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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland

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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland

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Abstract

Objectives: The aim was to study mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths through 20 years in Iceland.

Design: A population-based register study.

Participants: Individuals who died due to road traffic injury, suicide, accidental poisoning, event of undetermined intent, and drug-related deaths in the population of Iceland during the years 1996-2015. Annual age-standardized rates were calculated, and the trend analysed by Pearson correlation and joinpoint regression.

Setting: The population of Iceland framed the study material, and the data was obtained from nation-wide registries for information on number of deaths and age specific mean population in each year by gender.

Results: The crude overall suicide rate during the last ten years was 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1), while the crude overall rate due to road traffic injuries was 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3). Among men suicide rates decreased, however not significantly (r (19) = -0.22, p = 0.36), and for overdose by narcotics the rates increased significantly (r (19) = 0.72, p < 0.001) during the study period. Among women the suicide rates increased , however not significantly (r (19) = 0.35, p = 0.13), for accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly (r (19) = 0.60, p = 0.006); and the rates for overdose by sedative, and overdose by narcotics both increased significantly r (19) = 0.49, p =0.3, and r (19) =0.67, p =0.001, respectively.

Conclusion: The suicide rates have not changed during 1996 to 2015, however the rates for the combined accidental poisoning, suicide, and event of undetermined intent increased

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significantly for women. The rise of the overdose rates for sedative among women and for

narcotics among both genders are consistent with reports elsewhere.

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Strength and limitation

- Nation-wide data coverage was an advantage in the data analysis and secured completeness.

- The causes of death were obtained from death certificates and were systematically reported by International Classification of Diseases, tenth version.

- Underreporting and misclassification of suicide may occur in unknown magnitude, and thus separate and combined analysis of suicide, accidental poisoning and death due to event of undetermined intent augment the information in the present study.

- The combination of deaths because of overdose enhanced the analysis of this topical problem.

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Introduction

Suicide rates increased in the United States (US) through 1999 to 2016, and in 25 states more than 30% increases were observed (1). In 2016 the overall suicide rates in US was 15.6/100,000 (age-adjusted) (1). This comprehensive US report (1) did not include injury death of undetermined intent, which is conventional in studies in the United Kingdom (UK) (2), and in accordance with UK Office for National Statistic (ONS) reporting practice (3). Despite the differences in definition of suicide, the 2017 suicide rate in the UK, combining suicide and deaths of undetermined intent, was 10.1/100,000 (age-adjusted) which is the lowest rate observed since 1981 (4), and substantially lower than the US rates.

The invers association between suicides and unintentional poisoning mortality through time has been suggested to be due to misclassification of poisoning deaths (5,6), however, the increases in unintentional poisoning and undetermined poisoning rates exceed the reciprocal decrease in suicide rates according to US studies (5,6).

Increasing poisoning mortality rates in US and other places (7,8) further adds to the difficulties in registration of suicides in national data registries. Undercounting of suicide and misclassification of suicides as accidental poisonings or event of undetermined intent diminish the possibility to measure potential effects of prevention and intervention attempts (6,9). The situation is even more difficult in a small population as in Iceland; however, the mortality statistic of the country has been considered of high quality (10) and the population dimensions in the National Registry have the character of annual census (11). According to recent overview from the Director of Health it is not possible to state whether any changes have occurred in the overall death rates of suicides in Iceland through the last decades (12) when counting death by intentional self-harm as an underlaying cause of death. During the last ten years the annual overall suicide death rate in Iceland was 12.1/100,000 (12). This report did not mention deaths due to accidental poisoning or event of undetermined intent (12). A work group established by the Director of Health has proposed several detailed measures in attempt to cut down the number of suicides (13) and the office has conducted studies on suicidal thoughts and attempts among young people (14).

The aim was to study mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths by gender through 20 years in Iceland.

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Materials and methods

The primary source of data was from the website of Statistic Iceland, (National Cause-of-Death Registry, a nation-wide death registry) accessed April 2018 (15), and from the same website the age specific population figures were obtained from the National Registry. The available age groups were 0 to 5 years, 6 to 15 years, 16 to 20 years, 21 to 66 years, and 67 years and older. The registered cause of deaths was according to death certificates which were issued by physician according to Icelandic law (16). The causes of death have been coded according to the 10th revision of the International Classification of Diseases (ICD-10) since 1996 (17), and available were the external cause of injury mortality. The National Registry contains all inhabitants of Iceland and is continuously updated. The mean population was 269 thousand in 1996 and increased to 331 thousand in 2015; and during the period the proportion of foreign citizens grew from 2 to 7% (11).

The injury mortality categories of interest were: V02-V89 Motor vehicle transport accidents, called Road traffic injuries; X40-X49 Accidental poisoning by and exposure to noxious substances, X60-X84 Intentional self-harm (suicide); Y10-Y34 Event of undetermined intent; X40-X49, X60-X84 and Y10-Y34 combined Accidental poisoning by and exposure to noxious substances, Intentional self-harm, and Event of undetermined intent, called Poisoning, Suicide, and Undetermined; X41, X61 and Y11 combined Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, Intentional self-poisoning and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, and Poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent, called overdose by sedative; X42, X62 and Y12 combined Accidental poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, Intentional self-poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewere classified, Poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, called overdose by narcotics.

The number of injury deaths per category were all cases in the population and these were related to population age and gender specific numbers in the annual mid-year versions of the National Registry through the study period (11). Annual crude mortality was calculated per

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100,000 for the last ten years of the study period with 95% confidence intervals (CI). Annual gender specific age-adjusted mortality rates were calculated using modified World Standard as a reference. Pearson correlation coefficient were computed for annual changes during the study period. Differences were judged significant based on a two-sided test if p values were less than 0.05. The changes in rates from 1996 to 2015 were analysed by joinpoint regression model (18). The smallness of the data limited the possibility to apply complex models, however, the estimated annual changes in rate from the beginning to the end of the study period were calculated for road traffic injury, the combined categories of poisoning, suicide, and event of undetermined intent, and suicide. The slopes were converted to annual percentage changes (APC) showed with 95% CI.

The Data Protection Commission and the National Bioethics Committee (VSNb2019040011/03.03) approved the study.

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Results

The crude overall suicide rate representing the last ten years were 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1). The crude overall rate for combined accidental poisoning, suicide and events of undetermined intent, during the same period was 14.8 per 100,000 persons per year (95% CI 9.3 to 22.1). The crude overall rate due to road traffic injuries was in comparison low 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3).

Tables 1 and 2 show the annual number of the selected categories of external causes of deaths: road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics in male and female respectively through 1996 to 2015. In some of these categories for some years there are no deaths or one or two, and overall the figures are low per category per years and varied considerably through the years obscuring trend when comparing individual years to each other.

Table 3 shows the age standardized rates per 100,000 males per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Across 1996 to 2015, rates decreased for road traffic injuries, calendar years and rates were negatively correlated, $r(19) = -0.66$, $p = 0.001$. For suicide the rates also decreased however not significantly ($r(19) = -0.22$, $p = 0.36$). For other categories or combined categories, the rates did not change significantly during the study period except for overdose by narcotics where the rates increased significantly ($r(19) = 0.72$, $p < 0.001$).

Table 4 shows the age standardized rates per 100,000 females per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Similarly, as among the males across 1996 to 2015, the rates decreased for road traffic injuries, calendar years and rates were negatively correlated, however not significantly ($r(19) = -0.38$, $p = 0.09$). For the separate categories of accidental poisoning, suicide, and events of undetermined intent the rates were found to increase, however not significantly, the calendar years and the rates were moderately positively correlated. For accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly ($r(19) = 0.60$, $p = 0.006$). The rates for overdose

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by sedative, and overdose by narcotics increased significantly with a positive correlation, r (19) = 0.49, p =0.3, and r (19) =0.67, p = 0.001, respectively.

In the joinpoint regression analysis the trend was analysed through the study period for road traffic injuries rates where the APC indicates decrease by 5.5 (95% CI -8.3 to -2.6) for men and decrease by 6.4 (95% CI -12.2 to -0.2) for women. During the same period the combined categories accidental poisoning, suicide, and event of undetermined intent the APC was increased by 0.2 (95% CI -1.1 to 1.6) for men, and the APC was increased by 2.6 (95% CI 0.9 to 4.2) for women. Corresponding for suicide the APC was decreased by 0.7 (95% CI -2.4 to 1.1) for men and increased by 1.1 (95% CI -0.7 to 3.0) for women.

Table 5 shows the number and percentages of causes of death for Accidental poisoning, Intentional self-harm, and Event of undetermined intent during 1996 to 2015. The pattern for the categories accidental poisoning, self-poisoning, and poisoning when the intent is undetermined show some similarities. However, there were some exceptions, the proportion of overdose by sedative is highest for undetermined intent, the proportion of overdose by narcotics is lower for self-poisoning than for the other two categories, and the proportion of poisoning by other gases and vapours is higher for self-poisonings than for the other categories. When alcohol was involved the proportion was highest for the category accidental poisoning followed by undetermined intent, and was unusual for suicide. Hanging, strangulation and suffocation was the most common methods for suicide followed by self-poisoning, and firearm. These violent methods were uncommon for undetermined intent, where poisoning were about 85%.

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Discussion

The suicide rates in men and women did not appear to change noticeable during the study period in Iceland. The suicide rates were approximately threefold higher in men than in women. The rates for combined accidental poisoning, suicide, and event of undetermined intent increased for women, but not for men. The rates for road traffic injuries, which is based on fewer cases in the population, decreased among both genders, and significantly so for men. The rates for overdose by sedative increased among women, and the rates for overdose by narcotics increased significantly among both genders. The smallness of the population may explain some of the fluctuations of the annual rates.

The overall suicide rate reported in the present study is of similar magnitude as was seen in a previous study on suicide mortality trends in the Nordic countries (19), however somewhat higher than in the recent reports from the UK (4), and lower than reported from the US (1). In the study of the Nordic countries the Icelandic rates stood out as the lowest suicide rates, and the Icelandic rates did not decline through the years 1980 to 2009 as was the case in most of the other countries (19). Still earlier report on suicide in Iceland showed stable suicide rates through the years 1950 to 2000 (20).

The decreasing trend for road traffic mortality seen in the present study, has also been reported recently in several western countries, however not in all (21). This finding may indicate appropriateness of the present methodological approach of the small size data.

The increased rates of overdose by sedative and narcotics in the present study are notable and in accordance with reports from other populations (7,8).

In the break down of the causes of death by the categories accidental poisoning, suicide, and event of undetermined intent, the proportion of death due to poisoning/intoxication may be considered to show some similarities. However, there are differences between the categories, which in the light of possible misclassification, and relatively few cases, rule out firm conclusion from the figures. The causes of death for undetermined intent is dominated by poisoning while more violent causes are proportionally few as compared to causes of death reported as suicide. Some studies discuss the suicide methods in attempt to suggest possible preventive actions (19), however that was not the scope of the present study.

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Strength and limitation

The use of the comprehensive population registries, the National Cause-of-Death Register and the National Registry strengthen the study. Only one version of the classification of cause of death, namely the ICD-10, was used during the study period, however, the registration of cause of death depends on different attesting persons. Death certificates in Iceland are issued by a physician. If the deceased person's physician is not able to attest the cause of death, or in cases where the circumstances of the death are unexplained, unusual, suspicious, due to intoxication or following an accident the death is reported to the police and the medical examiner, who decides whether to arrange for an autopsy and forensic investigations before the death certificate is issued (16). The quality of death registration at a global level have been studied, and the data from Iceland was evaluated as high overall and ranked in the same category as data from 23 developed countries, including the US and the UK (10).

The smallness of the material consisting of 722 suicide, 195 accidental poisoning and 126 deaths due to event of undetermined intent distributed according to gender and calendar years across study period of 20 years is an obvious drawback, however the registries ensure the completeness of the data.

Injury, poisoning and certain other consequences of external cause according to ICD-10, that is codes S00 to T98, particularly concerning poisoning by drugs, medicaments and biological substances, would have given different and perhaps more precise information. However, these codes were not available from the website of Statistic Iceland (15).

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Conclusions

The suicide rates in Iceland have not changed during 1996 to 2015, however the rates for the

combined accidental poisoning, suicide, and event of undetermined intent increased

significantly for women. The rise of the overdose rates for sedative among women and for

narcotics among both genders are according to increase in rates of prescription and non-

prescription drug overdose deaths reported elsewhere.

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Table 1 Annual number of selected external causes of deaths with ICD-10 codes among men

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	8	32	4	28	0	1	0
1997	11	30	3	26	1	7	0
1998	19	33	10	23	0	1	3
1999	13	25	1	24	0	2	0
2000	22	43	1	42	0	0	1
2001	20	38	8	28	2	6	1
2002	14	27	5	19	3	6	4
2003	15	25	3	20	2	5	1
2004	15	31	2	26	3	4	2
2005	11	28	4	24	0	0	4
2006	24	28	3	22	3	3	2
2007	13	42	0	30	12	7	7
2008	12	40	4	27	9	6	6
2009	10	40	3	29	8	9	2
2010	5	43	7	36	0	6	6
2011	11	35	13	22	0	5	6
2012	9	37	10	26	1	7	3
2013	8	45	6	35	4	3	7
2014	4	43	10	33	0	0	6
2015	11	38	5	30	3	6	5
Total	255	703	102	550	51	84	66

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Table 2 Annual number of selected external causes of deaths with ICD-10 codes among women

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	3	9	1	5	2	1	0
1997	4	10	2	7	0	3	0
1998	8	16	8	7	0	5	0
1999	5	9	1	7	0	2	0
2000	10	13	3	8	2	5	1
2001	8	15	6	8	2	5	2
2002	15	13	5	9	0	7	1
2003	6	10	3	6	1	2	1
2004	7	14	2	9	3	5	2
2005	5	20	8	9	3	4	4
2006	12	16	2	10	4	10	1
2007	1	17	1	7	9	10	4
2008	4	27	4	11	12	9	5
2009	1	16	2	7	7	7	3
2010	3	15	5	10	1	4	3
2011	4	14	8	5	1	7	2
2012	2	18	5	11	0	5	1
2013	7	21	6	14	2	10	1
2014	2	23	10	11	2	5	8
2015	2	27	11	11	5	9	8
Total	109	323	93	172	56	115	47

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Table 3 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among men

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	6.18	22.00	2.74	19.26	0	0.7	0
1997	8.62	19.78	2.03	17.26	0.48	4.53	0
1998	12.82	21.48	6.29	15.18	0	0.68	2.05
1999	9.03	16.22	0.46	15.76	0	1.04	0
2000	13.88	28.75	0.65	28.10	0	0	0.66
2001	13.04	23.80	5.05	17.67	1.08	3.42	0.36
2002	9.23	16.71	2.94	11.89	1.88	3.82	2.26
2003	8.35	15.74	1.86	12.65	1.24	2.87	0.63
2004	8.96	18.62	1.03	15.77	1.81	2.49	1.25
2005	7.68	16.98	2.21	14.77	0	0	2.18
2006	13.00	16.09	1.69	12.70	1.69	1.80	1.20
2007	7.36	22.63	0	16.13	6.51	4.11	4.11
2008	6.20	21.19	1.85	14.42	4.91	3.18	3.62
2009	5.40	21.18	1.61	15.43	4.14	4.84	1.13
2010	2.57	24.02	3.83	20.20	0	3.14	3.38
2011	6.63	18.74	6.93	11.81	0	2.80	2.86
2012	4.53	20.16	5.64	13.98	0.54	3.89	1.67
2013	4.64	22.34	3.04	17.14	2.16	1.65	3.60
2014	2.35	21.96	4.92	17.04	0	0	3.26
2015	5.88	20.68	2.62	16.48	1.57	3.22	2.69
r	-0.66	0.05	0.25	-0.22	0.24	0.19	0.72
p	0.001	0.829	0.290	0.363	0.298	0.429	0.0004

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Table 4 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among women

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	2.40	6.44	1.55	3.34	1.55	0.70	0
1997	2.55	7.22	2.23	4.99	0	2.07	0
1998	5.41	10.61	5.99	4.62	0	3.11	0
1999	3.50	6.03	1.48	4.55	0	1.35	0
2000	6.63	7.99	1.68	4.98	1.32	3.00	0.66
2001	5.77	9.12	2.94	5.17	1.00	2.94	1.29
2002	9.86	7.71	2.55	5.16	0	4.17	0.64
2003	3.69	6.31	1.89	3.79	0.63	1.26	0.63
2004	4.22	8.45	1.25	5.61	1.59	2.84	1.25
2005	3.04	11.46	4.36	5.53	1.57	1.91	2.46
2006	8.80	9.34	1.20	5.74	2.40	5.74	0.60
2007	0.59	9.47	0.59	3.86	5.03	5.62	2.09
2008	1.80	14.63	2.04	5.79	6.80	5.13	2.61
2009	0.56	9.03	1.13	3.95	3.95	3.95	1.69
2010	1.63	8.21	2.25	5.39	0.56	2.00	1.69
2011	3.00	7.75	4.43	2.75	0.56	3.62	1.12
2012	0.60	10.62	4.07	6.55	0	2.78	0.56
2013	5.26	10.28	2.24	6.94	1.10	5.47	0.55
2014	1.33	12.66	5.77	5.80	1.09	2.72	4.93
2015	1.85	12.93	5.37	5.13	2.43	4.58	4.30
r	-0.38	0.60	0.32	0.35	0.27	0.49	0.67
p	0.094	0.006	0.165	0.130	0.254	0.03	0.001

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Table 5 Number and percentages of cause of death according death certificates, Accidental poisoning, (ICD-10 codes X40-X49), Intentional self-harm (Suicide) (ICD-10 codes X60-X84), and Event of undetermined intent (ICD-10 codes Y10-Y34), during the study period

By means of - (ICD-10)	Accidental poisoning N (%)	Suicide N (%)	Undetermined intent N (%)
- nonopioid analgesics, antipyretics, and antirheumatics (X40, X60, Y10)	12 (6.2)	15 (6.6)	8 (7.5)
- antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs (X41, X61, Y11)	61 (31.3)	85 (37.4)	52 (48.6)
- narcotics, and psychodysleptics (hallucinogens) (X42, X62, Y12)	57 (29.2)	26 (11.5)	31 (29.0)
- other drugs acting on the autonomic nervous system (X43, X63, Y13)	3 (1.5)	7 (3.1)	0
- other and unspecified drug, medicaments, and biological substances (X44, X64, Y14)	18 (9.2)	16 (7.0)	5 (4.7)
- alcohol (X45, X65, Y15)	29 (14.9)	1 (0.4)	7 (6.5)
- organic solvents and halogenated hydrocarbons (X46, X66, Y16)	0	1 (0.4)	0
- other gases and vapours (X47, X67, Y17)	14 (7.2)	71 (31.3)	0
- other and unspecified chemicals and noxious substances (X49, X69, Y19)	1 (0.5)	5 (2.2)	4 (3.7)
Total/Subtotal	195	227	107
- hanging, strangulation, and suffocation (X70, Y20)		281 (38.9)	2 (1.6)
- drowning, and submersion (X71, Y21)		42 (5.8)	5 (4.0)
- handgun discharge (X72, Y22)		1 (0.1)	0
- rifle, shotgun, and larger firearm discharge (X73, Y23)		46 (6.4)	0
- other and unspecified firearm discharge (X74, Y24)		54 (7.5)	0
- explosive material (X75, Y25)		2 (0.3)	0
- smoke, fire, and flames (X76, Y26)		3 (0.4)	0
- sharp object (X78, Y28)		17 (2.4)	1 (0.8)
- blunt object (X79, Y29)		1 (0.1)	1 (0.8)
- jumping from a high place (X80, Y30)		34 (4.7)	0
- crashing of motor vehicle (X82, Y32)		4 (0.6)	2 (1.6)
- other specified means (X83, Y33)		5 (0.7)	0
- unspecified means (X84, Y34)		5 (0.7)	8 (6.3)
Total		722 (100)	126 (100)

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Reporting checklist for prediction model development and validation study.

Based on the TRIPOD guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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In your methods section, say that you used the TRIPODreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title			
	#1	Identify the study as developing and / or validating a multivariable prediction model, the target population, and the outcome to be predicted.	1
Abstract			
	#2	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	2-3
Introduction			
	#3a	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	5
	#3b	Specify the objectives, including whether the study describes	5

the development or validation of the model or both.

Methods

Source of data	#4a	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	6
Source of data	#4b	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	6
Participants	#5a	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	6
Participants	#5b	Describe eligibility criteria for participants.	6
Participants	#5c	Give details of treatments received, if relevant	NA
Outcome	#6a	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	6-7
Outcome	#6b	Report any actions to blind assessment of the outcome to be predicted.	NA
Predictors	#7a	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured	6-7
Predictors	#7b	Report any actions to blind assessment of predictors for the outcome and other predictors.	NA
Sample size	#8	Explain how the study size was arrived at.	6
Missing data	#9	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	NA
Statistical analysis methods	#10a	If you are developing a prediction model describe how predictors were handled in the analyses.	6-7
Statistical analysis methods	#10b	If you are developing a prediction model, specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	7
Statistical analysis methods	#10c	If you are validating a prediction model, describe how the predictions were calculated.	NA

Statistical analysis methods	#10d	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	6-7
Statistical analysis methods	#10e	If you are validating a prediction model, describe any model updating (e.g., recalibration) arising from the validation, if done	NA
Risk groups	#11	Provide details on how risk groups were created, if done.	NA
Development vs. validation	#12	For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors.	NA

Results

Participants	#13a	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	8
Participants	#13b	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	8
Participants	#13c	For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome).	8
Model development	#14a	If developing a model, specify the number of participants and outcome events in each analysis.	9
Model development	#14b	If developing a model, report the unadjusted association, if calculated between each candidate predictor and outcome.	8-9
Model specification	#15a	If developing a model, present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	8-9
Model specification	#15b	If developing a prediction model, explain how to the use it.	9
Model performance	#16	Report performance measures (with CIs) for the prediction model.	9
Model-updating	#17	If validating a model, report the results from any model	NA

updating, if done (i.e., model specification, model performance).

Discussion

Limitations	#18	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	11
Interpretation	#19a	For validation, discuss the results with reference to performance in the development data, and any other validation data	10-11
Interpretation	#19b	Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence.	12
Implications	#20	Discuss the potential clinical use of the model and implications for future research	12

Other information

| Supplementary information | #21 | Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets. | NA |
| Funding | #22 | Give the source of funding and the role of the funders for the present study. | 13 |

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9, Tables 1, 2, and 5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	8, Tables 1, 2, 5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9 Tables 3, and 4
		(*b*) Report category boundaries when continuous variables were categorized	8-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	
Limitations			10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11, 12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland: A population-based cohort study

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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland: A population-based cohort study

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Abstract

Objectives: The aim was to study mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths through 20 years in Iceland.

Design: A population-based register study.

Participants: Individuals who died due to road traffic injury, suicide, accidental poisoning, event of undetermined intent, and drug-related deaths in the population of Iceland during the years 1996-2015. Annual age-standardized rates were calculated, and the trend analysed by Pearson correlation and joinpoint regression.

Setting: The population of Iceland framed the study material, and the data was obtained from nation-wide registries for information on number of deaths and age specific mean population in each year by gender.

Results: The crude overall suicide rate during the last ten years was 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1), while the crude overall rate due to road traffic injuries was 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3). Among men suicide rates decreased, however not significantly (r (19) = -0.22, p = 0.36), and for overdose by narcotics the rates increased significantly (r (19) = 0.72, p < 0.001) during the study period. Among women the suicide rates increased , however not significantly (r (19) = 0.35, p = 0.13), for accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly (r (19) = 0.60, p = 0.006); and the rates for overdose by sedative, and overdose by narcotics both increased significantly r (19) = 0.49, p =0.3, and r (19) =0.67, p =0.001, respectively.

Conclusion: The suicide rates have not changed during 1996 to 2015, however the rates for the combined accidental poisoning, suicide, and event of undetermined intent increased

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significantly for women. The rise of the overdose rates for sedative among women and for

narcotics among both genders are consistent with reports elsewhere.

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Strength and limitation

- Nation-wide data coverage was an advantage in the data analysis and secured completeness.

- The causes of death were obtained from death certificates and were systematically reported by International Classification of Diseases, tenth version.

- Underreporting and misclassification of suicide may occur in unknown magnitude, and thus separate and combined analysis of suicide, accidental poisoning and death due to event of undetermined intent augment the information in the present study.

- The combination of deaths because of overdose enhanced the analysis of this topical problem.

4

Introduction

Suicide rates increased in the United States (US) through 1999 to 2016, and in 25 states more than 30% increases were observed (1). In 2016 the overall suicide rates in US was 15.6/100,000 (age-adjusted) (1). This comprehensive US report (1) did not include injury death of undetermined intent, which is conventional in studies in the United Kingdom (UK) (2), and in accordance with UK Office for National Statistic (ONS) reporting practice (3). Despite the differences in definition of suicide, the 2017 suicide rate in the UK, combining suicide and deaths of undetermined intent, was 10.1/100,000 (age-adjusted) which is the lowest rate observed since 1981 (4), and substantially lower than the US rates.

The invers association between suicides and unintentional poisoning mortality through time has been suggested to be due to misclassification of poisoning deaths (5,6), however, the increases in unintentional poisoning and undetermined poisoning rates exceed the reciprocal decrease in suicide rates according to US studies (5,6).

Increasing poisoning mortality rates in US and other places (7,8) further adds to the difficulties in registration of suicides in national data registries. Undercounting of suicide and misclassification of suicides as accidental poisonings or event of undetermined intent diminish the possibility to measure potential effects of prevention and intervention attempts (6,9). The situation is even more difficult in a small population as in Iceland; however, the mortality statistic of the country has been considered of high quality (10) and the population dimensions in the National Registry have the character of annual census (11). According to recent overview from the Director of Health it is not possible to state whether any changes have occurred in the overall death rates of suicides in Iceland through the last decades (12) when counting death by intentional self-harm as an underlaying cause of death. During the last ten years the annual overall suicide death rate in Iceland was 12.1/100,000 (12). This report did not mention deaths due to accidental poisoning or event of undetermined intent (12). A work group established by the Director of Health has proposed several detailed measures in attempt to cut down the number of suicides (13) and the office has conducted studies on suicidal thoughts and attempts among young people (14).

In the light of this uncertainty and the risk of misclassification in the registration of the above-mentioned categories the aim was to describe mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths by gender through 20 years in Iceland.

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Materials and methods

The primary source of data was from the website of Statistic Iceland, (National Cause-of-Death Registry, a nation-wide death registry) accessed April 2018 (15), and from the same website the age specific population figures were obtained from the National Registry. The available age groups were 0 to 5 years, 6 to 15 years, 16 to 20 years, 21 to 66 years, and 67 years and older. The registered cause of deaths was according to death certificates which were issued by physician according to Icelandic law (16). The causes of death have been coded according to the 10th revision of the International Classification of Diseases (ICD-10) since 1996 (17), and available were the external cause of injury mortality. The registry contains only one main causes of death per individual. No information was available as to whether the death certificate was issued by medical coroner or other physicians, however, assertation of drug related deaths had been confirmed after forensic investigation. The National Registry contains all inhabitants of Iceland and is continuously updated. The mean population was 269 thousand in 1996 and increased to 331 thousand in 2015; and during the period the proportion of foreign citizens grew from 2 to 7% (11).

The injury mortality categories of interest were: V02-V89 Motor vehicle transport accidents, called Road traffic injuries; X40-X49 Accidental poisoning by and exposure to noxious substances, X60-X84 Intentional self-harm (suicide); Y10-Y34 Event of undetermined intent; X40-X49, X60-X84 and Y10-Y34 combined Accidental poisoning by and exposure to noxious substances, Intentional self-harm, and Event of undetermined intent, called Poisoning, Suicide, and Undetermined; X41, X61 and Y11 combined Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, Intentional self-poisoning and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, and Poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent, called overdose by sedative; X42, X62 and Y12 combined Accidental poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, Intentional self-poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewere classified, Poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, called

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overdose by narcotics. Road traffic injury is included as decrease in mortality due to this category has been widely observed and often contrasted to increase in suicidal rates (9).

The number of injury deaths per category were all cases in the population and these were related to population age and gender specific numbers in the annual mid-year versions of the National Registry through the study period (11). Annual crude mortality was calculated per 100,000 for the last ten years of the study period with 95% confidence intervals (CI). Annual gender specific age-adjusted mortality rates were calculated using modified World Standard as a reference. Pearson correlation coefficient were computed for annual changes during the study period. Differences were judged significant based on a two-sided test if p values were less than 0.05. The changes in rates from 1996 to 2015 were analysed by joinpoint regression model (18). The smallness of the data limited the possibility to apply complex models, however, the estimated annual changes in rate from the beginning to the end of the study period were calculated for road traffic injury, the combined categories of poisoning, suicide, and event of undetermined intent, and suicide. The slopes were converted to annual percentage changes (APC) showed with 95% CI.

The Data Protection Commission and the National Bioethics Committee (VSNb2019040011/03.03) approved the study.

Patient and Public involvement

No patient involved.

Results

Altogether there were 722 suicide, 195 accidental poisoning and 126 deaths due to event of undetermined intent. The crude overall suicide rate (ICD-10 codes: X60-X84) representing the last ten years were 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1). The crude overall rate for combined accidental poisoning, suicide and events of undetermined intent (ICD-10 codes: X40-X49, X60-X84, and Y10-Y34), during the same period was 14.8 per 100,000 persons per year (95% CI 9.3 to 22.1). The crude overall rate due to road traffic injuries (ICD-10 codes: V02-V89) was in comparison low 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3).

Figures 1 and 2 show the annual number of the selected categories of external causes of deaths: road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics in male and female respectively through 1996 to 2015. In some of these categories for some years there are no deaths or one or two, and overall the figures are low per category per years and varied considerably through the years obscuring trend when comparing individual years to each other.

Table 1 shows the age standardized rates per 100,000 males per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Across 1996 to 2015, rates decreased for road traffic injuries, calendar years and rates were negatively correlated, r (19) = -0.66, p = 0.001. For suicide the rates also decreased however not significantly (r (19) = -0.22, p = 0.36). For other categories or combined categories, the rates did not change significantly during the study period except for overdose by narcotics where the rates increased significantly (r (19) = 0.72, p < 0.001).

Table 2 shows the age standardized rates per 100,000 females per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Similarly, as among the males across 1996 to 2015, the rates decreased for road traffic injuries, calendar years and rates were negatively correlated, however not significantly (r (19) = -0.38, p = 0.09). For the separate categories of accidental poisoning, suicide, and events of undetermined intent the

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rates were found to increase, however not significantly, the calendar years and the rates were moderately positively correlated. For accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly (r (19) = 0.60, p = 0.006). The rates for overdose by sedative, and overdose by narcotics increased significantly with a positive correlation, r (19) = 0.49, p =0.3, and r (19) =0.67, p = 0.001, respectively.

In the joinpoint regression analysis the trend was analysed through the study period for road traffic injuries rates where the APC indicates decrease by 5.5 (95% CI -8.3 to -2.6) for men and decrease by 6.4 (95% CI -12.2 to -0.2) for women. During the same period the combined categories accidental poisoning, suicide, and event of undetermined intent the APC was increased by 0.2 (95% CI -1.1 to 1.6) for men, and the APC was increased by 2.6 (95% CI 0.9 to 4.2) for women. Corresponding for suicide the APC was decreased by 0.7 (95% CI -2.4 to 1.1) for men and increased by 1.1 (95% CI -0.7 to 3.0) for women.

Table 3 shows the number and percentages of causes of death for Accidental poisoning, Intentional self-harm, and Event of undetermined intent during 1996 to 2015. The pattern for the categories accidental poisoning, self-poisoning, and poisoning when the intent is undetermined show some similarities. However, there were some exceptions, the proportion of overdose by sedative is highest for undetermined intent, the proportion of overdose by narcotics is lower for self-poisoning than for the other two categories, and the proportion of poisoning by other gases and vapours is higher for self-poisonings than for the other categories. When alcohol was involved the proportion was highest for the category accidental poisoning followed by undetermined intent, and was unusual for suicide. Hanging, strangulation and suffocation was the most common methods for suicide followed by self-poisoning, and firearm. These violent methods were uncommon for undetermined intent, where poisoning were about 85%.

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Discussion

The suicide rates in men and women did not appear to change noticeable during the study period in Iceland. The suicide rates were approximately threefold higher in men than in women. The rates for combined accidental poisoning, suicide, and event of undetermined intent increased for women, but not for men. The rates for road traffic injuries, which is based on fewer cases in the population, decreased among both genders, and significantly so for men. The rates for overdose by sedative increased among women, and the rates for overdose by narcotics increased significantly among both genders. The smallness of the population may explain some of the fluctuations of the annual rates.

The overall suicide rate reported in the present study is of similar magnitude as was seen in a previous study on suicide mortality trends in the Nordic countries (19). However, the rate is somewhat higher than in the recent reports from the UK (4), and lower than reported from the US (1), and in these studies the overall rates were calculated for the last ten years as in the present study. In the study of the Nordic countries the Icelandic rates stood out as the lowest suicide rates, and the Icelandic rates did not decline through the years 1980 to 2009 as was the case in most of the other countries (19). Still earlier report on suicide in Iceland showed stable suicide rates through the years 1950 to 2000 (20).

The decreasing trend for road traffic mortality seen in the present study, has also been reported recently in several western countries, however not in all (21). This finding may indicate appropriateness of the present methodological approach of the small size data.

The increased rates of overdose by sedative and narcotics in the present study are notable and in accordance with reports from other populations (7,8).

In the break down of the causes of death by the categories accidental poisoning, suicide, and event of undetermined intent, the proportion of death due to poisoning/intoxication may be considered to show some similarities. However, there are differences between the categories, which in the light of possible misclassification, and relatively few cases, rule out firm conclusion from the figures. The causes of death for undetermined intent is dominated by poisoning while more violent causes are proportionally few as compared to causes of death

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reported as suicide. Some studies discuss the suicide methods in attempt to suggest possible preventive actions (19), however that was not the scope of the present study.

Strength and limitation

The use of the comprehensive population registries, the National Cause-of-Death Register and the National Registry strengthen the study. Only one version of the classification of cause of death, namely the ICD-10, was used during the study period, however, the registration of cause of death depends on different attesting persons. Death certificates in Iceland are issued by a physician. If the deceased person's physician is not able to attest the cause of death, or in cases where the circumstances of the death are unexplained, unusual, suspicious, due to intoxication or following an accident the death is reported to the police and the medical examiner, who decides whether to arrange for an autopsy and forensic investigations before the death certificate is issued (16). The quality of death registration at a global level have been studied, and the data from Iceland was evaluated as high overall and ranked in the same category as data from 23 developed countries, including the US and the UK (10).

The small material and the distribution according to gender and calendar years across study period of 20 years is an obvious drawback, however the registries ensure the completeness of the data. The age groups available were rather crude and the low numbers in some of the ICD-10 categories preclude meaningful detailed description of the mortality according to age groups.

Injury, poisoning and certain other consequences of external cause according to ICD-10, that is codes S00 to T98, particularly concerning poisoning by drugs, medicaments and biological substances, would have given different and perhaps more precise information. However, these codes were not available from the website of Statistic Iceland (15).

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Conclusions

The suicide rates in Iceland have not changed during 1996 to 2015, however the rates for the combined accidental poisoning, suicide, and event of undetermined intent increased significantly for women. The rise of the overdose rates for sedative among women and for narcotics among both genders are according to increase in rates of prescription and non-prescription drug overdose deaths reported elsewhere.

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Authors Contribution OSG and VR contributed to the conception and design, VR obtained the data and conducted the analyses, OSG and VR interpreted the data, drafted the article and revised it, and approved the final version of the submitted manuscript.

Competing interest None competing interest to report.

Ethics approval The National Bioethics Committee (VSNb2019040011/03.03) approved the study.

Data sharing statement All basic data available from the website of Statistic Iceland.

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Legends to figures

Figure 1 Annual number of deaths among men through the years 1996 to 2015 in the categories Road traffic injury V02-V89, Poisoning; Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

Figure 2 Annual number of deaths among women through the years 1996 to 2015 in the categories Road traffic injury V02-V89, Poisoning; Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

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Table 1 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among men

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	6.18	22.00	2.74	19.26	0	0.7	0
1997	8.62	19.78	2.03	17.26	0.48	4.53	0
1998	12.82	21.48	6.29	15.18	0	0.68	2.05
1999	9.03	16.22	0.46	15.76	0	1.04	0
2000	13.88	28.75	0.65	28.10	0	0	0.66
2001	13.04	23.80	5.05	17.67	1.08	3.42	0.36
2002	9.23	16.71	2.94	11.89	1.88	3.82	2.26
2003	8.35	15.74	1.86	12.65	1.24	2.87	0.63
2004	8.96	18.62	1.03	15.77	1.81	2.49	1.25
2005	7.68	16.98	2.21	14.77	0	0	2.18
2006	13.00	16.09	1.69	12.70	1.69	1.80	1.20
2007	7.36	22.63	0	16.13	6.51	4.11	4.11
2008	6.20	21.19	1.85	14.42	4.91	3.18	3.62
2009	5.40	21.18	1.61	15.43	4.14	4.84	1.13
2010	2.57	24.02	3.83	20.20	0	3.14	3.38
2011	6.63	18.74	6.93	11.81	0	2.80	2.86
2012	4.53	20.16	5.64	13.98	0.54	3.89	1.67
2013	4.64	22.34	3.04	17.14	2.16	1.65	3.60
2014	2.35	21.96	4.92	17.04	0	0	3.26
2015	5.88	20.68	2.62	16.48	1.57	3.22	2.69
r	-0.66	0.05	0.25	-0.22	0.24	0.19	0.72
p	0.001	0.829	0.290	0.363	0.298	0.429	0.0004

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Table 2 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among women

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	2.40	6.44	1.55	3.34	1.55	0.70	0
1997	2.55	7.22	2.23	4.99	0	2.07	0
1998	5.41	10.61	5.99	4.62	0	3.11	0
1999	3.50	6.03	1.48	4.55	0	1.35	0
2000	6.63	7.99	1.68	4.98	1.32	3.00	0.66
2001	5.77	9.12	2.94	5.17	1.00	2.94	1.29
2002	9.86	7.71	2.55	5.16	0	4.17	0.64
2003	3.69	6.31	1.89	3.79	0.63	1.26	0.63
2004	4.22	8.45	1.25	5.61	1.59	2.84	1.25
2005	3.04	11.46	4.36	5.53	1.57	1.91	2.46
2006	8.80	9.34	1.20	5.74	2.40	5.74	0.60
2007	0.59	9.47	0.59	3.86	5.03	5.62	2.09
2008	1.80	14.63	2.04	5.79	6.80	5.13	2.61
2009	0.56	9.03	1.13	3.95	3.95	3.95	1.69
2010	1.63	8.21	2.25	5.39	0.56	2.00	1.69
2011	3.00	7.75	4.43	2.75	0.56	3.62	1.12
2012	0.60	10.62	4.07	6.55	0	2.78	0.56
2013	5.26	10.28	2.24	6.94	1.10	5.47	0.55
2014	1.33	12.66	5.77	5.80	1.09	2.72	4.93
2015	1.85	12.93	5.37	5.13	2.43	4.58	4.30
r	-0.38	0.60	0.32	0.35	0.27	0.49	0.67
p	0.094	0.006	0.165	0.130	0.254	0.03	0.001

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Table 3 Number and percentages of cause of death according death certificates, Accidental poisoning, (ICD-10 codes X40-X49), Intentional self-harm (Suicide) (ICD-10 codes X60-X84), and Event of undetermined intent (ICD-10 codes Y10-Y34), during the study period

By means of - (ICD-10)	Accidental poisoning N (%)	Suicide N (%)	Undetermined intent N (%)
- nonopioid analgesics, antipyretics, and antirheumatics (X40, X60, Y10)	12 (6.2)	15 (6.6)	8 (7.5)
- antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs (X41, X61, Y11)	61 (31.3)	85 (37.4)	52 (48.6)
- narcotics, and psychodysleptics (hallucinogens) (X42, X62, Y12)	57 (29.2)	26 (11.5)	31 (29.0)
- other drugs acting on the autonomic nervous system (X43, X63, Y13)	3 (1.5)	7 (3.1)	0
- other and unspecified drug, medicaments, and biological substances (X44, X64, Y14)	18 (9.2)	16 (7.0)	5 (4.7)
- alcohol (X45, X65, Y15)	29 (14.9)	1 (0.4)	7 (6.5)
- organic solvents and halogenated hydrocarbons (X46, X66, Y16)	0	1 (0.4)	0
- other gases and vapours (X47, X67, Y17)	14 (7.2)	71 (31.3)	0
- other and unspecified chemicals and noxious substances (X49, X69, Y19)	1 (0.5)	5 (2.2)	4 (3.7)
Total/Subtotal	195	227	107
- hanging, strangulation, and suffocation (X70, Y20)		281 (38.9)	2 (1.6)
- drowning, and submersion (X71, Y21)		42 (5.8)	5 (4.0)
- handgun discharge (X72, Y22)		1 (0.1)	0
- rifle, shotgun, and larger firearm discharge (X73, Y23)		46 (6.4)	0
- other and unspecified firearm discharge (X74, Y24)		54 (7.5)	0
- explosive material (X75, Y25)		2 (0.3)	0
- smoke, fire, and flames (X76, Y26)		3 (0.4)	0
- sharp object (X78, Y28)		17 (2.4)	1 (0.8)
- blunt object (X79, Y29)		1 (0.1)	1 (0.8)
- jumping from a high place (X80, Y30)		34 (4.7)	0
- crashing of motor vehicle (X82, Y32)		4 (0.6)	2 (1.6)
- other specified means (X83, Y33)		5 (0.7)	0
- unspecified means (X84, Y34)		5 (0.7)	8 (6.3)
Total		722 (100)	126 (100)

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Figure 1 Annual number of deaths among men through the years 1996 to 2015 in the categories Road traffic injury V02-V89, Poisoning; Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

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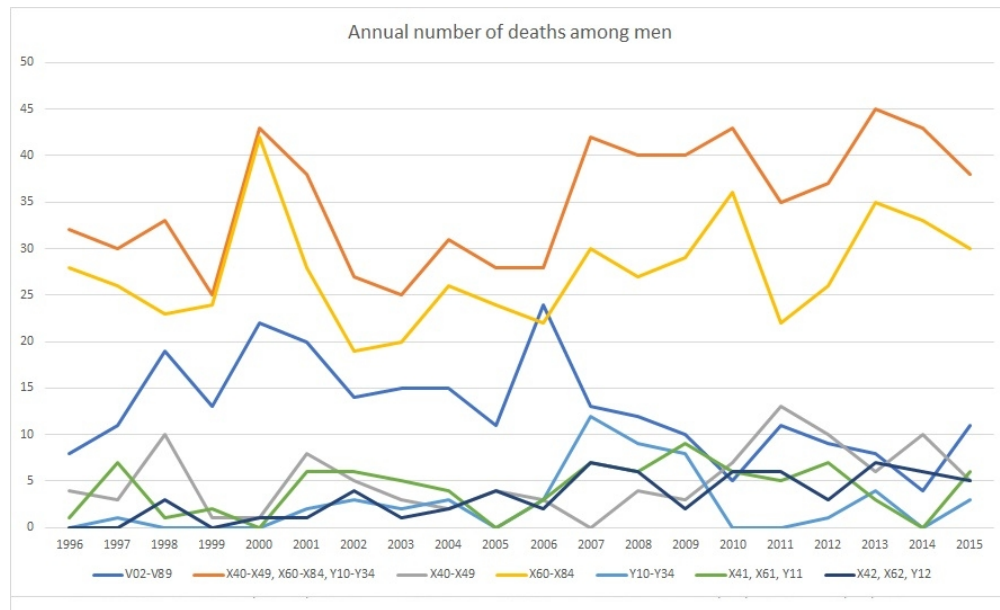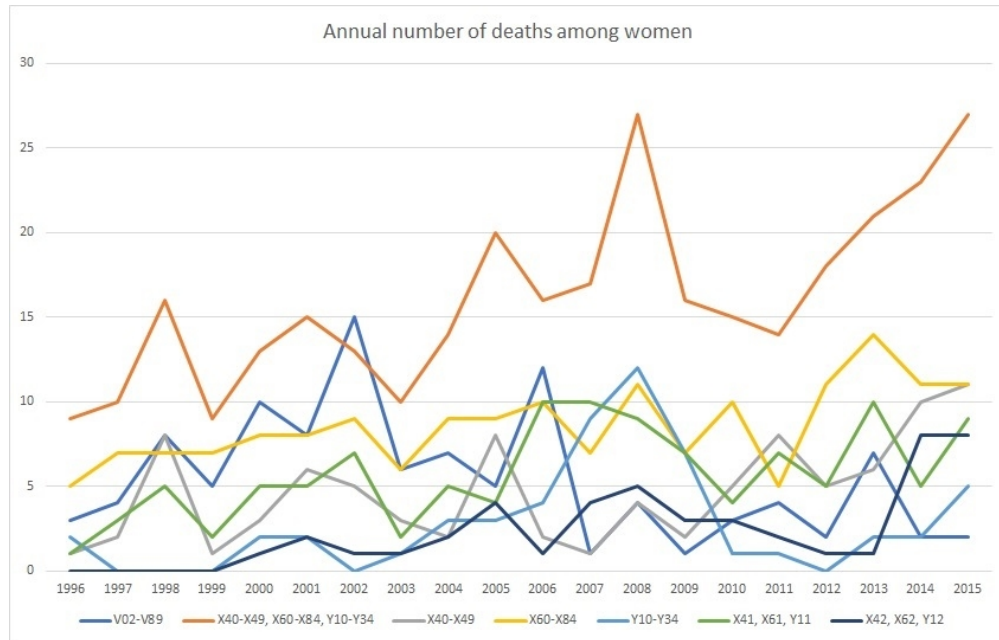
Figure 2 Annual number of deaths among women through the years 1996 to 2015 in the categories Road traffic injury V02-V89, Poisoning; Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

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Reporting checklist for prediction model development and validation study.

Based on the TRIPOD guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the TRIPODreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title			
	#1	Identify the study as developing and / or validating a multivariable prediction model, the target population, and the outcome to be predicted.	1
Abstract			
	#2	Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions.	2-3
Introduction			
	#3a	Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models.	5
	#3b	Specify the objectives, including whether the study describes	5

the development or validation of the model or both.

Methods

Source of data	#4a	Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable.	6
Source of data	#4b	Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up.	6
Participants	#5a	Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres.	6
Participants	#5b	Describe eligibility criteria for participants.	6
Participants	#5c	Give details of treatments received, if relevant	NA
Outcome	#6a	Clearly define the outcome that is predicted by the prediction model, including how and when assessed.	6-7
Outcome	#6b	Report any actions to blind assessment of the outcome to be predicted.	NA
Predictors	#7a	Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured	6-7
Predictors	#7b	Report any actions to blind assessment of predictors for the outcome and other predictors.	NA
Sample size	#8	Explain how the study size was arrived at.	6
Missing data	#9	Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method.	NA
Statistical analysis methods	#10a	If you are developing a prediction model describe how predictors were handled in the analyses.	6-7
Statistical analysis methods	#10b	If you are developing a prediction model, specify type of model, all model-building procedures (including any predictor selection), and method for internal validation.	7
Statistical analysis methods	#10c	If you are validating a prediction model, describe how the predictions were calculated.	NA

Statistical analysis methods	#10d	Specify all measures used to assess model performance and, if relevant, to compare multiple models.	6-7
Statistical analysis methods	#10e	If you are validating a prediction model, describe any model updating (e.g., recalibration) arising from the validation, if done	NA
Risk groups	#11	Provide details on how risk groups were created, if done.	NA
Development vs. validation	#12	For validation, identify any differences from the development data in setting, eligibility criteria, outcome, and predictors.	NA

Results

Participants	#13a	Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful.	8
Participants	#13b	Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome.	8
Participants	#13c	For validation, show a comparison with the development data of the distribution of important variables (demographics, predictors and outcome).	8
Model development	#14a	If developing a model, specify the number of participants and outcome events in each analysis.	9
Model development	#14b	If developing a model, report the unadjusted association, if calculated between each candidate predictor and outcome.	8-9
Model specification	#15a	If developing a model, present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point).	8-9
Model specification	#15b	If developing a prediction model, explain how to the use it.	9
Model performance	#16	Report performance measures (with CIs) for the prediction model.	9
Model-updating	#17	If validating a model, report the results from any model	NA

updating, if done (i.e., model specification, model performance).

Discussion

Limitations	#18	Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data).	11
Interpretation	#19a	For validation, discuss the results with reference to performance in the development data, and any other validation data	10-11
Interpretation	#19b	Give an overall interpretation of the results, considering objectives, limitations, results from similar studies, and other relevant evidence.	12
Implications	#20	Discuss the potential clinical use of the model and implications for future research	12

Other information

| Supplementary information | #21 | Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets. | NA |
| Funding | #22 | Give the source of funding and the role of the funders for the present study. | 13 |

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of _cohort studies_

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2-3
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	6
Study size	10	Explain how the study size was arrived at	6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8-9, Tables 1, 2, and 5
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	8
Outcome data	15*	Report numbers of outcome events or summary measures over time	8, Tables 1, 2, 5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9 Tables 3, and 4
		(*b*) Report category boundaries when continuous variables were categorized	8-9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	8-9
Discussion			
Key results	18	Summarise key results with reference to study objectives	
Limitations			10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11, 12
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland: A population-based cohort study

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Accidental poisoning, intentional self-harm, and event of undetermined intent mortality over 20 years in Iceland: A population-based cohort study

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Abstract

Objectives: The aim was to study mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths through 20 years in Iceland.

Design: A population-based register study.

Participants: Individuals who died due to road traffic injury, suicide, accidental poisoning, event of undetermined intent, and drug-related deaths in the population of Iceland during the years 1996-2015. Annual age-standardized rates were calculated, and the trend analysed by Pearson correlation and joinpoint regression.

Setting: The population of Iceland framed the study material, and the data was obtained from nation-wide registries for information on number of deaths and age specific mean population in each year by gender.

Results: The crude overall suicide rate during the last ten years was 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1), while the crude overall rate due to road traffic injuries was 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3). Among men suicide rates decreased, however not significantly (r (19) = -0.22, p = 0.36), and for overdose by narcotics the rates increased significantly (r (19) = 0.72, p < 0.001) during the study period. Among women the suicide rates increased , however not significantly (r (19) = 0.35, p = 0.13), for accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly (r (19) = 0.60, p = 0.006); and the rates for overdose by sedative, and overdose by narcotics both increased significantly r (19) = 0.49, p =0.3, and r (19) =0.67, p =0.001, respectively.

Conclusion: The suicide rates have not changed during 1996 to 2015, however the rates for the combined accidental poisoning, suicide, and event of undetermined intent increased

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significantly for women. The rise of the overdose rates for sedative among women and for

narcotics among both genders are consistent with reports elsewhere.

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Strength and limitation

- Nation-wide data coverage was an advantage in the data analysis and secured completeness.

- The causes of death were obtained from death certificates and were systematically reported by International Classification of Diseases, tenth version.

- Underreporting and misclassification of suicide may occur in unknown magnitude, and thus separate and combined analysis of suicide, accidental poisoning and death due to event of undetermined intent augment the information in the present study.

- The combination of deaths because of overdose enhanced the analysis of this topical problem.

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Introduction

Suicide rates increased in the United States (US) through 1999 to 2016, and in 25 states more than 30% increases were observed (1). In 2016 the overall suicide rates in US was 15.6/100,000 (age-adjusted) (1). This comprehensive US report (1) did not include injury death of undetermined intent, which is conventional in studies in the United Kingdom (UK) (2), and in accordance with UK Office for National Statistic (ONS) reporting practice (3). Despite the differences in definition of suicide, the 2017 suicide rate in the UK, combining suicide and deaths of undetermined intent, was 10.1/100,000 (age-adjusted) which is the lowest rate observed since 1981 (4), and substantially lower than the US rates.

The invers association between suicides and unintentional poisoning mortality through time has been suggested to be due to misclassification of poisoning deaths (5,6), however, the increases in unintentional poisoning and undetermined poisoning rates exceed the reciprocal decrease in suicide rates according to US studies (5,6).

Increasing poisoning mortality rates in US and other places (7,8) further adds to the difficulties in registration of suicides in national data registries. Undercounting of suicide and misclassification of suicides as accidental poisonings or event of undetermined intent diminish the possibility to measure potential effects of prevention and intervention attempts (6,9). The situation is even more difficult in a small population as in Iceland; however, the mortality statistic of the country has been considered of high quality (10) and the population dimensions in the National Registry have the character of annual census (11). According to recent overview from the Director of Health it is not possible to state whether any changes have occurred in the overall death rates of suicides in Iceland through the last decades (12) when counting death by intentional self-harm as an underlaying cause of death. During the last ten years the annual overall suicide death rate in Iceland was 12.1/100,000 (12). This report did not mention deaths due to accidental poisoning or event of undetermined intent (12). A work group established by the Director of Health has proposed several detailed measures in attempt to cut down the number of suicides (13) and the office has conducted studies on suicidal thoughts and attempts among young people (14).

In the light of this uncertainty and the risk of misclassification in the registration of the above-mentioned categories the aim was to describe mortality due to suicide, accidental poisoning, event of undetermined intent, and drug-related deaths by gender through 20 years in Iceland.

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Materials and methods

The primary source of data was from the website of Statistic Iceland, (National Cause-of-Death Registry, a nation-wide death registry) accessed April 2018 (15), and from the same website the age specific population figures were obtained from the National Registry. The available age groups were 0 to 5 years, 6 to 15 years, 16 to 20 years, 21 to 66 years, and 67 years and older. The registered cause of deaths was according to death certificates which were issued by physician according to Icelandic law (16). The causes of death have been coded according to the 10th revision of the International Classification of Diseases (ICD-10) since 1996 (17), and available were the external cause of injury mortality. The registry contains only one main causes of death per individual. No information was available as to whether the death certificate was issued by medical coroner or other physicians, however, assertation of drug related deaths had been confirmed after forensic investigation. The National Registry contains all inhabitants of Iceland and is continuously updated. The mean population was 269 thousand in 1996 and increased to 331 thousand in 2015; and during the period the proportion of foreign citizens grew from 2 to 7% (11).

The injury mortality categories of interest were: V02-V89 Motor vehicle transport accidents, called Road traffic injuries; X40-X49 Accidental poisoning by and exposure to noxious substances¸ X60-X84 Intentional self-harm (suicide); Y10-Y34 Event of undetermined intent; X40-X49, X60-X84 and Y10-Y34 combined Accidental poisoning by and exposure to noxious substances, Intentional self-harm, and Event of undetermined intent, called Poisoning, Suicide, and Undetermined; X41, X61 and Y11 combined Accidental poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, Intentional self-poisoning and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, and Poisoning by and exposure to antiepileptic, sedative-hypnotic, antiparkinsonism and psychotropic drugs, not elsewhere classified, undetermined intent, called overdose by sedative; X42, X62 and Y12 combined Accidental poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, Intentional self-poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewere classified, Poisoning by and exposure to narcotics and psychodysleptics (hallucinogens), not elsewhere classified, called

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overdose by narcotics. Road traffic injury is included as decrease in mortality due to this category has been widely observed and often contrasted to increase in suicidal rates (9).

The number of injury deaths per category were all cases in the population and these were related to population age and gender specific numbers in the annual mid-year versions of the National Registry through the study period (11). Annual crude mortality was calculated per 100,000 for the last ten years of the study period with 95% confidence intervals (CI). Annual gender specific age-adjusted mortality rates were calculated using modified World Standard as a reference. Pearson correlation coefficient were computed for annual changes during the study period. Differences were judged significant based on a two-sided test if p values were less than 0.05. The changes in rates from 1996 to 2015 were analysed by joinpoint regression model (18). The smallness of the data limited the possibility to apply complex models, however, the estimated annual changes in rate from the beginning to the end of the study period were calculated for road traffic injury, the combined categories of poisoning, suicide, and event of undetermined intent, and suicide. The slopes were converted to annual percentage changes (APC) showed with 95% CI.

The Data Protection Commission and the National Bioethics Committee (VSNb2019040011/03.03) approved the study.

Patient and Public involvement

No patient involved.

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Results

Altogether there were 722 suicide, 195 accidental poisoning and 126 deaths due to event of undetermined intent. The crude overall suicide rate (ICD-10 codes: X60-X84) representing the last ten years were 12.2 per 100,000 persons per year (95% CI 7.4 to 18.1). The crude overall rate for combined accidental poisoning, suicide and events of undetermined intent (ICD-10 codes: X40-X49, X60-X84, and Y10-Y34), during the same period was 14.8 per 100,000 persons per year (95% CI 9.3 to 22.1). The crude overall rate due to road traffic injuries (ICD-10 codes: V02-V89) was in comparison low 4.6 per 100,000 persons per year (95% CI 2.0 to 8.3).

Figures 1 and 2 show the annual number of the selected categories of external causes of deaths: road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics in male and female respectively through 1996 to 2015. In some of these categories for some years there are no deaths or one or two, and overall the figures are low per category per years and varied considerably through the years obscuring trend when comparing individual years to each other.

Table 1 shows the age standardized rates per 100,000 males per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Across 1996 to 2015, rates decreased for road traffic injuries, calendar years and rates were negatively correlated, r (19) = -0.66, p = 0.001. For suicide the rates also decreased however not significantly (r (19) = -0.22, p = 0.36). For other categories or combined categories, the rates did not change significantly during the study period except for overdose by narcotics where the rates increased significantly (r (19) = 0.72, p < 0.001).

Table 2 shows the age standardized rates per 100,000 females per year for road traffic injuries, accidental poisoning, suicide, event of undetermined intent, these last three categories combined, overdose by sedative, and overdose by narcotics. Similarly, as among the males across 1996 to 2015, the rates decreased for road traffic injuries, calendar years and rates were negatively correlated, however not significantly (r (19) = -0.38, p = 0.09). For the separate categories of accidental poisoning, suicide, and events of undetermined intent the

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rates were found to increase, however not significantly, the calendar years and the rates were moderately positively correlated. For accidental poisoning, suicide, and event of undetermined intent combined the rates increased significantly (r (19) = 0.60, p = 0.006). The rates for overdose by sedative, and overdose by narcotics increased significantly with a positive correlation, r (19) = 0.49, p =0.3, and r (19) =0.67, p = 0.001, respectively.

In the joinpoint regression analysis the trend was analysed through the study period for road traffic injuries rates where the APC indicates decrease by 5.5 (95% CI -8.3 to -2.6) for men and decrease by 6.4 (95% CI -12.2 to -0.2) for women. During the same period the combined categories accidental poisoning, suicide, and event of undetermined intent the APC was increased by 0.2 (95% CI -1.1 to 1.6) for men, and the APC was increased by 2.6 (95% CI 0.9 to 4.2) for women. Corresponding for suicide the APC was decreased by 0.7 (95% CI -2.4 to 1.1) for men and increased by 1.1 (95% CI -0.7 to 3.0) for women.

Table 3 shows the number and percentages of causes of death for Accidental poisoning, Intentional self-harm, and Event of undetermined intent during 1996 to 2015. The pattern for the categories accidental poisoning, self-poisoning, and poisoning when the intent is undetermined show some similarities. However, there were some exceptions, the proportion of overdose by sedative is highest for undetermined intent, the proportion of overdose by narcotics is lower for self-poisoning than for the other two categories, and the proportion of poisoning by other gases and vapours is higher for self-poisonings than for the other categories. When alcohol was involved the proportion was highest for the category accidental poisoning followed by undetermined intent, and was unusual for suicide. Hanging, strangulation and suffocation was the most common methods for suicide followed by self-poisoning, and firearm. These violent methods were uncommon for undetermined intent, where poisoning were about 85%.

Discussion

The suicide rates in men and women did not appear to change noticeable during the study period in Iceland. The suicide rates were approximately threefold higher in men than in women. The rates for combined accidental poisoning, suicide, and event of undetermined intent increased for women, but not for men. The rates for road traffic injuries, which is based on fewer cases in the population, decreased among both genders, and significantly so for men. The rates for overdose by sedative increased among women, and the rates for overdose by narcotics increased significantly among both genders. The smallness of the population may explain some of the fluctuations of the annual rates.

The overall suicide rate reported in the present study is of similar magnitude as was seen in a previous study on suicide mortality trends in the Nordic countries (19). However, the rate is somewhat higher than in the recent reports from the UK (4), and lower than reported from the US (1), and in these studies the overall rates were calculated for the last ten years as in the present study. In the study of the Nordic countries the Icelandic rates stood out as the lowest suicide rates, and the Icelandic rates did not decline through the years 1980 to 2009 as was the case in most of the other countries (19). Still earlier report on suicide in Iceland showed stable suicide rates through the years 1950 to 2000 (20).

The decreasing trend for road traffic mortality seen in the present study, has also been reported recently in several western countries, however not in all (21). This finding may indicate appropriateness of the present methodological approach of the small size data.

The increased rates of overdose by sedative and narcotics in the present study are notable and in accordance with reports from other populations (7,8).

In the break down of the causes of death by the categories accidental poisoning, suicide, and event of undetermined intent, the proportion of death due to poisoning/intoxication may be considered to show some similarities. However, there are differences between the categories, which in the light of possible misclassification, and relatively few cases, rule out firm conclusion from the figures. The causes of death for undetermined intent is dominated by poisoning while more violent causes are proportionally few as compared to causes of death

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reported as suicide. Some studies discuss the suicide methods in attempt to suggest possible preventive actions (19), however that was not the scope of the present study.

Strength and limitation

The use of the comprehensive population registries, the National Cause-of-Death Register and the National Registry strengthen the study. Only one version of the classification of cause of death, namely the ICD-10, was used during the study period, however, the registration of cause of death depends on different attesting persons. Death certificates in Iceland are issued by a physician. If the deceased person's physician is not able to attest the cause of death, or in cases where the circumstances of the death are unexplained, unusual, suspicious, due to intoxication or following an accident the death is reported to the police and the medical examiner, who decides whether to arrange for an autopsy and forensic investigations before the death certificate is issued (16). The quality of death registration at a global level have been studied, and the data from Iceland was evaluated as high overall and ranked in the same category as data from 23 developed countries, including the US and the UK (10).

The small material and the distribution according to gender and calendar years across study period of 20 years is an obvious drawback, however the registries ensure the completeness of the data. The age groups available were rather crude and the low numbers in some of the ICD-10 categories preclude meaningful detailed description of the mortality according to age groups.

Injury, poisoning and certain other consequences of external cause according to ICD-10, that is codes S00 to T98, particularly concerning poisoning by drugs, medicaments and biological substances, would have given different and perhaps more precise information. However, these codes were not available from the website of Statistic Iceland (15).

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Conclusions

The suicide rates in Iceland have not changed during 1996 to 2015, however the rates for the

combined accidental poisoning, suicide, and event of undetermined intent increased

significantly for women. The rise of the overdose rates for sedative among women and for

narcotics among both genders are according to increase in rates of prescription and non-

prescription drug overdose deaths reported elsewhere.

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Legends to figures

Figure 1 Annual number of deaths among men through the years 1996 to 2015 in the categories Road traffic injury V02-V89; Poisoning, Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

Figure 2 Annual number of deaths among women through the years 1996 to 2015 in the categories Road traffic injury V02-V89; Poisoning, Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

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Table 1 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among men

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	6.18	22.00	2.74	19.26	0	0.7	0
1997	8.62	19.78	2.03	17.26	0.48	4.53	0
1998	12.82	21.48	6.29	15.18	0	0.68	2.05
1999	9.03	16.22	0.46	15.76	0	1.04	0
2000	13.88	28.75	0.65	28.10	0	0	0.66
2001	13.04	23.80	5.05	17.67	1.08	3.42	0.36
2002	9.23	16.71	2.94	11.89	1.88	3.82	2.26
2003	8.35	15.74	1.86	12.65	1.24	2.87	0.63
2004	8.96	18.62	1.03	15.77	1.81	2.49	1.25
2005	7.68	16.98	2.21	14.77	0	0	2.18
2006	13.00	16.09	1.69	12.70	1.69	1.80	1.20
2007	7.36	22.63	0	16.13	6.51	4.11	4.11
2008	6.20	21.19	1.85	14.42	4.91	3.18	3.62
2009	5.40	21.18	1.61	15.43	4.14	4.84	1.13
2010	2.57	24.02	3.83	20.20	0	3.14	3.38
2011	6.63	18.74	6.93	11.81	0	2.80	2.86
2012	4.53	20.16	5.64	13.98	0.54	3.89	1.67
2013	4.64	22.34	3.04	17.14	2.16	1.65	3.60
2014	2.35	21.96	4.92	17.04	0	0	3.26
2015	5.88	20.68	2.62	16.48	1.57	3.22	2.69
r	-0.66	0.05	0.25	-0.22	0.24	0.19	0.72
p	0.001	0.829	0.290	0.363	0.298	0.429	0.0004

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Table 2 Annual age standardized rates per 100.000 people of selected external causes of deaths with Pearson correlation coefficient (r) and p-values among women

Calendar years	Road traffic injury	Poisoning, Suicide, and Undetermined	Accidental poisoning	Intentional self-harm (Suicide)	Event of undetermined intent	Overdose by sedative	Overdose by narcotics
	V02-V89	X40-X49, X60-X84, Y10-Y34	X40-X49	X60-X84	Y10-Y34	X41, X61, Y11	X42, X62, Y12
1996	2.40	6.44	1.55	3.34	1.55	0.70	0
1997	2.55	7.22	2.23	4.99	0	2.07	0
1998	5.41	10.61	5.99	4.62	0	3.11	0
1999	3.50	6.03	1.48	4.55	0	1.35	0
2000	6.63	7.99	1.68	4.98	1.32	3.00	0.66
2001	5.77	9.12	2.94	5.17	1.00	2.94	1.29
2002	9.86	7.71	2.55	5.16	0	4.17	0.64
2003	3.69	6.31	1.89	3.79	0.63	1.26	0.63
2004	4.22	8.45	1.25	5.61	1.59	2.84	1.25
2005	3.04	11.46	4.36	5.53	1.57	1.91	2.46
2006	8.80	9.34	1.20	5.74	2.40	5.74	0.60
2007	0.59	9.47	0.59	3.86	5.03	5.62	2.09
2008	1.80	14.63	2.04	5.79	6.80	5.13	2.61
2009	0.56	9.03	1.13	3.95	3.95	3.95	1.69
2010	1.63	8.21	2.25	5.39	0.56	2.00	1.69
2011	3.00	7.75	4.43	2.75	0.56	3.62	1.12
2012	0.60	10.62	4.07	6.55	0	2.78	0.56
2013	5.26	10.28	2.24	6.94	1.10	5.47	0.55
2014	1.33	12.66	5.77	5.80	1.09	2.72	4.93
2015	1.85	12.93	5.37	5.13	2.43	4.58	4.30
r	-0.38	0.60	0.32	0.35	0.27	0.49	0.67
p	0.094	0.006	0.165	0.130	0.254	0.03	0.001

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Table 3 Number and percentages of cause of death according death certificates, Accidental poisoning, (ICD-10 codes X40-X49), Intentional self-harm (Suicide) (ICD-10 codes X60-X84), and Event of undetermined intent (ICD-10 codes Y10-Y34), during the study period

By means of - (ICD-10)	Accidental poisoning N (%)	Suicide N (%)	Undetermined intent N (%)
- nonopioid analgesics, antipyretics, and antirheumatics (X40, X60, Y10)	12 (6.2)	15 (6.6)	8 (7.5)
- antiepileptic, sedative-hypnotic, antiparkinsonism, and psychotropic drugs (X41, X61, Y11)	61 (31.3)	85 (37.4)	52 (48.6)
- narcotics, and psychodysleptics (hallucinogens) (X42, X62, Y12)	57 (29.2)	26 (11.5)	31 (29.0)
- other drugs acting on the autonomic nervous system (X43, X63, Y13)	3 (1.5)	7 (3.1)	0
- other and unspecified drug, medicaments, and biological substances (X44, X64, Y14)	18 (9.2)	16 (7.0)	5 (4.7)
- alcohol (X45, X65, Y15)	29 (14.9)	1 (0.4)	7 (6.5)
- organic solvents and halogenated hydrocarbons (X46, X66, Y16)	0	1 (0.4)	0
- other gases and vapours (X47, X67, Y17)	14 (7.2)	71 (31.3)	0
- other and unspecified chemicals and noxious substances (X49, X69, Y19)	1 (0.5)	5 (2.2)	4 (3.7)
Total/Subtotal	195	227	107
- hanging, strangulation, and suffocation (X70, Y20)	n/a	281 (38.9)	2 (1.6)
- drowning, and submersion (X71, Y21)	n/a	42 (5.8)	5 (4.0)
- handgun discharge (X72, Y22)	n/a	1 (0.1)	0
- rifle, shotgun, and larger firearm discharge (X73, Y23)	n/a	46 (6.4)	0
- other and unspecified firearm discharge (X74, Y24)	n/a	54 (7.5)	0
- explosive material (X75, Y25)	n/a	2 (0.3)	0
- smoke, fire, and flames (X76, Y26)	n/a	3 (0.4)	0
- sharp object (X78, Y28)	n/a	17 (2.4)	1 (0.8)
- blunt object (X79, Y29)	n/a	1 (0.1)	1 (0.8)
- jumping from a high place (X80, Y30)	n/a	34 (4.7)	0
- crashing of motor vehicle (X82, Y32)	n/a	4 (0.6)	2 (1.6)
- other specified means (X83, Y33)	n/a	5 (0.7)	0
- unspecified means (X84, Y34)	n/a	5 (0.7)	8 (6.3)
Total	n/a	722 (100)	126 (100)

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Figure 1 Annual number of deaths among men through the years 1996 to 2015 in the categories Road traffic injury V02-V89; Poisoning, Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

308x176mm (300 x 300 DPI)

Annual number of deaths among women
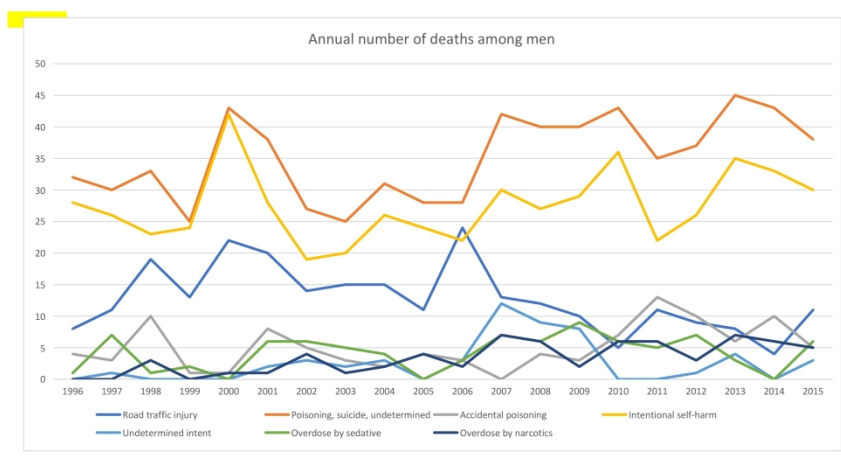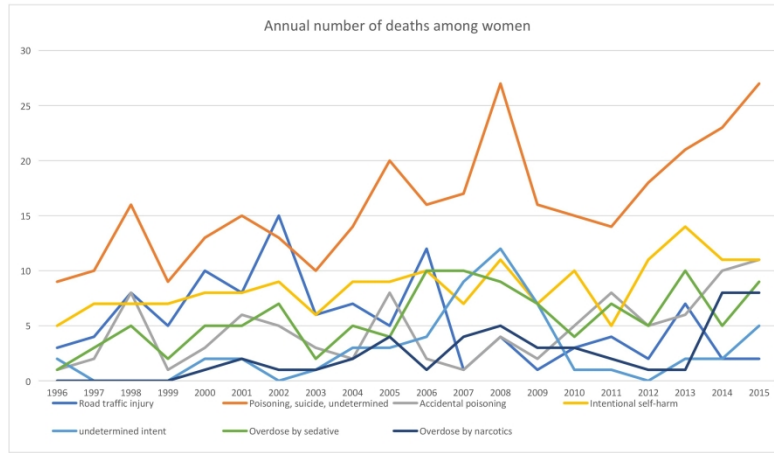
Figure 2 Annual number of deaths among women through the years 1996 to 2015 in the categories Road traffic injury V02-V89; Poisoning, Suicide, and Undetermined X40-X49, X60-X84, Y10-Y34; Accidental poisoning X40-X49; Intentional self-harm (suicide) X60-X84; Event of undetermined intent Y10-Y34; Overdose by sedative X41, X61, Y11; Overdose by narcotics X42, X62; Y12

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The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	1-2	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.	1-2
				RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract.	1
				RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	n/a
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	5		5
Objectives	3	State specific objectives, including any prespecified hypotheses	5		5
Methods					
Study Design	4	Present key elements of study design early in the paper	6		6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6		6

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	6	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided.	6
		Case-control study - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls	n/a	RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided.	n/a
		Cross-sectional study - Give the eligibility criteria, and the sources and methods of selection of participants	n/a		
		(b) Cohort study - For matched studies, give matching criteria and number of exposed and unexposed	n/a	RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	n/a
		Case-control study - For matched studies, give matching criteria and the number of controls per case	n/a		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	6-7	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	6-7
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6-7		6-7

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Bias	9	Describe any efforts to address potential sources of bias	6		6
Study size	10	Explain how the study size was arrived at	6		6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6-7		6-7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7		7
		(b) Describe any methods used to examine subgroups and interactions	7		7
		(c) Explain how missing data were addressed	n/a		n/a
		(d) *Cohort study* - If applicable, explain how loss to follow-up was addressed	n/a		n/a
		Case-control study - If applicable, explain how matching of cases and controls was addressed	n/a		n/a
		Cross-sectional study - If applicable, describe analytical methods taking account of sampling strategy	n/a		n/a
		(e) Describe any sensitivity analyses	n/a		n/a
Data access and cleaning methods		..	6-7	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	6-7

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				RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	n/a
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	n/a
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed)	7-8	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	7-8
		(b) Give reasons for non-participation at each stage.	n/a		
		(c) Consider use of a flow diagram	n/a		
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders	8, Fig. 1 and 2		8, Fig. 1 and 2
		(b) Indicate the number of participants with missing data for each variable of interest	n/a		n/a
		(c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	7-8		7-8
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time	8-9, Tables 1 and 2		8-9, Tables 1 and 2
		Case-control study - Report numbers in each exposure	n/a		n/a

		category, or summary measures of exposure			
		Cross-sectional study - Report numbers of outcome events or summary measures	n/a		n/a
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9, Tables 1 and 2		8-9, Talbes 1 and 2
		(b) Report category boundaries when continuous variables were categorized	n/a		n/a
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	n/a		n/a
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	n/a		n/a
Discussion					
Key results	18	Summarise key results with reference to study objectives	10 and 12		10 and 12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	11	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	10-11
Interpretation	20	Give a cautious overall interpretation of results considering objectives,	10-11		10-11

		limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results	10-11		10-11
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	13		13
Accessibility of protocol, raw data, and programming code		..	13	RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	13

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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