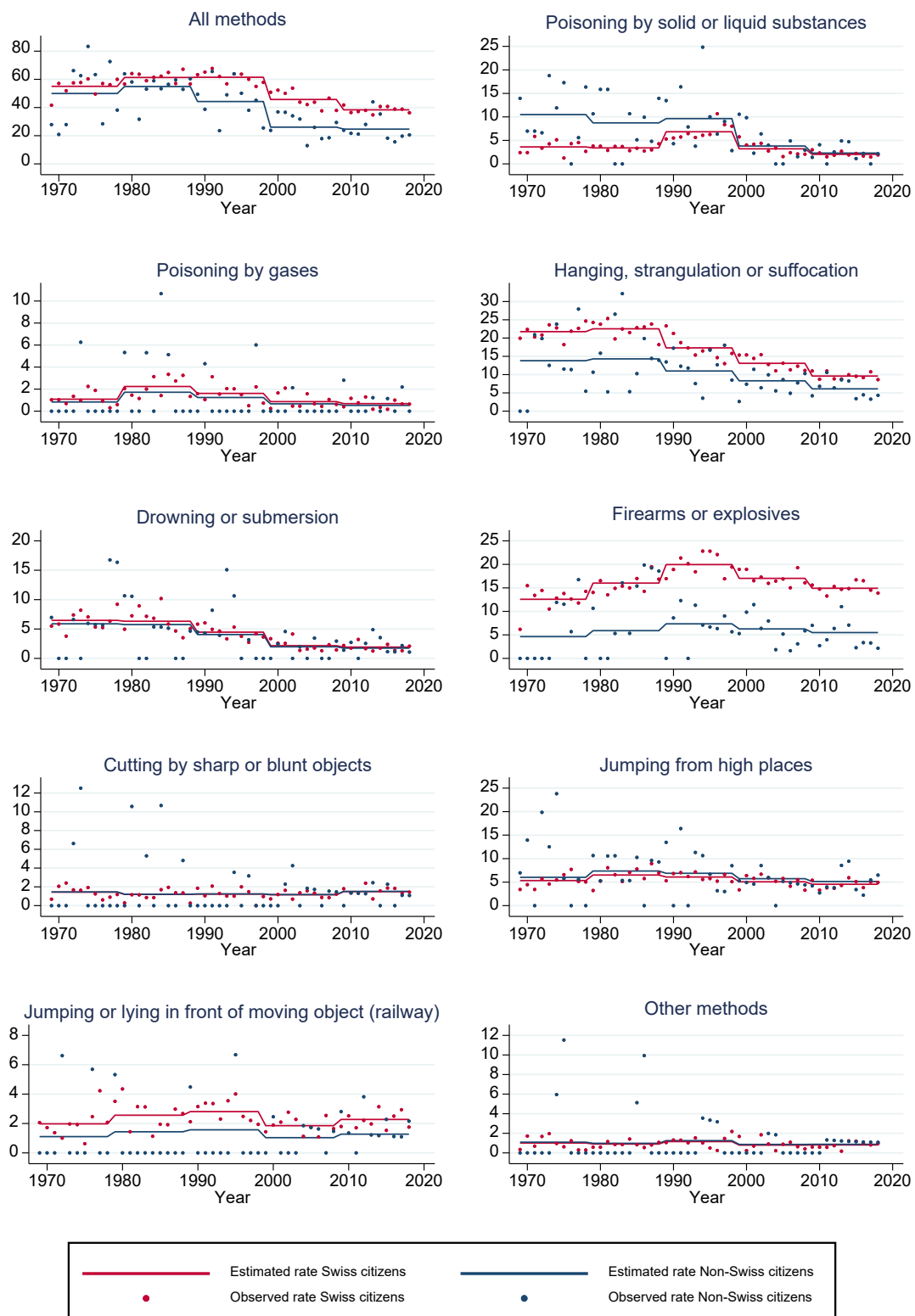
Note: Estimated true rates were derived from Poisson regression models.

**Figure S6.** Rates of suicide methods per 100'000 population (person-years) in 30-64 years old women.



Note: Estimated true rates were derived from Poisson regression models.

**Figure S7.** Rates of suicide methods per 100'000 population (person-years) in 65 or more years old men.



Note: Estimated true rates were derived from Poisson regression models.

**Figure S8.** Rates of suicide methods per 100'000 population (person-years) in 65 or more years old women.



Note: Estimated true rates were derived from Poisson regression models.