RESEARCH REPORT

Diversity and change in suicide seasonality over 125 years

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Background: Recent research has corroborated the notion that seasonality in suicide is more heterogeneous and less consistent than postulated by former scholars. This work investigates the smoothing out of suicide seasonality in Switzerland between the late 19th and the end of the 20th century. It includes analyses by region and by suicide method.

Methods: Monthly suicide frequencies in Switzerland are available for the period 1876–2000. Data on canton/region are available for the periods 1901–1920 and 1969–2000, and data on suicide method for the periods 1881–1920 and 1969–2000. Analyses focusing on the overall change rely on data aggregated by quinquennia. The Edwards' test and the peak-low ratio were used in univariate analyses of seasonality. Putative determinants of the peak-low ratio were examined using regression analysis with cantonal data.

Results: The decrease of seasonal effects in suicide applies to a period of more than 100 years in Switzerland. Big differences of seasonal effects have existed all the time with regard to specific methods and to specific regions. No seasonality was apparent in poisoning, and in Geneva and Basle City, respectively. However, the seasonal effects have been most impressive in drowning and hanging suicides, and in rural Catholic regions. In regression analysis, the decline in suicide seasonality is associated with the decline in the agricultural work force.

Conclusions: The smoothing out of suicide seasonality in Switzerland has been a continuous long term process, which probably started by the end of 19th century. Seasonal effects in suicide will probably fade away in most regions of Switzerland and in most suicide methods. This process is in parallel with the disappearance of the traditional rural society.

Seasonality in suicide is one of those topics in epidemiology that we believe to know much about but understand fairly little in actuality. Research in this domain has a long tradition, starting with the very prominent exponents of biological psychiatry and sociology of the 19th century—that is, Ferri and Morselli on the one hand and Emile Durkheim on the other.[1] Since then many scholars have reported uniformly higher suicide frequencies in spring and summer than in autumn and winter.[2 3] The findings were corroborated by analyses in many countries and of many subgroups. Seasonality in suicide emerged as a universal fact.

Recent research in suicide seasonality has accumulated evidence that interesting issues might have been disregarded for over 100 years. These issues touch on the anomalous empirical results, for example, the heterogeneity of seasonality. A preliminary intriguing observation was reported by Durkheim: he had observed that seasonal effects in suicide are stronger in rural than in urban communities.[4 5] Another matter of discussion was the question of unimodal or bimodal peaks in suicide seasonality since a modest second peak in autumn appeared after the spring peak in some analyses.[6–8] Some authors suggested that seasonality differs by suicide method, whereby non-violent (poisoning) suicides lack any seasonal patterns.[9–11] More detailed analyses have shown that seasonality is actually missing also in specific violent methods like firearm suicides and cutting.[12] International data showed consistently reciprocal patterns in the Southern hemisphere[13–16] but weak/absent seasonality in equatorial regions.[17] Finally, longitudinal data provided new evidence that seasonal effects have decreased in recent decades.[18 19]

Very few studies have examined the change of suicide seasonality over a long period, and their results seem to have fallen into oblivion.[2 20] This work picks up this thread and reports the continuous change of suicide seasonality in Switzerland from the end of 19th century until now. Additional analyses address seasonality by suicide method and by canton at around 1900 and compare them with patterns from recent decades. The analyses address the following questions:

- has seasonality in suicide changed over the past 125 years and, if so, how?
- were there any differences in seasonality between suicide methods in 1900, and have they changed in recent times?
- were there any differences between the cantons/regions of Switzerland in 1900 and today?
- how can we explain the actual differences?

METHODS

Data on suicide mortality have been gathered in Switzerland since 1876 when standardised registration for cause of death was introduced.[21] Within the period 1876–2000, 128 862 suicides were registered in the Swiss cause of death statistics. Monthly suicide data are available for each year from the publications of the Swiss Federal Statistical Office. The data also include monthly data by suicide method for the period 1881–1920 and monthly data by canton 1901–1920. The cantonal and method specific monthly frequencies from the period 1921–1968 were lost and remain unrecoverable. Since 1969 the data are available on the level of individual records thus enabling more detailed analyses.

Besides the availability of statistical data the sociocultural heterogeneity within Switzerland provides interesting clues for epidemiological research—different regions and cantons

belonging to the German or French or Italian speaking parts of the country, sharing either a Protestant or a Catholic tradition, being either urban or rural, with a longer or shorter history of industrialisation. However, some cantons are very small and need to be merged for analyses. The selection criterion was suicide frequencies below 200 in the period 1901–1920. The following cantons were merged:

- the small cantons of central Switzerland (Uri, Schwyz, Nidwalden, Obwalden, Zug) that share a rural Catholic tradition;
- Appenzell Innerrhoden and Appenzell Ausserrhoden: these small cantons have attracted much attention in recent decades because suicide has reached endemic status;
- Jura and Bern: the canton of Jura (French speaking, mainly Catholic population) was founded in 1979 after secession from Bern, so sociodemographic and mortality data from former decades are not available;
- Glarus and St Gallen.

Thereby the number of geographical units diminished from 26 to 19.

Multivariate analyses relied on cantonal data including monthly suicide frequencies as well as:

- the proportion of the agricultural work force (census 1900 and enterprise census 1985): This variable serves as an indicator of rural societal units. It may be supposed that the higher the proportion of the agricultural work force (that is, the stronger the rurality), the stronger the seasonal fluctations in suicide frequencies. The decline in the agricultural work force has accelerated in the past 100 years, but it did not involve all cantons/regions in the same way.
- religious affiliation—that is, the proportion of Catholics (census 1900 and 1990): this variable accounts for the close interrelation between the proportion of the agricultural work force and the dominant religious affiliation of a region. In Switzerland, like elsewhere in Western Europe, Catholic regions are more rural than Protestant regions, and they have experienced a slower socioeconomic development. Religious affiliation changes slowly in contrast with the agricultural work force.

No cantonal data were available with regard to specific suicide methods in 1900.

In univariate analyses, the monthly suicide data were aggregated and standardised by the length of months. The standardised values have a mean index value of 100 and thus may be regarded as percentage deviations.

The hypothetical seasonal patterns we may find in the data include sinusoidal and pulse patterns. The common models used in the analysis of seasonalities are the Edwards' procedure,[22 23] which tests for the former pattern and the ratchet scan statistics designed for pulse patterns.[24] In this study we used the Edwards' test because it applies to the most common type of seasonality—that is, unimodal sinusoidal seasonal effects. The test relies on the χ^2 statistics with two degrees of freedom. It is the oldest specific test for seasonality in aggregate data, and despite some more recent approaches, it remains the ''benchmark''.[24] The basic idea is elegant: observed monthly frequencies figure as weights for 12 equally spaced points on the rim of the unit circle; the target parameter is the deviation of the centre of gravity from the centre of the circle. Moreover, to represent the magnitude of seasonal effects, Edwards provided also a calculation of the peak-low ratio that can be derived from the peak and the nadir of the sine curve fitted through aggregated monthly data. The respective procedure was adapted and implemented online by Rothman (http://members.aol.com/krothman/episheet.xls). A modified approach for the calculation of peak-low ratio confidence intervals has been published recently.[25]

The Edwards' test—as well as most of its successors—comes with three problems. Firstly, it is restricted to unimodal sinusoidal seasonal patterns. A test for a bimodal sinusoidal pattern was developed in the 1980s.[26 27] Secondly—and in contrast with Pocock's claim[28] that the Edwards' test ''is liable to detect other trends without being able to distinguish between them''—this test was shown to have little power with respect to pulse patterns.[29] This led to the development of the ratchet scan statistics.[24] Thirdly, in any real data two (or more) seasonal patterns may interfere, and also the length of peaks and troughs may vary. For aggregated data, there are no statistical procedures available that would account for structures more complex than a bimodal sinusoidal pattern.

In multivariate analysis with cantonal data, the proportion of Catholics and the proportion of the agricultural work force were introduced as logits to mitigate floor and ceiling effects. Modelling was done within the framework of random coefficient models.[30] Optionally, the period 1969–2000 was split into two or three subperiods. As boundary constraints arose in all model variants, the final models were restricted to fixed effects and correspond to conventional multivariate regression models.

All analyses were performed using SAS for Macintosh, version 6.12 (SAS Institute, Cary, NC). The Edwards' test was programmed by the authors.

RESULTS

Preliminary evidence of the change in suicide seasonality in Switzerland is given by figure 1 and table 1. While the absolute frequencies of suicide have doubled, the amplitude of seasonal deviation has smoothed from ±25% around 1900 down to ±10% in the past 30 years. The decline of seasonal effects in suicide can be depicted, for example, by quinquennial peak-low ratios, which have decreased in a fairly linear way from 1.7 over 100 years ago to values around 1.1 today (fig 2).

However, the decline of suicide seasonality did not progress in the same way in all cantons/regions of Switzerland. First of all, there are cantons that do not exhibit any regular patterns neither in 1901–20 nor in the recent decades—such as Basle City and Geneva, which are both urban cantons and have a Protestant tradition. In general, cantons with a Protestant tradition have higher suicide rates than predominantly

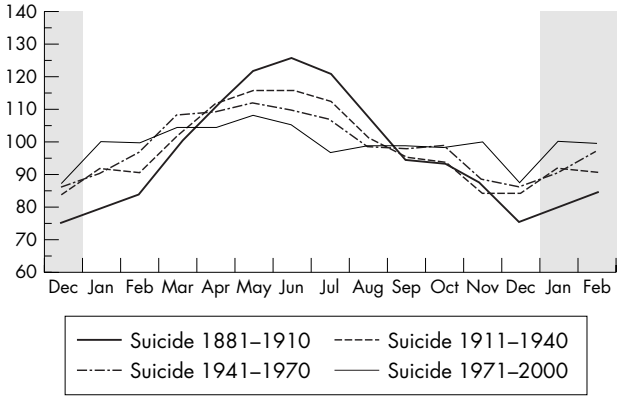

Figure 1 Aggregated monthly suicide frequencies in Switzerland, 1881–1910/1911–40/1941–70/1971–2000; values are standardised to 100.

Table 1 Monthly frequencies in suicide in Swiss cantons/regions, 1901–20 and 1969–2000

	1901–1920					1969–2000				
Canton/region	Number	χ^2 (2 df)	Peak-low ratio	Lower CI	Upper CI	Number	χ^2 (2 df)	Peak-low ratio	Lower CI	Upper CI
Zurich	2756	63.6***	1.57	1.40	1.76	8400	0.7	1.03	1.00	1.09
Bern	2854	63.2***	1.53	1.38	1.71	7253	6.1*	1.08	1.02	1.16
Lucerne	409	3.6	1.19	1.01	1.40	1850	14.4***	1.29	1.13	1.47
Central CH	254	27.9***	2.81	1.79	4.39	1449	9.0*	1.23	1.06	1.43
Fribourg	336	25.3***	2.27	1.59	3.25	1432	11.8**	1.30	1.12	1.50
Solothurn	437	6.1*	1.40	1.07	1.84	1583	5.3	1.18	1.02	1.36
Basle City	492	0.7	1.12	1.00	1.43	1785	0.6	1.05	1.00	1.20
Basle Country	338	5.3	1.43	1.05	1.94	1485	4.6	1.17	1.01	1.35
Schaffhausen	236	7.2*	1.65	1.13	2.43	527	0.3	1.07	1.00	1.37
Appenzell	379	11.3**	1.64	1.22	2.23	574	3.0	1.23	1.00	1.55
St Gallen†	1138	13.8***	1.37	1.16	1.62	2968	9.9**	1.18	1.06	1.31
Graubünden	428	20.4***	1.89	1.41	2.55	1119	11.5**	1.33	1.13	1.58
Aargau	900	39.0***	1.83	1.50	2.25	3158	4.8	1.12	1.01	1.32
Thurgau	622	15.4***	1.57	1.25	1.99	1331	2.4	1.13	1.00	1.31
Ticino	365	3.2	1.31	1.00	1.76	1174	6.4*	1.23	1.05	1.45
Vaud	2195	31.6***	1.41	1.25	1.59	4273	4.1	1.09	1.00	1.19
Valais	235	17.7***	2.26	1.48	3.47	1431	3.3	1.15	1.00	1.33
Neuchatel	778	25.9***	1.70	1.37	2.10	1286	4.2	1.18	1.00	1.38
Geneva	935	3.6	1.19	1.00	1.43	2619	6.5*	1.15	1.03	1.29

†Including Glarus. *p<0.05; **p<0.01; ***p<0.001. Edwards' test χ^2 values, peak-low ratios, and 95% confidence intervals.

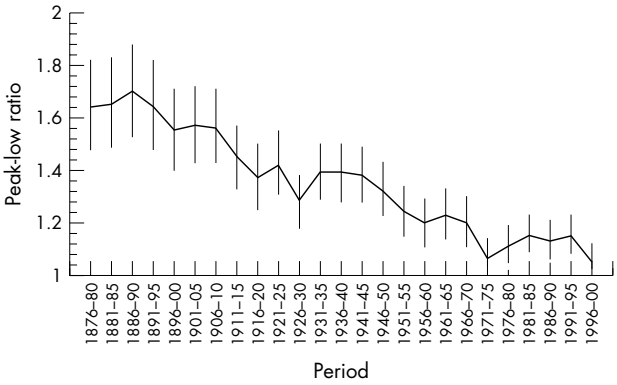

Figure 2 Change of peak-low ratios based on monthly suicide frequencies in Switzerland, 1876–2000, by five year intervals; overlaid: 95% confidence intervals.

Catholic cantons but lower peak-low ratios with regard to seasonality. In predominantly Catholic and rural regions like St Gallen, Central Switzerland, or Fribourg, the seasonality pattern was less accentuated in recent decades but has not faded away completely. The results of almost all cantons and regions (table 1) show that the peak-low ratio has decreased in the course of the 20th century.

Differentiating suicide frequencies by suicide methods shows heterogeneous seasonality patterns in both periods 1881–1920 and 1969–2000 (fig 3, table 2). In both periods poisoning suicide lacked any seasonality whereas hanging and drowning yielded the strongest seasonal effects. The seasonal effects have been distinctly weaker in the recent period. Seasonal effects in cutting and firearms suicides have faded away entirely.

Multivariate regression analysis of cantonal data examined the effect of rurality and Catholic religious affiliation on the peak-low ratio and its change in the 20th century. Table 3 shows the results of two regression models, whereby the second model relies on 17 cantons/regions (instead of 19) after the exclusion of Lucerne and Ticino that exhibited bimodal seasonal patterns. The proportion of explained variance increased substantially in model two reaching almost 80%. Therefore—and even though we do not know the reasons why bimodal seasonal patterns occurred in Lucerne and in Ticino—we suppose that model 2 describes the historical change more appropriately than model 1.

The initial peak-low ratio is higher than in the overall data (fig 1) because the predominantly Catholic cantons have a smaller average population than predominantly Protestant cantons. The effect for period represents directly the decline of the peak-low ratio. The variation of the initial seasonality pattern around 1900 is determined by the proportion of the agricultural work force as well as the proportion of Catholics (model 2) that both yield higher peak-low ratios. However, the change rate of the peak-low ratio is modified mainly by change in the rurality indicator, whereby predominantly rural cantons experienced a faster decrease of the peak-low ratios. Thus, seasonality in suicide diminished faster in cantons with an initially high peak-low ratio.

DISCUSSION

Change and heterogeneity are fairly prominent characteristics in the epidemiology of suicide. Thus, the consistently uniform suicide seasonality patterns reported have been an irritating issue. Only recently have researchers begun to pay closer attention to the diversity of seasonal effects.[10 18 31] This study is the first to assess and model the long term change of seasonality in suicide since the end of the 19th century and to shed some light on former method specific seasonality patterns. We are just beginning to understand a phenomenon, which, obviously, is about to fade away.

The basic finding from the Swiss data is that seasonality in suicide has diminished gradually over the past 125 years. So when did this process begin? Historical data[32] suggest that seasonal effects in suicide had reached a similar magnitude in previous centuries like around 1900. Thus, it is most likely that the decrease started by the end of 19th century. This conclusion is corroborated by the results from Dreyer's study[20] that analysed Danish data 1835–1955. Her results show that the attenuation of suicide seasonality in Denmark started presumably at the beginning of the 20th century. In contrast with Canadian data reported by Kevan,[2] which show a sharp increase of seasonal effects immediately after the second world war, the Swiss data do not show any extraordinary moves on the level of quinquennial data. Analyses with more detailed data will show if this notion also holds for short term fluctuations.

The decline of suicide seasonalities begs explanation. Basically, there are three hypothetical approaches:

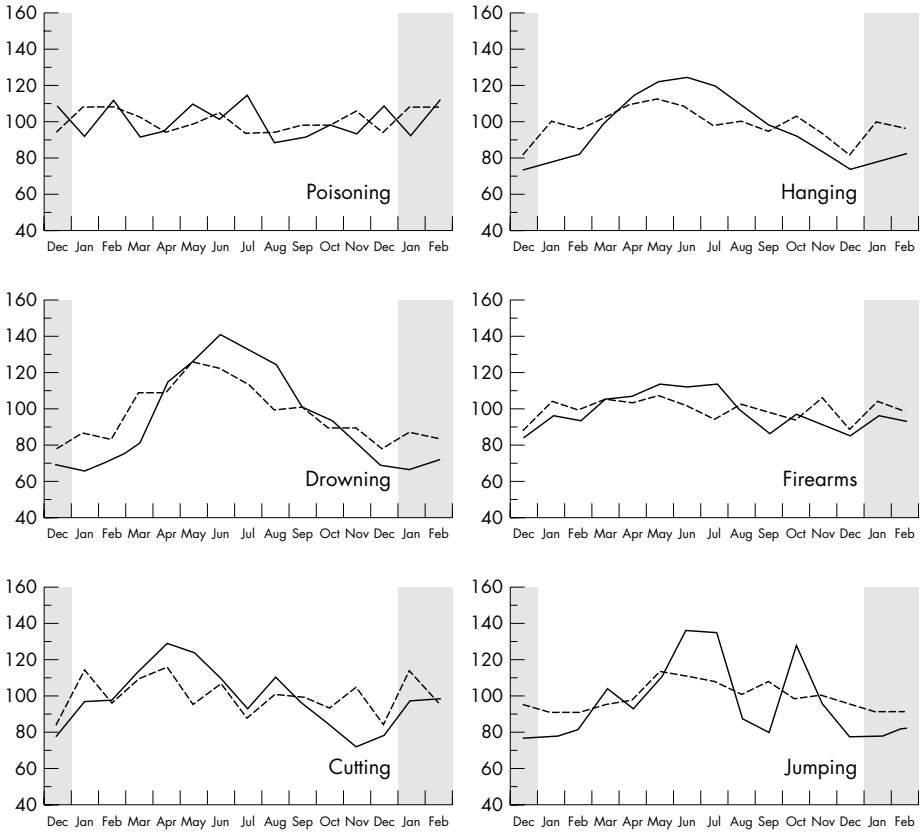

Figure 3 Aggregated monthly suicide frequencies by suicide method, 1881–1920 (thick line) compared with 1969–2000 (dashed line); values are standardised to 100.

Table 2 Monthly frequencies in suicides in Switzerland, 1881–1920 and 1969–2000, by suicide method†

	1881–1920					1969–2000				
Suicide method	**Number**	**χ^2 (2 df)**	**Peak-low ratio**	**Lower CI**	**Upper CI**	**Number**	**χ^2 (2 df)**	**Peak-low ratio**	**Lower CI**	**Upper CI**
Poisoning by solid or liquid substance	1272	0.9	1.08	1.00	1.26	6336	5.3	1.09	1.01	1.16
Hanging, strangulation	12129	357.5***	1.64	1.56	1.73	11635	44.0***	1.19	1.13	1.25
Drowning	6614	444.7***	2.16	2.00	2.34	4177	82.7***	1.50	1.37	1.64
Firearms, explosives	6351	48.3***	1.28	1.19	1.38	10902	7.6*	1.08	1.02	1.14
Cutting, piercing	1313	28.7***	1.53	1.30	1.79	862	1.5	1.13	1.00	1.36
Jumping from high places	907	15.4***	1.45	1.20	1.76	4664	17.7***	1.19	1.10	1.29

†Poisoning by gas, run over by train, etc, were omitted because of low frequencies in the first period or in both periods. *p<0.05; **p<0.01; ***p<0.001. Edwards' test χ^2 values, peak-low ratios and 95% confidence intervals.

Table 3 Regression analysis on the peak-low ratio in suicide seasonality, by cantons/regions

Variable	**Estimates model 1 (standard error)**	**Estimates model 2 (standard error)**
Interception	1.816***	1.891***
	(0.088)	(0.067)
(A) period (0, 1)	−0.595**	−0.671***
	(0.187)	(0.145)
(B) % agricultural work force	0.191**	0.182**
	(0.069)	(0.052)
(C) % Catholics	0.036	0.119***
	(0.034)	(0.029)
(A)×(B)	−0.168	−0.159*
	(0.094)	(0.072)
(A)×(C)	0.009	−0.080
	(0.072)	(0.064)
R^2	0.581	0.785

*p<0.05; **p<0.01; ***p<0.001. Model 1: 19 units; model 2: 17 units (Lucerne and Ticino excluded because of bimodal seasonal patterns).

Key points

- The decline of suicide seasonality is a gradual long term process. In Switzerland, it started by the end of 19th century.
- The process has progressed further in urban and Protestant regions—that is, more than in rural and Catholic regions.
- Findings for suicide methods like poisoning show that seasonality in suicide was never a universal phenomenon.

(A) Change in compound effects: because the overall seasonality in suicide can be decomposed along distinct method specific seasonalities,[12] the change in relative frequencies of suicide methods—as well as their internal seasonality structures—might determine change in the overall data.

(B) Change in the (seasonal) availability of methods.

(C) Change in the sociocultural context: because there are regional differences in suicide seasonalities[32] the change in overall data might be driven by specific sociocultural determinants.

Approach (A)

Several authors noted in the 1990s that suicide seasonalities vary by suicide method. A first interpretation effort sought to differentiate between violent and non-violent methods—that is poisoning suicides.[9 33 34] A more detailed analysis[12] showed that seasonality may lack not only in poisoning but also in violent methods like firearms and cutting suicides. The Swiss data show that differences existed already 100 years ago. Drowning and hanging exhibited very strong seasonality whereas poisoning did not show any seasonality at all. Jumping, cutting, and firearm suicides yielded modest seasonal effects. The decline of seasonality at the end of the 20th century may be seen in all methods. In some cantons like Zurich, the seasonality has disappeared even in hanging and drowning suicides.[32] However, in other cantons hanging and drowning suicides are still important sources of seasonal variation, such that the decreasing importance of these suicide methods—with an overall proportion of 62% in 1881–1920 but only 35% in 1969–2000—has accentuated the smoothing process in the overall data.

Approach (B)

Seasonality in suicide might depend on seasonal availability of methods. It is obvious that seasonality is lacking mainly in suicide methods/instruments, which are evenly available throughout the year—that is, poisons, firearms, knifes. In other methods like drowning or jumping the association does not necessarily rely on the availability of instruments but on the subjective perception of their availability—that is, on the social circannual timing of activities like swimming or climbing.[12] For example, in drowning suicides, which show(ed) the most impressive seasonality by far, the ''availability'' is diminishing at the same rate as children and adults have learned to swim. Moreover, indoor pools have turned swimming into a year round activity. Possibly, the availability hypothesis is specific for drowning and jumping but not for hanging.

Approach (C)

It was Durkheim who observed that seasonality in suicide is more accentuated in rural than in urban contexts.[4] He did not report differences between Catholic and Protestant regions, but, as the Swiss data suggest, he would have reported stronger seasonal effects in Catholic regions. This is not a coincidence. The most important urban and industrial centres in Switzerland—Zurich, Basle, Bern, Geneva—are all located in Protestant cantons. Like in other countries of central Europe, industrialisation developed later and more gradually in Catholic regions of Switzerland. Either economic and structural development (and the resulting urbanicity trend) or religious affiliation might figure as the driving force behind the decline of seasonal effects in suicide.

At first glance the empirical evidence is hardly conclusive: seasonality has diminished in all regions of Switzerland. However, the process presumably started later in Catholic than in Protestant cantons where seasonality has mostly faded away. In multivariate analysis the decline was modified by structural change—shown by the proportion of the agricultural work force. The decline progressed faster in cantons with higher proportions of the agricultural work force, which is, possibly, some kind of demand backlog. It would be imprudent to conclude that the variable that modifies the change is also the cause of change. It is merely the best candidate for lack of a better one.

Study limitations and conclusions

The limitations of this study are, firstly, the missing cantonal and method specific monthly suicide frequencies for the period 1921–1968. Secondly, only few variables of interest were available for the longitudinal analysis. It is possible—although not very probable regarding the analysis of spatial units—that variables other than the proportion of agricultural work force and the proportion of Catholics are more conclusive. The third limitation relates to the limited number of cantons/regions in our analysis as outliers like Lucerne or Ticino have too much impact.

To conclude, supposing that seasonality in suicide is not a universal fact, we must consider that it emerges/increases under specific conditions. Better knowledge about the preconditions of seasonality—and their changes—will allow us to better understand the role of impulsivity and other types of ambivalent notions in suicidal behaviour. In turn, this is the precondition to implement different strategies in the prevention of planned and unplanned suicidal acts.[35]

In this study, the Swiss suicide data allowed us to go back to the end of 19th century by analysing the same data, which the pioneers in suicidology might have examined. The analyses showed that heterogeneity in suicide seasonalities is not a novel phenomenon. They showed that even around 1900 some suicide methods like poisoning and some cantons like Basle City or Geneva were lacking seasonal effects. Seasonal effects in suicide will probably fade away in most regions of Switzerland and in most suicide methods. The figures show that this process is now in its final stage. The main impulse of this process is probably the transformation of a rural society into a modern one. The relevant implications of this transformation—for example, change of social rhythms, access to suicide methods—still remain a matter for discussion.

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