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Accident or suicide? Improvement in the classification of suicides among road traffic fatalities in Sweden by extended psychosocial investigations, during the years 2010–2019

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ABSTRACT

Introduction: Suicide is the second leading cause of death in the ages 15–29 worldwide, exceeded only by road injury. However, fatalities in road traffic may be either accidents or suicides. In 2010 Sweden began efforts to separately report deaths in road traffic as either accidents or suicides. *Method:* Three alternative criteria defining what constitutes a fatality by suicide were introduced. After exclusion of natural deaths, fatalities were also classified on a five-level graded scale, which distinguished between accident, undetermined, and suicide. The investigations of fatalities were complemented by extended psychosocial investigations in 2012. The improvement in the classification of suicide deaths was evaluated by an intra-year 2012 comparison, as well as using the 2010–2012 period as a control to evaluate the continued use of extended psychosocial investigations during the 2013–2019 period. *Results:* The 2012 intra-year comparison showed a 63% increase in the number of identified suicides when using extended psychosocial investigations. The additional 14 suicides identified in 2012 were mainly attributed to a resolution of 12 "undetermined" causes of deaths. Suicides of all road fatalities increased from 5.7-6.8% in 2010–2011, to 11.2% in 2012. Over the subsequent period 2013–2019 with extended psychosocial investigations, suicides of all road fatalities averaged 10%, a 60% increase over prior years. An average of ~9 additional suicides was identified each year during 2013–2019, which was accompanied by an annual reduction of ~6 "undetermined" fatalities. *Conclusion:* The use of extended psychosocial investigations is of major importance for our knowledge about the occurrence of suicides in road traffic. *Practical applications:* A standardized and in-depth classification of suicide deaths is a basic prerequisite needed for the cooperation, implementation, and effect-evaluations of suicide intervention and prevention efforts, with potential to include the entire Swedish transportation system.

1. Introduction

Suicides and suicidal behaviors represent a major public health problem, whereby close to 800,000 people die of suicide each year worldwide. It is the second leading cause of death among the ages 15–29, exceeded only by road injury (World Health Organisation, 2014, 2019). However, fatalities in road traffic may be either accidents or suicides (natural deaths excluded). Therefore, the fatalities occurring in road traffic involves two of the leading causes of death among the ages 15–29 worldwide. Despite this, there is a large degree of missing data about suicides occurring in the road traffic overall (Harrison, 2017; Routley, Staines, Brennan, Haworth, & Ozanne-Smith, 2003; Varnik et al., 2010). The Swedish Parliament was the first to introduce Vision Zero in 1997, which is the ethical standpoint that no one should be killed or suffer lifelong injury in road traffic (Andersson & Svensson, 2022; The Swedish Parliament, 1997). Therefore, the Swedish Transport Administration (STA) began recording extended data about all fatal accidents in road traffic, storing information about the vehicle, the road and event, and other basic information about the road user. This provided a basis for identifying suspected suicides. An initial report about road traffic fatalities between 1997 and 2002 estimated that about 5% were due to suicides (Andersson et al., 2011).

In 2008, the Swedish government also presented a new health policy, stating that no person should end up in a situation where suicide is seen as the only way out (Reinfeldt & Larsson, 2008).

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As a consequence, the STA started additional efforts to report road traffic fatalities as either suicides or accidents. However, reporting statistics about suicides is a complex task, since suicides often appear as accidents. The major, distinguishing factors involved in suicides is the intent of the subject to die, which occurs in parallel with a psychosocial or mental health crisis (Goodfellow, Kolves, & de Leo, 2019; Mann, Waternaux, Haas, & Malone, 1999), whereby identifying suicide fatalities requires investigation of these factors in the road user. Overall, there is an underestimation of suicides in road traffic, mainly due to shortages of the necessary information to make such judgments about the cause of death (Breen, Naess, Gjerde, Gaarder, & Stray-Pedersen, 2018; Routley, et al., 2003; Varnik, et al., 2010). The fatalities in road traffic may thus be divided into accidents, suicides, natural deaths, as well as "undetermined" cases, which may not be possible to classify (Ahlm, Eriksson, Lekander, & Björnstig, 2001; Hernetkoski & Keskinen, 1998). Development of suicide criteria and a classification scale that takes these issues into account was subsequently introduced at the STA in 2010, and initially evaluated on the recorded road traffic fatalities from 2008 and 2009. However, it became evident that many of the suspected suicides were still classified as "undetermined" and some even as "strongly supported accident." It was suggested that more psychosocial information needed to be collected (Andersson, et al., 2011), similar to the detailed procedures reported by others (Ohberg, Penttila, & Lonnqvist, 1997). Subsequently, detailed psychosocial investigations were introduced in 2012 for all fatalities that were suspected suicides (Andersson & Svensson, 2014, 2015). In the current study we describe the criteria and classification of suicides in road traffic that are in use at the STA since 2010, as well as the impact of using extended suicide investigations since 2012, encompassing a total study period of 10 years (2010–2019). The main aim was to investigate if more suicides could be identified among road traffic deaths by the additional use of extended psychosocial investigations, as well as if there were subsequent consequences on the number of road traffic fatalities classified as accidents or "undetermined."

2. Materials and methods

2.1. Criteria for suicide

Three alternative criteria for the definition of suicide fatalities are shown in Table 1 (Andersson et al., 2011). The criteria's were influenced by the European Railway Agency, who developed a list of factors that may indicate that a death is an intentional act, based on the so-called Ovenstone criteria (European Railway Agency, 2004; Ovenstone, 1973). In addition to information about the traffic event and the vehicle, criteria 1 and 2 require knowledge about psychosocial and intent factors of the road user, for example prior suicide attempts, indirect suicidal communication, or knowledge of ongoing depression.

Table 1
Three alternative criteria for suicide in road traffic.

Criteria
1. Farewell message, oral or written, where the intention is clearly communicated and where the traffic event supports a suicide
2. A traffic event which indicates a suicide in combination with knowledge of :
(a) recent known suicide attempts
(b) recent indirect suicidal communication
(c) communication about suicide intent or having no reason to live
(d) ongoing prolonged depression or mental illness
(e) recent severe emotional or stressful life event
3. A traffic event which strongly indicates a suicide

2.2. Classification scale of fatality by suicide vs accident

A five level, graded classification scale of the fatalities was developed and is shown in Table 2 (Andersson et al., 2011). It was developed on the basis of assessing a suicidal diagnosis (Lönnqvist, 1977). The classification harmonizes with the National Board of Forensic Medicine concerning the nine-point scale for assessment of the cause of death (Swedish National Board of Forensic Medicine Board (2014)), but here a scale using five grades was used (Table 2). Those who died within 30 days due to the injuries from the road traffic event were included in the classification, but with natural deaths excluded. The distinction between natural deaths (disease-caused) and unnatural (caused by non-illness, mainly external violence and poisoning) deaths, were made according to the World Health Organizatioń s official International Classification of Diseases (ICD). Furthermore, we here only considered events occurring in the road traffic (i.e., in an area intended for public traffic or an area that is generally used for traffic), whereby at least one of the involved parties was some type of moving road vehicle. Examples are a head-on collision, a single vehicle collision into an inflexible object or water, a pedestrian or cyclist against a vehicle, or a motor vehicle against a train. However, a person colliding against a train would not be counted as a road traffic suicide in this study.

2.3. Primary data collection and selecting potential suicide fatalities for further examination

The police and the accident investigators did the collection of the primary data at the scene of the fatality. The *accident investigator* at STA gathered important documents such as the autopsy report, photos, information from the police, press clippings and details of the technical investigation of the car, and information about the road environment. This information was registered in the STA "In-depth" database, which constituted the only information available for suicide classifications during 2010 and 2011. In 2012 and beyond, extended psychosocial examinations were also conducted by a *psychosocial investigator*. The psychosocial investigator was directly contacted either by the accident investigator or the police, if the fatality was suspected to be due to a suicide according to the criteria (Table 1). In addition, the psychosocial investigator identified suspected suicides on the monthly review of fatal road traffic crashes that were held by the accident investigator by using the criteria (Table 1).

2.4. Extended psychosocial data collection about suspected suicide fatalities

The psychosocial investigator, educated in behavioral and medical sciences, conducted an expanded psychosocial data collection about the suspected suicides to gather more information in relation to the suicide criteria (Table 1). The psychosocial investigator collected written and oral reports from the police, information from relatives and witnesses of the accidents scene, as well as information from autopsy reports, and when possible, case records from earlier medical service. The data collection concerned any socio-economic background factors, as well earlier and current life events prior to the traffic event. Psychosocial and mental health factors such as marital status, education, gainful employment and working situation, health, economy, residence, alcohol or drug abuse, as well as mental illness, neuropsychiatric diagnoses or use of psychotropic drugs were investigated, to the greatest extent possible. Such recent psychosocial trauma (i.e., stressful life events,

Table 2
5-grade classification scale for road traffic fatalities.

Grade	The result of the examination
1	Shows that cause of death was suicide: - requires farewell letter or equivalent proof of intent to die directly from the deceased subject
2	Strongly supports that the cause of death was suicide: - almost certain suicide, but the intent is judged primarily on indirect / surrounding sources rather than directly from the deceased subject
3	Cannot determine whether the cause of death was suicide or the result of an accident: - the information is not sufficient to determine whether an event was a suicide or accident
4	Strongly supports that cause of death was accidental: - almost certainly an accident
5	Shows that the cause of death was accidental: - certain accident

ongoing mental illnesses or drug use) may be triggering events of suicidal acts. In addition, evidence of prior antisocial behaviors was investigated, as for example impulsive aggression that increases the risk of suicidal acts (Mann et al., 1999). Finally, information about, for example, suicide notes, previous suicide attempts, suicidal communication, or recent suicide threats were investigated to gain insights about the suicidal intent of the road user (Beck, Weissman, Lester, & Trexler, 1976). Overall, the data collection by the psychosocial investigator was similar to being guided by a C-SSRS lifetime checklist (Posner et al., 2008, 2011). The psychosocial investigations were approved by the Central Ethical Review Board in Gothenburg (Dnr 497–10).

2.5. Final classification by an expert team – from 2012 and onward

The final classification of deaths on the classification scale (Table 2) was performed by an expert group consisting of five experienced professionals (psychosocial investigator included), with knowledge in forensic medicine, behavioral and medical sciences, practice counselling, and traffic safety. Complex cases were sometimes further discussed with a special referee group. Those who died within 30 days due to the injuries from the road traffic event were included, but with natural deaths excluded. The cases classified as suicides (classification grades 1 or 2; Table 2) were finally reported to the Swedish government agency for transport policy analysis, which compiles and publishes the official statistics on road traffic injuries.

2.6. Classification in 2010–2011 without extended psychosocial information

The in-depth database was used to classify deaths on the classification scale (Table 2), using information about the road environment, the vehicle, and basic information about the road user, as collected by the accident investigator.

2.7. Classification in 2012 without or with extended psychosocial information

The information from the in-depth database was used as a starting point, as done in 2010–2011. The main focus was to implement further psychosocial examinations of the road user, as described above. A classification using only the in-depth database was conducted by four people in the expert group, with the psychosocial investigator and the extended psychosocial information excluded. Next, the final classification was made by all five in the group as described above, including the use of the extended psychosocial information collected by the psychosocial investigator.

2.8. Statistical testing

We first wished to test if more subjects were classified as suicides in 2012, after introducing extended psychosocial investigations (Table 3). We tested the number of (#) subjects classified as suicides (grades 1 + 2 combined) against the number of subjects classified as "undetermined" or "strongly supported accidents" (grades 3 and 4), by using 2 × 2 contingency tables and odds ratios (ORs). In Results Section 3.1, an intra-year 2012 comparison was performed with *vs* without use of extended psychosocial information (i.e., 36 and 13 *vs* 22 and 27; Table 3). In Results Section 3.2, we then tested if the average proportion of suicides in relation to all fatalities (% suicides; grades 1 + 2/total fatalities), or crude average number of (#) suicides, were higher in 2013–2019 compared against the years 2010–2012, by using a t-test with exact permutation *p*-values (Fig. 1). We complemented this with the OR of suicides *vs* accidents/"undetermined" (grades 3–5), for 2013–2019, compared against 2010–2012 (i.e., 206 and 1857 *vs* 61 and 885; Table 4). These analyses were repeated for comparisons of # suicides *vs* # undetermined only (i.e., 206 and 53 *vs* 61 and 41; Table 4), further supplemented by a standard difference-in-differences (DID) analysis by using the following regression model and dummy variables: # deaths classified = $\beta_0 + \beta_1 * [\text{suicide}] + \beta_2 * [t_{2013\text{-}2019}] + \beta_3 * [\text{suicide} \times t_{2013\text{-}2019}]$. The DID effect is the interaction-term and regression was conducted by the *reg* command in Stata v.9.2 (Columbia University, 2019; StataCorp, 2005). Otherwise, tests were conducted by the help of the PAST v.4.03 software (Hammer, Harper, & Ryan, 2001), available at https://past.en.lo4d.com/windows. Exact *P*-values ≤0.05 were regarded as significant.

3. Results

3.1. The introduction of extended psychosocial investigations in 2012

Prior to 2012, deaths in road traffic were solely classified according to a five grade scale (Table 2), whereby fatalities obtaining grades 1 and 2 were reported as suicides by the STA. In 2012, extended psychosocial investigations of any suspected suicides were introduced, resulting in 36 suicides and 13 "undetermined" or "strongly supported accidents" (grades 1 + 2 and grades 3 + 4; Table 3). This represented a significant shift towards an increased # suicides, compared to when not using extended psychosocial investigations in 2012 (OR = 3.40, 95% CI 1.47–7.87). In particular, 14 additional fatalities were classified as suicides in 2012 when using extended psychosocial investigations (i.e., a ~63% increase in the # suicides; from 22 to 36; Table 3). This increase in # suicides in 2012 by using extended psychosocial investigations (from 22 to 36), was almost entirely attributed to a reclassification of "undetermined" fatalities (reduced from 20 to 8). Indeed, 2 × 2 contingency table comparison of the 36 and 13 classified deaths *vs* the 20 and 8 "undetermined" (grade 3), remained significant (OR = 4.09, 95% CI 1.56–10.7). Overall, the proportion of total fatalities classified as suicides (% suicides) increased to 11.2% when using extended psychosocial investigations in 2012, while having a similar, lower range of 5.7–6.8% without the use of extended psychosocial investigations during 2010–2012 (Table 3).

3.2. The continued use of extended psychosocial investigations in the years 2013–2019

The extended psychosocial investigations were continuously in use from 2013 and onward (Table 4). Fig. 1A shows that during 2013–2019, the percent of suicides were on average 10% (95% CI 4.8–9.0%) of all fatalities, which was significantly higher compared

Table 3
Results of road traffic fatality classifications in 2010–2012 and after the introduction of extended psychosocial investigations in 2012.

Grade	2010[a]	2011[a]	2012			
			Without[a]		With[b]	
1	9	7	10	22[c]	14	36[c]
2	7	16	12		22	
3	10	11	20	27[c]	8	13[c]
4	13	9	7		5	
5	243	299	273		273	
Total[d]	282	342	322		322	
% suicides[e]	5.7	6.7	6.8		11.2	

[a]Without extended psychosocial investigations.
[b]With the use of extended psychosocial investigations.
[c]Statistical testing by 2 × 2 contingency tables involved comparing the sums of grades 1 + 2, against the sums of grades 3 + 4.
[d]Sum of all fatalities with grades 1–5 during each year.
[e]Classification of grades 1 + 2 *vs* total.

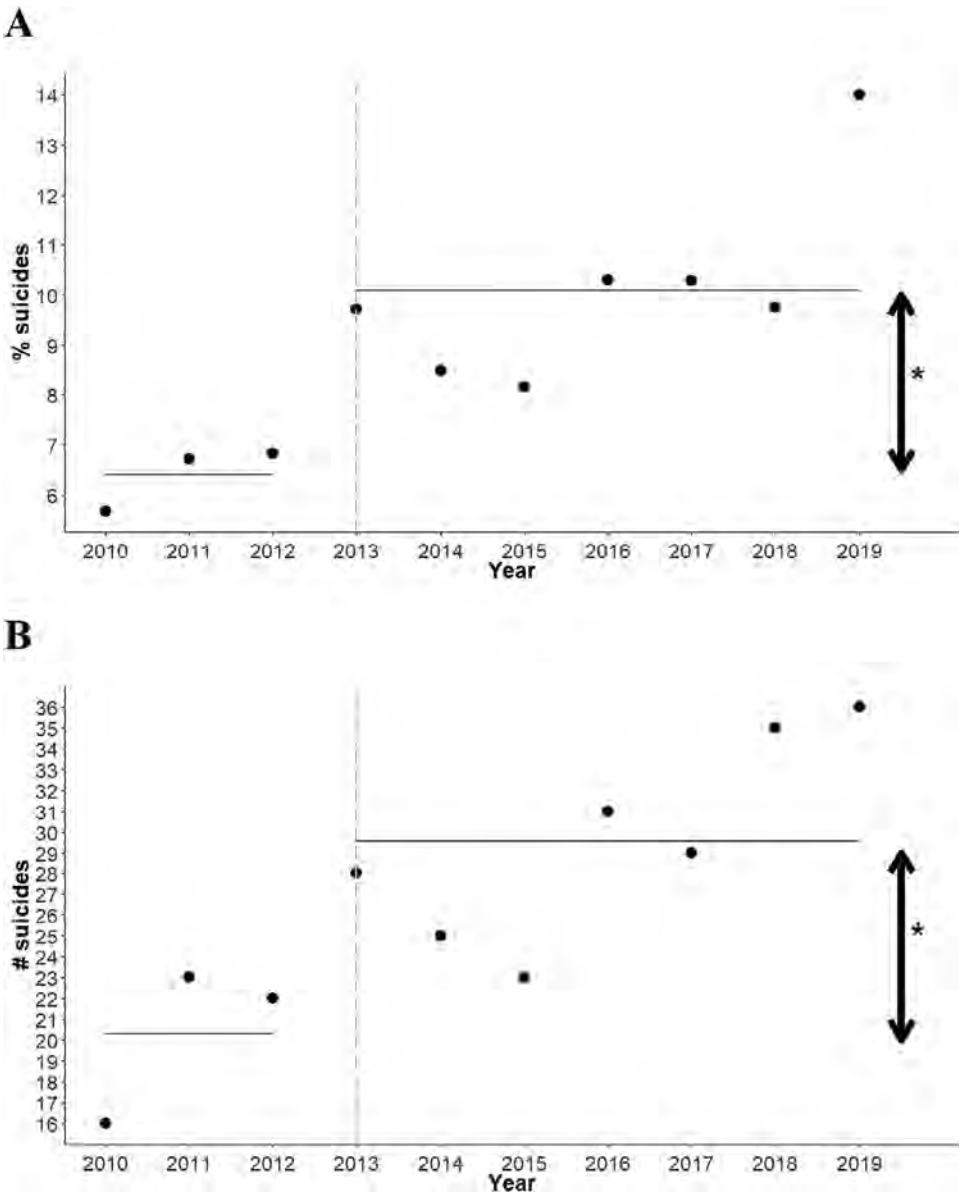

Fig. 1. Significantly more suicides were identified during 2013–2019 (*, double arrow), after introducing extended psychosocial investigations (vertical, dashed line). Horizontal lines show the averages during either years 2010–2012 or 2013–2019 (A) Proportion suicides per year in relation to all road traffic fatalities (% suicides, black dots). (B) # suicides per year (crude numbers, black dots).

Table 4
Results of road fatality classifications during the entire study period 2010–2019

Grade	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
1	9	7	10	9	7	9	15	16	12	14
2	7	16	12	19	18	14	16	13	22	22
3	10	11	20	13	6	7	10	3	9	5
4	13	9	7	7	10	12	17	6	10	8
5	243	299	273	240	254	240	243	244	305	208
Total[a]	282	342	322	288	295	282	301	282	358	257
% suicides[b]	5.7	6.7	6.8	9.7	8.5	8.2	10.3	10.3	9.5	14.0

Note. Years 2010–2012 are without, and years 2013 – 2019 are with extended psychosocial investigations, respectively.
[a]sum of all fatalities with grades 1–5 during each year
[b]classification of grades 1 + 2 *vs* total

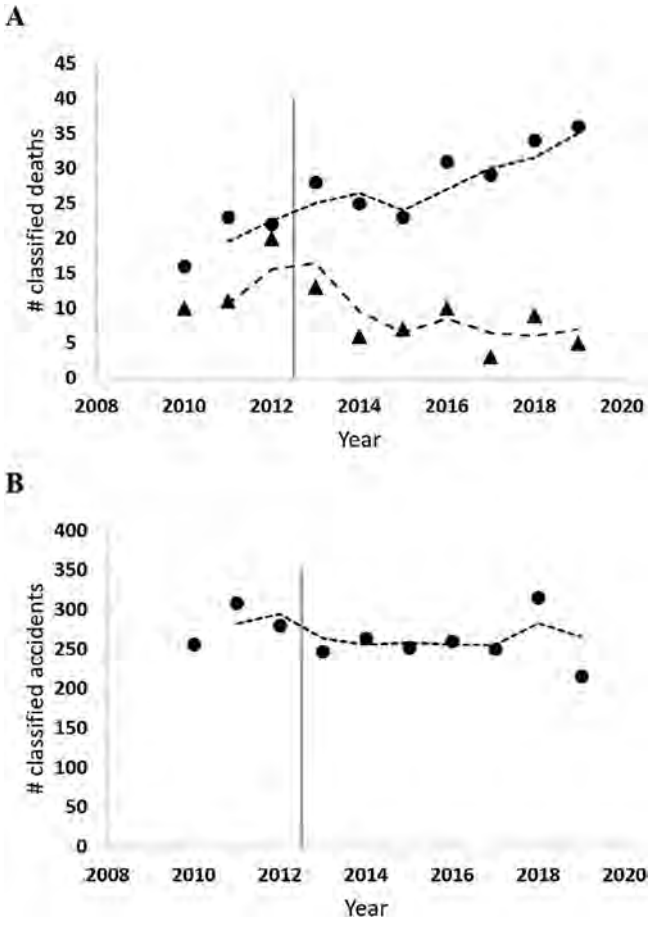

Fig. 2. The increase in classified suicides was mainly accompanied by a reduction in the number of undetermined causes of deaths, rather than changes in the classified accidents. Extended psychosocial investigations were introduced after 2012 (vertical grey line) (A) Number of deaths classified as either suicides (grades 1 + 2, black dots) or "undetermined" (grade 3, black triangles), shown with their respective 2-period simple moving averages (dashed trend-lines). (B) Number of deaths classified as accidents (grades 4 + 5, black dots), shown with a 2-period simple moving average (dashed trend-line).

to the average percent of suicides of 6.4% (95% CI 8.3–11.8%) during 2010–2012 (i.e., when extended psychosocial investigations were not in use). This represented a ~60% increase in percent of suicides. Alternatively, using a 2 × 2 contingency table to compare all fatalities classified either as suicides or accidents/"undetermined" (grades 3–5) during 2013–2019 *vs* 2010–2012, confirmed the significant increase in deaths classified as suicides during 2013–2019 (OR = 1.61, 95% CI 1.20–2.17). Fig. 1B shows that the crude # suicides identified were also significantly higher in 2013–2019 (average 29.4, 95% CI 25.1–33.7), compared to the prior years 2010–2012 (average 20.3, 95% CI 10.9–29.7). This represents an average of ~9.1 (95% CI bootstrap 4.2–13.7), or ~45% additional # suicides identified each year during the 2013–2019 period.

Similar to what was observed for the 2012 intra-year comparison (Table 3), the increase in identified suicides during 2013–2019 was accompanied by a reduction in "undetermined" deaths (Fig. 2A). In contrast, accidents remained at similar levels throughout the time period (Fig. 2B and Table 4). For example, the number of "undetermined" grade-3 deaths was reduced from an average of 13.7 during 2010–2012, down to 7.6 cases per year during 2013–2019, whereas there was an average of ~10 yearly grade-4 accidents during both time periods (Table 4). We therefore tested the difference between the ~9.1 additional suicides and ~6.1 fewer "undetermined" deaths during years 2013–2019. A linear DID analysis of the time series data (Fig. 2A) revealed that the average yearly difference between the number of deaths classified as either suicides or "undetermined" increased significantly, from 6.7 to 21.9, between the periods 2010–2012 and 2013–2019, respectively (DID β_3 = 15.2 deaths/year, 95% CI 6.4–23.9). Alternatively, using a 2x2 contingency table to compare all fatalities classified either as suicides or "undetermined" (grade 3) during 2013–2019 *vs* 2010–2012, confirmed the significant increase in suicides *vs* "undetermined" during 2013–2019 (OR = 2.61, 95% CI 1.59–4.29).

4. Discussion

Here we report about the implementation of methods and procedures at the STA, which are currently used to enable the separate reporting of suicides and accidents among road fatalities. The use of extended psychosocial information resulted in a 45–63% increase of additional suicides reported, on average ~9 additional suicides per year since 2013 and onward. The proportion of all fatalities classified as suicides (% suicides) increased by ~60%. In particular, the additional use of extended psychosocial information since the year 2012 resulted in the reclassification and subsequent reduction of mainly "undetermined" fatalities, while accidents remained at similar levels throughout the entire time period 2010–2019. There was no overall increase in suicides in Sweden during the 2010–2019 period, which might have contributed to the increase in classified suicides beyond 2012 (National Centre for Suicide Research and Prevention, 2020).

The extended psychosocial information from the psychosocial investigator was taken into account by an expert team, which also used their knowledge about traffic safety and pre-crash, crash and post-crash factors (Haddon, 1973). The analyses thus also took into account the road environment, the factors concerning the vehicles, and the course of the event. Suspected events are, for example, pedestrians whom throw themselves against moving vehicles and car collisions with inflexible objects or heavy vehicles, which occurred without any noted attempts to avoid it. Nevertheless, such events still often require extended psychosocial information

about suicidal intent, ongoing mental illness, and/or other significant life stressors proximal to the event, to be resolved (Table 1). A forensic doctor also interpreted the autopsy report in relation to the use of alcohol, drug, or psychotropic medications. Intoxication increases the risk of both suicidal behaviors and traffic accidents. This is another example of when extended psychosocial information becomes important for obtaining a possible resolution of a suicide *vs* accident (i.e., by taking into account any information about suicidal intent and recent psychosocial or mental health crisis, used as a complement of the more technical circumstances surrounding the crash event, the road environment, and the vehicle's performance; Table 1, criteria 3). Finally, the psychosocial investigator had competence in behavioral, psychological, and clinical sciences and from counselling patients, enabling more efficient collection of the available psychosocial information (e.g., the private situation of the deceased). Overall, the multifaceted and in-depth classification procedure described here resembles that reported from Finland (Ohberg, et al., 1997). A combined expertise in forensic medicine, psychology, behavioral science, and traffic safety is required to perform these more comprehensive suicide classifications.

We found that the number of "undetermined" fatalities were reduced from 20 to 8 in 2012, and that the percent of suicides increased by 60–73% when using extended psychosocial investigations. In Finland, it was also reported that thorough investigations, including the use of psychosocial factors and intent of the road users, more than doubled the proportion of fatalities classified as suicides, from 2.6% to 5.9%. As was also observed here, the reclassification to suicides involved undetermined and "unintentional" fatalities (Ohberg et al., 1997). In Switzerland, there were similarly 23 suspected suicides during 2000–2010, which could not be resolved due to a lack of further information (Gauthier, Reisch, Ajdacic-Gross, & Bartsch, 2015). Such "undetermined" fatalities that are suspected to be suicides have also been called "open verdicts." Three previous studies concluded that 65–89% of "open verdicts" were actually probable suicides (Routley et al., 2003). Indeed, we similarly found that 12 out of 20 "undetermined" were suicides in 2012 (~60%). Furthermore, the additional ~9 suicides classified each year during 2013–2019, was accompanied by a yearly reduction of 6 "undetermined" fatalities (~66%). Taken together, the use of extended psychosocial investigations appears particularly helpful in resolving a majority of undetermined fatalities, or "open verdicts," in particular.

Between the years 2013–2019, an average of ~10% of all fatalities were classified as suicides herein. This in the upper range of previously reported observations, reported to vary between 1 and 14.3% (Breen et al., 2018; Gauthier et al., 2015; Ohberg et al., 1997; Routley et al., 2003). There is actually only one investigation reporting a higher proportion (14.3%) of classified suicides, namely a detailed investigation of 28 vehicle fatalities that also used extended psychosocial information (Pokorny, Smith, & Finch, 1972). This indicates that the classification system that was introduced in Sweden in 2012 might now be operating at near maximum capacity for identifying and classifying suicides in the road traffic.

Suicide is the result of complex interactions between genetic (individual) and environmental (social) factors. The most effective way of approaching this complex topic is through interdisciplinary research and cooperation between authorities and organizations (World Health Organisation, 2010; Zalsman et al., 2016). Indeed, the suicide classification described here also required the involvement and the cooperation of many interdisciplinary competences in order to be successful (i.e., the accident and psychosocial investigators, the police, an expert team and even an outside referee group for complex cases). Since 2015, the method has also been adapted and become a standard for suicide classification on railways in Sweden, and is thus being adopted by other authorities in the Swedish transportation system. By using a standardized and more in-depth classification method, the underestimation of suicide numbers in the traffic system is decreasing. This also creates the basic prerequisites for cooperation concerning future suicide intervention and prevention work. One of the more promising preventive measures for suicide prevention is the restriction of access to lethal means (Pirkis et al., 2015; World Health Organisation, 2014; Zalsman et al., 2016). Despite this, there is currently not even one study published that evaluates this preventive strategy against suicides in the road traffic (Okolie et al., 2020). Clearly, a system that sufficiently identifies suicides must first be in place before one can start to evaluate any preventive measures taken against suicides. In Sweden, the next steps forward are to conduct scientific evaluations of the suicide preventive effects of, for example different fencing/barriers, which are being installed continuously to prevent road fatalities overall (Fredin-Knutzén, Andersson, Hadlaczky, & Sokolowski, 2020). The generation of an increased evidence base that better distinguishes between suicides and accidents may be important for reducing these major, but preventable, causes of deaths affecting mainly the younger to middle age groups (i.e., road injury and suicides; Andersson & Svensson, 2014; World Health Organisation, 2019). The increasing knowledge will help to incentivize the involved authorities to focus on implementing novel and current preventive measures that have the greatest effects.

5. Conclusion

Both the 2012 intra-year and the 2013–2019 *vs* 2010–2012 comparisons showed that the use of extended psychosocial investigations resulted in at least a 60% increase in the amount of suicides among road traffic fatalities (e.g., ~9 additional suicides identified each year during 2013–2019). This increase was mainly accompanied by the reclassification and reduction of previously "undetermined" causes of deaths (i.e., "open verdicts" as to whether the road traffic fatalities involved an accident or suicide). Therefore, the use of extended psychosocial investigations was found to be of major importance for completing our knowledge about suicides occurring in road traffic. A standardized and more in-depth classification method for suicides is deemed to be a basic prerequisite for the cooperation, implementation, and evaluation of suicide intervention and prevention efforts in the Swedish transportation system. Generation of an increased evidence base that better distinguishes between suicides and accidents may thus be of importance to enable future reductions in the major, but preventable, causes of deaths involving road injury and suicide.

Conflict of interest

The authors declare no conflict of interest.

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References

Ahlm, K., Eriksson, A., Lekander, T., & Björnstig, U. (2001). All traffic related deaths are not "fatalities"–analysis of the official Swedish statistics of traffic accident fatalities in 1999. *Läkartidningen, 98*(17), 2016–2022.

Andersson, A. -L., & Svensson, K. (2015). Fatalities in road traffic, a result of accidents or suicides. *2015*(Proceedings of the 24th World International Traffic Medicine Association Congress, Qatar 2015), 10.5339/jlghs.2015.itma.27.

Andersson, A. -L., & Svensson, K. (2022). Suicide in the transport system. In K. Edvardsson Björnberg, S.O. Hansson, M.-Å. Belin & C. Tingvall (Eds.), *The Vision Zero Handbook*: Springer International Publishing.

Andersson, A.L., Berkowicz, A., Beskow, J., Fredlund, T., Lindberg, E., Rådbo, H., & Svensson, K. (2011). Method for suicide classification of deaths in the transportation system. Suicide classification of deaths in road traffic in the years 2008 and 2009 [in Swedish] (Report 2011:128). In: Swedish Transport Administration, https://trafikverket.ineko.se/Files/sv-SE/10475/RelatedFiles/2011_128_metod_for_suicidklassning_av_dodsfall_i_transportsystemet_2.pdf.

Andersson, A.-L., & Svensson, K. (2014). Which road traffic fatalities are suicides? Method description and analysis of the years 2010-2013 [in Swedish] (Report 2014:113). In: Swedish Transport Administration, https://trafikverket.ineko.se/Files/sv-SE/12323/RelatedFiles/2014_113_Vilka_dodsfall_i_vagtrafiken_ar_suicid.pdf.

Beck, A. T., Weissman, A., Lester, D., & Trexler, L. (1976). Classification of suicidal behaviors. II. Dimensions of suicidal intent. *Archives of General Psychiatry, 33*(7), 835–837.

Breen, J. M., Naess, P. A., Gjerde, H., Gaarder, C., & Stray-Pedersen, A. (2018). The significance of preexisting medical conditions, alcohol/drug use and suicidal behavior for drivers in fatal motor vehicle crashes: A retrospective autopsy study. *Forensic Science, Medicine and Pathology, 14*(1), 4–17. https://doi.org/10.1007/s12024-017-9934-x.

Columbia University. (2019). Difference-in-Difference Estimation. In: Columbia University Mailman School of Public Health, https://www.publichealth.columbia.edu/research/population-health-methods/difference-difference-estimation.

European Railway Agency. (2004). Implementaion guidance for CSIs. In *Annex I of directive 2004/49/EC* (pp. 19-20), https://erail.era.europa.eu/documents/implementation_guidance_for_csis_en.pdf.

Fredin-Knutzén, J., Andersson, A.-L., Hadlaczky, G., & Sokolowski, M. (2020). Scoping study - Suicide in the transport system, https://ki.se/en/nasp/suicide-in-the-transport-system.

Gauthier, S., Reisch, T., Ajdacic-Gross, V., & Bartsch, C. (2015). Road Traffic Suicide in Switzerland. *Traffic Injury Prevention, 16*(8), 768–772. https://doi.org/10.1080/15389588.2015.1021419.

Goodfellow, B., Kolves, K., & de Leo, D. (2019). Contemporary definitions of suicidal behavior: A systematic literature review. *Suicide and Lifethreatening Behavior, 49*(2), 488–504. https://doi.org/10.1111/sltb.12457.

Haddon, W. Jr., (1973). Energy damage and the ten countermeasure strategies. *Human Factors, 15*(4), 355–366. https://doi.org/10.1177/001872087301500407.

Hammer, Ø., Harper, D., & Ryan, P. (2001). PAST: Paleontological statistics software package for education and data analysis. *Palaeontologia Electronica, 4*(1), 9.

Harrison, K. (2017). Suicide on UK roads: lifting the lid. In: Parliamentary Advisory Council for Transport Safety, www.pacts.org.uk/wp-content/uploads/PACTS_Report_SuicidesUKRoads_LOWRES.pdf.

Hernetkoski, K., & Keskinen, E. (1998). Self-destruction in Finnish motor traffic accidents in 1974–1992. *Accident Analysis and Prevention, 30*(5), 697–704. https://doi.org/10.1016/s0001-4575(97)00092-4.

Lönnqvist, J. (1977). *Suicide in Helsinki: An Epidemiological and Socialpsychiatric Study of Suicides in Helsinki in 1960–61 and 1970–71* (p. 33). Helsinki, Finland: Psychiatria Fennica.

Mann, J. J., Waternaux, C., Haas, G. L., & Malone, K. M. (1999). Toward a clinical model of suicidal behavior in psychiatric patients. *American Journal of Psychiatry, 156*(2), 181–189. https://doi.org/10.1176/ajp.156.2.181.

National Centre for Suicide Research and Prevention. (2020). Suicide in Sweden, https://ki.se/nasp/sjalvmord-i-sverige.

Ohberg, A., Penttila, A., & Lonnqvist, J. (1997). Driver suicides. *British Journal of Psychiatry, 171*, 468–472. https://doi.org/10.1192/bjp.171.5.468.

Okolie, C., Hawton, K., Lloyd, K., Price, S. F., Dennis, M., & John, A. (2020). Means restriction for the prevention of suicide on roads. *Cochrane Database Systematic Review, 9*, CD013738. https://doi.org/10.1002/14651858.CD013738.

Ovenstone, I. M. (1973). A psychiatric approach to the diagnosis of suicide and its effect upon the Edinburgh statistics. *British Journal of Psychiatry, 123*(572), 15–21. https://doi.org/10.1192/bjp.123.1.15.

Pirkis, J., Too, L. S., Spittal, M. J., Krysinska, K., Robinson, J., & Cheung, Y. T. (2015). Interventions to reduce suicides at suicide hotspots: A systematic review and meta-analysis. *Lancet Psychiatry, 2*(11), 994–1001. https://doi.org/10.1016/S2215-0366(15)00266-7.

Pokorny, A. D., Smith, J. P., & Finch, J. R. (1972). Vehicular suicides. *Suicide and Life-threatening Behavior, 2*(2), 105–119.

Posner, K., Brown, G. K., Stanley, B., Brent, D. A., Yershova, K. V., Oquendo, M. A., ... Mann, J. J. (2011). The Columbia-Suicide Severity Rating Scale: Initial validity and internal consistency findings from three multisite studies with adolescents and adults. *American Journal of Psychiatry, 168*(12), 1266–1277. https://doi.org/10.1176/appi.ajp.2011.10111704.

Posner, K., Brown, G.K., Stanley, B., Brent, D.A., Yershova, K.V., Oquendo, M.A., Currier, G.W., Melvin, G.A., Greenhill, L., Shen, S., & Mann, J.J. (2008). Columbia suicide severity rating scale (C-SSRS). In, https://suicidepreventionlifeline.org/wp-content/uploads/2016/09/Suicide-Risk-Assessment-C-SSRS-Lifeline-Version-2014.pdf.

Reinfeldt, F., & Larsson, M. (2008). A renewed public health policy [in Swedish] (proposition 2007/2008:110). In: Swedish goverment, Ministry of Health and Social Affairs, https://riksdagen.se/sv/dokument-lagar/dokument/proposition/en-fornyad-folkhalsopolitik_GV03110.

Routley, V., Staines, C., Brennan, C., Haworth, N., & Ozanne-Smith, J. (2003). Suicide and Natural Deaths in Road Traffic - Review. In: Monash University Accident Research Centre, http://www.monash.edu.au/miri/research/reports/muarc216.html.

StataCorp. (2005). Stata Statistical Software: Release 9. In. College Station, TX: StataCorp LP.

Swedish National Board of Forensic Medicine. (2014). Guidance system for forensic medicine. Template for documentation in forensic examination (obduction) [in Swedish] (QB5.10 2001).

The Swedish Parliament. (1997). Vision Zero and the traffic safe society [in Swedish] (bill 1997/98:TU04). In: Committee on Transport and Communications, https://www.riksdagen.se/sv/dokument-lagar/arende/betankande/nollvisionen-och-det-trafiksakra-samhallet_GL01TU4.

Varnik, P., Sisask, M., Varnik, A., Laido, Z., Meise, U., Ibelshauser, A., ... Hegerl, U. (2010). Suicide registration in eight European countries: A qualitative analysis of procedures and practices. *Forensic Science International, 202*(1–3), 86–92. https://doi.org/10.1016/j.forsciint.2010.04.032.

World Health Organisation. (2019). Suicide in the world. In. Geneva, Switzerland: WHO Press, https://www.who.int/publications/i/item/suicide-in-the-world.

World Health Organisation. (2010). Towards evidence-based suicide prevention programmes. In. Geneva, Switzerland: WHO Press, https://apps.who.int/iris/rest/bitstreams/917630/retrieve.

World Health Organisation. (2014). Preventing suicide – a global imperative. In. Geneva, Switzerland: WHO Press, https://www.who.int/mental_health/suicide-prevention/world_report_2014/en/.

Zalsman, G., Hawton, K., Wasserman, D., van Heeringen, K., Arensman, E., Sarchiapone, M., ... Zohar, J. (2016). Suicide prevention strategies revisited: 10-year systematic review. *Lancet Psychiatry, 3*(7), 646–659. https://doi.org/10.1016/S2215-0366(16)30030-X.

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