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Self-harm in adolescence and risk of crash: a 13-year cohort study of novice drivers in New South Wales, Australia

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ABSTRACT

Introduction Self-harm and suicide are leading causes of morbidity and death for young people, worldwide. Previous research has identified self-harm is a risk factor for vehicle crashes, however, there is a lack of long-term crash data post licensing that investigates this relationship. We aimed to determine whether adolescent self-harm persists as crash risk factor in adulthood.

Methods We followed 20 806 newly licensed adolescent and young adult drivers in the DRIVE prospective cohort for 13 years to examine whether self-harm was a risk factor for vehicle crashes. The association between self-harm and crash was analysed using cumulative incidence curves investigating time to first crash and quantified using negative binominal regression models adjusted for driver demographics and conventional crash risk factors.

Results Adolescents who reported self-harm at baseline were at increased risk of crashes 13 years later than those reporting no self-harm (relative risk (RR) 1.29: 95% CI 1.14 to 1.47). This risk remained after controlling for driver experience, demographic characteristics and known risk factors for crashes, including alcohol use and risk taking behaviour (RR 1.23: 95% CI 1.08 to 1.39). Sensation seeking had an additive effect on the association between self-harm and single-vehicle crashes (relative excess risk due to interaction 0.87: 95% CI 0.07 to 1.67), but not for other types of crashes.

Discussion Our findings add to the growing body of evidence that self-harm during adolescence predicts a range of poorer health outcomes, including motor vehicle crash risks that warrant further investigation and consideration in road safety interventions. Complex interventions addressing self-harm in adolescence, as well as road safety and substance use, are critical for preventing health harming behaviours across the life course.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Self-harm in adolescence is a risk factor for motor vehicle crash for young drivers, however, it is unknown if this risk persists into adulthood.

WHAT THIS STUDY ADDS

⇒ Our findings add to evidence that self-harm predicts a range of health outcomes, including motor vehicle crash into adulthood, with additional risks for those who are also highly sensation seeking.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ Policy makers and practitioners in health, transport and education sectors must work collaboratively to target road safety interventions at adolescents at risk of/or reporting self-harm. Further research needs to explore the causal pathways that explain the association between self-harm and motor vehicle crash across different life stages.

INTRODUCTION

Poor mental health and injury (including self-harm and road injury) are the leading causes of morbidity and mortality for young people worldwide.[1] There are sex differences in the type and burden of mental health and injury; young men are over-represented in road injury and suicide deaths, while young women are more likely to self-harm than young men.[2–4] The global lifetime prevalence of self-harm among adolescents aged 12–18 years old is 16.9%[2] Although self-harming behaviour typically declines from adolescence into adulthood (and in most cases resolves spontaneously),[5 6] there is also evidence to suggest adolescents who self-harm are at greater risk of suicide, unintentional death and injury as well as other adverse psychosocial health outcomes later in life.[7–10]

One type of event for which self-harm is a risk factor is motor vehicle crashes. An explanation for this association centres on intentional motor vehicle crashes as a form of self-harm or suicide.[11 12] A study using police data in Queensland, Australia identified 52 confirmed cases of driver suicide between 1990–2007 and 29 potential cases.[13] The authors found that confirmed cases of driver suicide were more likely to involve head-on multivehicle crashes and speeding, while potential cases were more likely to involve single-vehicle crashes.[13]

Intentional road injury is considered to be vastly under-reported at least in part due to the likelihood of misclassification as unintentional injury.[13–16] This reflects difficulty in determining driver intent after a crash[17] and a recent Cochrane review explains that accurate prevalence data for driver suicide does not exist because of such misclassification.[18] Thereby, since intentional road injury is challenging

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to detect, we know little about its associations, which suggests the need for further investigation.

Self-harm could also indirectly predict vehicle crashes because of its overlap with other risk factors that predict crashes. For example, self-harm is associated with impulsivity, and impulsivity is associated with increased risk of motor vehicle crashes among young drivers.[19–21] Self-harm is also associated with other risk taking behaviours such as alcohol and drug use, which are risk factors for motor vehicle crashes.[22–24] Further, there is a strong relationship between self-harm and mental ill health, which are also independently associated with motor vehicle crashes.[25–27] For example, insomnia is a common symptom of mental ill health, and young drivers who experience insomnia have been found to be 31% more likely to have a motor vehicle crashes compared with those without insomnia.[28] There are few longitudinal studies investigating the relationship between self-harm and motor vehicle crashes. Yet longitudinal studies can provide crucial insights into cause-and-effect relationships and help to tease out 'chicken-and-egg' questions, such as the causal relationship between self-harm and vehicle crashes in the context of potential confounders.

One study that has investigated this association is the DRIVE prospective cohort study of 20 000 novice drivers aged 17–24 years old, which has identified sociodemographic[4 29] and behavioural factors[30 31] that influence the risk of crashes among young drivers,[32] including self-harm.[33] Among the DRIVE cohort, those who reported self-harm at the time of obtaining their provisional licence were more likely to have a crash by the 2-year follow-up than those who did not report earlier self-harm behaviour.[33] Recent analyses of the DRIVE cohort to investigate known risk factors for crash involvement at the 13-year follow-up found that drivers who engaged in risky driving behaviours at the time of provisional licensure, had higher rates of both multiple and single vehicle crashes.[30] Additionally, young drivers who lived in areas of greater socioeconomic disadvantage at the time of attaining their provisional licence had a higher risk of motor vehicle crashes (multiple vehicle crashes, single vehicle crashes and crashes resulting in hospitalisation) after 13 years.[29]

These recent findings from the DRIVE Study, in which the newly licensed drivers who originally enrolled are 30–37 years old at follow-up in 2016, indicate that young people's risk factors for crashes during adolescence persist into adulthood. Sex differences were apparent in that men in the DRIVE cohort had higher crash rates than women, yet women were more likely to be involved in a crash that resulted in hospitalisation, compared with men.[4] What remains unknown is whether self-harm as a crash risk factor persists into adulthood, and if so, if there are differences by type of crashes (multiple vs single vehicle). We; therefore, analysed data from the 13-year follow-up of the DRIVE cohort to address these questions.

METHODS

The DRIVE study

We used data from the DRIVE study, which involved a 2003/2004 survey of 20 806 newly licensed young drivers from New South Wales (NSW) that linked to individual level crash data. NSW is the most populous state in Australia with 7.5 million residents (1.7 million (23%) aged 20–35) at the 2016 census.[34] In 2018, five million people in NSW held a driver's licence for a car and there were 4.28 million registered passenger vehicles.[35 36]

Participants in the DRIVE cohort were drivers who were originally aged 17–24 years and holding their first-year independent motor vehicle driver licence from NSW Australia. Information on driver demographics, driving exposure, driving experiences and training and known or hypothesised crash risk factors was collected. The DRIVE study cohort methods and recruitment have been described in more detail previously.[29 37]

Data sources

The DRIVE survey data were linked with crash data from the NSW Centre for Road Safety, hospital data from the NSW Admitted Patient Data Collection (APDC) and death data from the NSW Registry of Births Deaths and Marriages and Australian Bureau of Statistics (ABS) cause-of-death data, up to 2016. The NSW Centre for Health Record Linkage performed probabilistic linkage of the data and supplied deidentified data sets for analysis.

The Centre for Road Safety Crash Link system provides information on all police reported road crashes that occur on NSW roads. These data contain information on crash circumstances and location, road conditions, and the crash outcome. The APDC includes records for all hospital separations (discharges, transfers and deaths) from NSW public and private hospitals and day procedure centres, coded according to the Australian modification of the International Statistical Classification of Diseases and Related Problems, 10th revision.[38] The ABS cause-of-death data include information derived from the death certificate, or coronial report, on the cause of deaths.

Analysis

The outcome measures were a total number of crashes (police recorded crashes, crashes resulting in hospitalisation or death) and single vehicle crashes that occurred during follow-up (2003–2016). Total crash-related hospital admissions on the same day or within 1 day of a record in the police reported crash data were considered the same crash. Only crashes related to vehicles that the study participants could legally drive with an NSW car licence were included. The exposure under investigation was self-harm. Participants were asked to report self-harm behaviours during the year before the baseline survey in response to questions based on the Beck Suicide Inventory: 'In the past 12 months have you deliberately hurt yourself or done anything that you knew might have harmed or even killed you?'.[39] The coding of responses has been described in detail previously.[33] The coding for true self-harm behaviour was applied to the open text responses where participants explained what self-harm behaviour they engaged in. The coding for true self-harm was done by an epidemiologist (and previous registered psychologist), together with a psychiatrist. Responses that were not true self-harm behaviour were removed, for instance, responses like 'ate a lot of burgers with my mate'.[33]

Other variables in the analysis were baseline measures of driver demographic characteristics (age, geographical remoteness and socioeconomic status of area of residence and country of birth), drug and alcohol use (cannabis, other drug and alcohol use), driver training and experience (supervised driving hours, months on learner licence, number of attempts on learner licence, self-rated driving ability, months between independent (provisional) driver licence and study entry, involvement in crashes before study), driving behaviour and attitude (risk taking behaviour, risk perception, sensation seeking) and driving exposure (average weekly driving hours) (table 1). Selection of these variables was informed by previous findings from the DRIVE study and known risk factors for crashes.[32 33 40–44]

Table 1 DRIVE cohort characteristics, NSW, Australia 2003–2016

Variable	Category	No self-harm	Self-harm	Missing	Total
Gender	Female	10 104 (54.1)	509 (58.6)	744 (58.4)	11 357 (54.6)
	Male	8559 (45.9)	360 (41.4)	530 (41.6)	9449 (45.4)
Age group	17	9070 (48.6)	450 (51.8)	608 (47.7)	10 128 (48.7)
	18–19	6922 (37.1)	324 (37.3)	495 (38.9)	7741 (37.2)
	20–25	2671 (14.3)	95 (10.9)	171 (13.4)	2937 (14.1)
Country of birth	Australia and New Zealand	16 015 (85.8)	786 (90.5)	1082 (84.9)	17 883 (86.0)
	Europe	198 (1.1)	15 (1.7)	7 (0.6)	220 (1.1)
	Asia	1067 (5.7)	25 (2.9)	85 (6.7)	1177 (5.7)
	Other	1336 (7.2)	43 (5.0)	86 (6.8)	1465 (7.0)
	Missing	47 (0.3)	0 (0.0)	14 (1.1)	61 (0.3)
Area-level remoteness	Metro	13 894 (74.5)	605 (69.6)	964 (75.7)	15 463 (74.3)
	Inner regional	3924 (21.0)	221 (25.4)	254 (19.9)	4399 (21.1)
	Outer regional/remote	845 (4.5)	43 (5.0)	56 (4.4)	944 (4.5)
Area-level socioeconomic status	Lowest	4665 (25.0)	197 (22.7)	273 (21.4)	5135 (24.7)
	second quartile	4620 (24.8)	226 (26.0)	290 (22.8)	5136 (24.7)
	third quartile	4831 (25.9)	239 (27.5)	383 (30.1)	5453 (26.2)
	Highest	4547 (24.4)	207 (23.8)	328 (25.8)	5082 (24.4)
Attempts on driver test	1	12 126 (65.0)	542 (62.4)	820 (64.4)	13 488 (64.8)
	2	4443 (23.8)	223 (25.7)	296 (23.2)	4962 (23.9)
	3 or more	2036 (10.9)	100 (11.5)	152 (11.9)	2288 (11.0)
	Missing	58 (0.3)	4 (0.5)	6 (0.5)	68 (0.3)
Time on learners licence	< 1 year	7072 (37.9)	339 (39.0)	523 (41.1)	7934 (38.1)
	1–1.5 years	6649 (35.6)	324 (37.3)	443 (34.8)	7416 (35.6)
	> 1.5 years	4873 (26.1)	201 (23.1)	301 (23.6)	5375 (25.8)
	Missing	69 (0.4)	5 (0.6)	7 (0.6)	81 (0.4)
Crash before study	No	18 058 (96.8)	834 (96.0)	1220 (95.8)	20 112 (96.7)
	Yes	605 (3.2)	35 (4.0)	54 (4.2)	694 (3.3)
Self-rated driving ability compared with other drivers	Much better	3472 (18.6)	164 (18.9)	98 (7.7)	3734 (18.0)
	Better	8131 (43.6)	390 (44.9)	247 (19.4)	8768 (42.1)
	Same	6743 (36.1)	297 (34.2)	210 (16.5)	7250 (34.9)
	Worse or much worse	307 (1.6)	18 (2.1)	17 (1.3)	342 (1.6)
	Missing	10 (0.1)	0 (0.0)	702 (55.1)	712 (3.4)
Lessons with professional driving instructor (hours) driver training (hours)	0	3310 (17.7)	173 (19.9)	177 (13.9)	3660 (17.6)
	1–4	5371 (28.8)	272 (31.3)	272 (21.4)	5915 (28.4)
	5–8	3923 (21.0)	191 (22.0)	180 (14.1)	4294 (20.6)
	9+	6059 (32.5)	233 (26.8)	645 (50.6)	6937 (33.3)
Cannabis smoking in last 12 months	Never	16 209 (86.9)	571 (65.7)	501 (39.3)	17 281 (83.1)
	Once a month or less	1831 (9.8)	207 (23.8)	59 (4.6)	2097 (10.1)
	2–4 times a month	345 (1.9)	46 (5.3)	9 (0.7)	400 (1.9)
	2–3 or >4 times per week	241 (1.3)	43 (5.0)	13 (1.0)	297 (1.4)
	Missing	37 (0.2)	2 (0.2)	692 (54.3)	731 (3.5)
Use of other drugs in last 12 months	Never	17 437 (93.4)	695 (80.0)	537 (42.2)	18 669 (89.7)
	Once a month or less	885 (4.7)	120 (13.8)	28 (2.2)	1033 (5.0)
	2–4 times a month	198 (1.1)	33 (3.8)	7 (0.6)	238 (1.1)
	2–3 or >4 times per week	75 (0.4)	17 (2.0)	3 (0.2)	95 (0.5)
	Missing	68 (0.4)	4 (0.5)	699 (54.9)	771 (3.7)
Alcohol AUDIT-C summary score	0–6	16 268 (87.2)	663 (76.3)	527 (41.4)	17 458 (83.9)
	>6	2390 (12.8)	206 (23.7)	64 (5.0)	2660 (12.8)
	Missing	5 (0.0)	0 (0.0)	683 (53.6)	688 (3.3)
Risk taking behaviour	Low	6617 (35.5)	147 (16.9)	92 (7.2)	6856 (33.0)
	Medium	6060 (32.5)	282 (32.5)	119 (9.3)	6461 (31.1)
	High	5868 (31.4)	438 (50.4)	153 (12.0)	6459 (31.0)
	Missing	118 (0.6)	2 (0.2)	910 (71.4)	1030 (5.0)

Continued

Table 1 Continued

Variable	Category	No self-harm	Self-harm	Missing	Total
Risk perception	Low	5939 (31.8)	176 (20.3)	102 (8.0)	6217 (29.9)
	Medium	5764 (30.9)	270 (31.1)	118 (9.3)	6152 (29.6)
	High	6735 (36.1)	416 (47.9)	147 (11.5)	7298 (35.1)
	Missing	225 (1.2)	7 (0.8)	907 (71.2)	1139 (5.5)
Sensation seeking	Low	6011 (32.2)	143 (16.5)	106 (8.3)	6260 (30.1)
	Medium	6051 (32.4)	212 (24.4)	135 (10.6)	6398 (30.8)
	High	6392 (34.3)	506 (58.2)	106 (8.3)	7004 (33.7)
	Missing	209 (1.1)	8 (0.9)	927 (72.8)	1144 (5.5)
Average weekly driving (hours)	0–2	3721 (19.9)	141 (16.2)	187 (14.7)	4049 (19.5)
	3–5	5933 (31.8)	256 (29.5)	275 (21.6)	6464 (31.1)
	6–9	2985 (16.0)	139 (16.0)	156 (12.2)	3280 (15.8)
	10+	6024 (32.3)	333 (38.3)	656 (51.5)	7013 (33.7)

Area-level socioeconomic status was derived from the Australian Bureau of Statistics 2001 area level Socio-Economic Indexes for Areas index of education and occupation (Trewin, 2001). Geographical remoteness of residence was classified using the Accessibility/Remoteness index of Australia, grouped into three groups (metropolitan, inner and outer regional, remote and very remote) (Trewin, 2004). Alcohol use was measured using a three-item subscale of the Alcohol Use Disorders Identification Test Consumption (AUDIT-C). Question related to self-harm: 'In the past 12 months have you ever deliberately hurt yourself or done anything that you knew might have harmed you or even killed you?'. Sensation seeking was measured using the Impulsive Sensation Seeking Scale of the Zuckerman Kuhlman Personality Questionnaire.
NSW, New South Wales.

Statistical analysis

Although nearly complete data (94%–100%) were available for each variable, the joint proportion of missing data across variables included in the analysis was 15%. Missing data were imputed using chained equations with 30 imputation cycles.[45] The imputation was assessed by plotting the imputed values against the non-missing data for each imputation cycle using the Stata user written package midiagplots[46] and through numerical checks using descriptive statistics comparing the imputed with the non-missing data.

The association between self-harm and vehicle crashes was examined by cumulative incidence curves investigating time to first crash and quantified using negative binominal regression models. Time between the baseline survey and the end of follow-up (31 December 2016) was included as an offset variable in the regression models to account for different lengths of exposure. Participants who died during follow-up (n=72) were censored at the date of death.

The joint effect of self-harm and risk taking behaviours (self-reported risk taking behaviour scale) and drug and alcohol use (self-reported alcohol, cannabis, other drug use) on crash involvement was explored by fitting the fully adjusted model to include the interaction term between these measures and risky driving. Effect modification was assessed on the additive scale by calculating the relative excess risk due to interaction (RERI).[47]

We carried out all statistical analyses using Stata V.15, using the midiagplots routine to assess the imputation process.[46]

RESULTS

A total of 20 806 novice drivers (54.6% women) were included, with a mean follow-up time of 13 years (SD 0.6). Most study participants were born in Australia or New Zealand (86.0%) and lived in metropolitan areas (74.3%) (table 1). Of these, 1542 (7.4%) said 'yes' to the question about engaging in self-harm. When the answers to the qualifying question (If yes, what was it that you did?) were coded for true self-harm behaviour, the number fell to 869 (4.2%), with 360 males (3.8% of all males) and 509 females (4.5% of all females) reporting true self-harm.

Compared with drivers who reported not engaging in self-harm, a higher proportion of those who self-harmed smoked cannabis 2–3 or more than 4 times per week, drank more alcohol and reported higher risk taking and sensation seeking behaviour.

During the study period, 222 (25.6%) drivers who reported self-harm as an adolescent, and 3747 (20.1%) who did not self-harm as an adolescent, were involved in a vehicle crashes as the driver (table 2). Of these, 37 drivers (4.3%) who reported self-harm as an adolescent and 650 (3.5%) who did not self-harm as an adolescent had single vehicle crashes. Differences in the proportion of crashes for those who self-harmed and those who did not increased over time (figure 1).

During the study period, drivers who reported self-harm had 1.29 (95% CI 1.14 to 1.47) times higher rates of any crash compared with those who did not report self-harm. After adjusting for confounding in the multivariable regression model the rate ratio decreased to 1.23 (95% CI 1.08 to 1.39). There was no statistically significant difference at the 5% level in the

Table 2 Number of crash events by type of crash, DRIVE cohort NSW Australia 2003–2016

Type of crash	Crash	No self-harm	Self-harm	Missing	Total
Any crash	None	14 916 (79.9)	647 (74.5)	994 (78.0)	16 557 (79.6)
	One or more	3747 (20.1)	222 (25.6)	280 (22.0)	4249 (20.4)
Single vehicle crash	None	18 013 (96.5)	832 (95.7)	1228 (96.4)	20 073 (96.5)
	One or more	650 (3.5)	37 (4.3)	46 (3.6)	733 (3.5)

NSW, New South Wales.

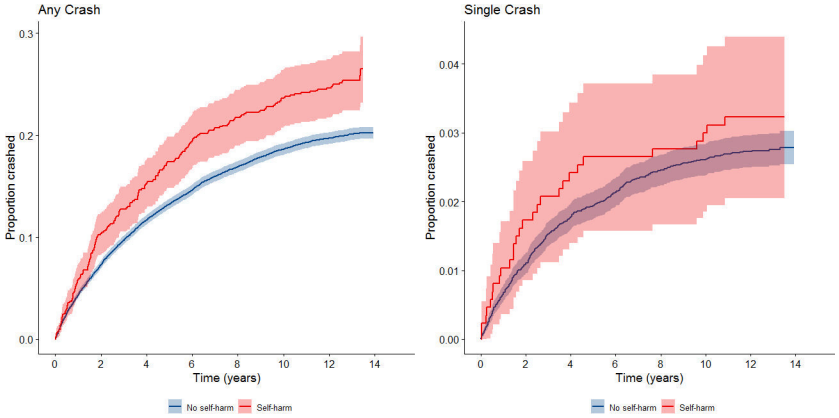

Figure 1 Cumulative incidence curves of first crash, DRIVE cohort NSW Australia 2003–2016. NSW, New South Wales.

Table 3 Risk of subsequent motor vehicle crashes among participants who reported having engaged in self-harm, DRIVE cohort NSW Australia 2003–2016

		Any crash	Single vehicle crash
Model*	Model description	RR (95% CI)	RR (95% CI)
0	Unadjusted	1.29 (1.14 to 1.47)	1.25 (0.90 to 1.74)
1	Model 0+ demographic characteristics and driving exposure	1.30 (1.15 to 1.48)	1.25 (0.90 to 1.74)
2	Fully adjusted	1.23 (1.08 to 1.39)	1.11 (0.79 to 1.57)

*Variables in model 1: age, gender, socioeconomic status of area of residence (SEIFA index), remoteness of area of residence and average driving per. Model 2: age, gender, socioeconomic status of area of residence (SEIFA index), remoteness of area of residence, average driving per week, self-rated driving ability, number of attempts on driver test, crash before study, professional driver training, time on learner licence, cannabis smoking, alcohol consumption, drug use, risk taking score, sensation seeking score and risk perception score.
NSW, New South Wales; RR, relative risk; SEIFA, Socio-Economic Indexes for Areas.

number of single vehicle crashes between those who reported self-harm and those who did not (table 3).

After adjusting for all considered covariates, there was a positive interaction on the additive scale between sensation seeking behaviour (tertile of highest sensation seekers) and self-harm for single vehicle crashes (RERI 0.87 (95% CI 0.07 to 1.67)) (table 4).

DISCUSSION

The DRIVE cohort follows more than 20 000 novice drivers as they transition from adolescence to adulthood and is a rich source of longitudinal information. In this 13-year follow-up of the cohort, we found that young drivers who reported self-harm during adolescence were at increased risk of motor vehicle crashes in adulthood. This risk remained after controlling for driver experience, demographic characteristics and other known risk factors such as alcohol use and risk taking behaviour. Adolescent self-harm was not an independent risk factor for single vehicle crashes, however, sensation seeking and self-harm together increased the risk of single vehicle crashes.

Our finding that adolescent self-harm predicted motor vehicle crashes at 13-year follow-up was consistent with our earlier research and demonstrates the longevity of the association between adolescent self-harm and risk of motor vehicle crashes, which was initially reported at the 2-year follow-up of the DRIVE cohort.[33] More broadly, our findings add to existing evidence that adolescent self-harm is associated with a range of poorer health and psychosocial outcomes in adulthood.[10 24]

Differences in the proportion of single-vehicle crashes between young drivers who did and did not self-harm were not substantial

Table 4 Analysis of the relative excess risk (RERI) due to interaction between self-harm and cannabis, drug and alcohol use, risk perception risky driving and sensation seeking

	Any crash		Single vehicle crash	
	RERI	P value	RERI	P value
Cannabis use × self-harm*	–0.47 (–1.21–0.28)	0.22	–1.74 (–3.58–0.11)	0.07
Drug use × self-harm†	0.22 (–1.12–1.56)	0.75	–0.13 (–0.64–0.38)	0.62
Alcohol consumption × self-harm‡	0.16 (–0.22–0.54)	0.40	0.31 (–0.69–1.30)	0.54
Risky driving × self-harm§	0.17 (–0.29–0.63)	0.47	0.58 (–0.38–1.55)	0.24
Sensation seeking × self-harm¶	0.22 (–0.24–0.67)	0.35	**0.87 (0.07–1.67)**	**0.03**
Risk perception × self-harm**	0.28 (-0.10–0.66)	0.15	0.45 (-0.55–1.44)	0.38

The DRIVE study, NSW, Australia, June 2003–December 2004.
*Cannabis use 2–3 or 4+ times per week per week × self-harm.
†Drug use 2–3 or 4+ times per week per week × self-harm.
‡Alcohol consumption >6 drinks per week × self-harm.
§Highest risky driving tertile × self-harm.
¶Highest sensation seeking tertile × self-harm.
**Highest risk perception tertile × self-harm.
NSW, New South Wales.

in our study. This contradicts evidence that single vehicle crashes are often an intentional form of self-harm or attempted suicide that is misclassified.[12 48] We found sensation seeking and self-harm had a synergistic effect on single vehicle crashes but not when including all types of vehicle crashes. Sensation seeking is a personality trait characterised by the tendency to seek out novel, thrilling and intense experiences that can increase stimulation and arousal. Sensation seeking is a known risk factor for self-harm and risk taking behaviour,[49 50] and our analysis is the first time in which the additive effect of sensation seeking and self-harm has been examined in the DRIVE cohort.[33] Sensation seeking had an additive effect on the association between self-harm and single-vehicle crashes in our cohort, and this may relate to increased use of alcohol and illicit drugs, which is risk factor for crash and known to be higher among those who are highly sensation seeking, as well as among adults who self-harm during adolescence.[10 51] However, it is also possible that drivers with a history of self-harm, who are highly sensation seeking may be involved in single-vehicle crashes as a form of intentional self-harm. This warrants further investigation.

Our findings highlight the need for road safety interventions to target adolescents at risk of/or reporting self-harm, including those identified as highly sensation seeking. Future research is needed to understand the causal pathways that explain why self-harm is a lasting risk factor for motor vehicle crashes across different life stages. Further research is also needed to understand the types of crashes associated with intentional self-harm, so that trends and priority needs can be monitored.

Strengths and limitations

DRIVE is a large prospective cohort study which allowed us to examine how multiple factors in adolescence predicted driving outcomes in adulthood. Furthermore, our study had a long follow-up period, allowing us to analyse the long-term effects of adolescent self-harm as a risk factor for motor vehicle crashes. Another strength was using linked data to obtain an objective measure of motor vehicle crashes without risk of participant dropout. Lastly, our study adjusted for multiple known risk factors such as socioeconomic status, driving history, drug and alcohol use, risk taking behaviour and sensation seeking. This strengthened our confidence that self-harm is an independent risk factor for crashes in adulthood.

The study had some limitations. Information was collected at baseline, however, there was no follow-up measure of self-harm. Non-suicidal self-harm behaviour has been found to peak at around age 16 in the Victorian Adolescent Health Cohort Study,[10] however, in our study, participants were aged 16–24 years, and therefore, it is possible that history of self-harm during adolescence was under-reported in our study. Further, self-harm was measured as 'yes' or 'no' in the past 12 months, yet it is known to be variable in its frequency and pattern, thereby we suggest that future research could explore self-harm with greater nuance. It is possible that adolescent self-harm predicts adult self-harm, which predicts crashes, however, this was not possible to ascertain. Second, other factors that were not reported in this study may have contributed to differences in crashes between the exposure groups. This includes key environmental factors such as road type and condition, time of occurrence of crashes and weather conditions that also modulate crash likelihood. Lastly, our study only included data on crashes that resulted from licensed driving. This could have led to the under-reporting of crashes, particularly among individuals who are highly sensation seeking who are at greater risk of unlicensed driving.[52]

CONCLUSION

This 13-year follow-up of 20 000 novice drivers indicates that adolescent self-harm is a persisting risk factor for motor vehicle crashes in adulthood. This highlights the need for policy makers and practitioners across transport, health and education sectors to work collaboratively to address mental health as a key component of novice driver training and road safety. We recommend future research focus on understanding the indicators and risk factors for intentional motor vehicle crashes, such that strategies to prevent this form of self-harm can be appropriately developed and tested.

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