Research paper

# Prevalence and risk factors for repetition of non-fatal self-harm in Hong Kong, 2002–2016: A population-based cohort study ☆

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## ARTICLE INFO

## ABSTRACT

*Background:* A history of self-harm is strongly associated with future self-harm attempts. Large-scale Asian cohort studies examining risk factors for repeated self-harm are lacking. This paper reports on annual prevalence, cumulative risk, annual risk of non-fatal self-harm repetition, and risk factors among Hong Kong patients with a history of self-harm.

*Methods:* The Hong Kong Clinical Data Analysis and Reporting System (CDARS) provided all accident & emergency department and inpatient self-harm records between Jan 1, 2002 and Dec 31, 2016. Demographic and clinical characteristics were extracted. Annual prevalence, over-time cumulative and annual risks of non-fatal self-harm repetition were estimated, and the adjusted hazard ratios (HR; plus 95% CIs) of putative risk factors associated with repetition were estimated using Wei-Lin-Weissfeld (WLW) generalization of the Cox model for recurrent event analysis.

*Findings:* There were 127,801 self-harm episodes by 99,116 individuals. Annual prevalence of repeated self-harm, of all self-harms, ranged from 7·36% to 28·71% during the study period. Risk of self-harm repetition within one year of the index event was 14·25% (95% CI, 14·04%-14·46%). People with four or more previous self-harm episodes carried the highest risk of self-harm repetition (adjusted HR 4·81 [95% CI 4·46–5·18]). Significant risk factors for non-fatal self-harm repetition included male gender (1·08 [1·05–1·11]), older age (65+ years) (1·07 [1·01–1·13]), social welfare for payment (1·30 [1·27–1·34]), psychiatric admission (1·60 [1·50–1·72]), self-injury only (1·19 [1·15–1·23]), self-injury combined with self-poisoning (1·38 [1·24–1·53]), depression and bipolar disorders (1·09 [1·04–1·14]), personality disorders (1·18 [1·06–1·32]), substance misuse (1·31 [1·27–1·36]), and asthma (1·18 [1·02–1·36]).

*Interpretation:* Hong Kong self-harm patients with non-fatal self-harm events should be supported by effective, timely and ongoing aftercare plans based on their risk profiles, to reduce risk of self-harm re-occurrence.

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## Research in context

**Evidence before this study**

Individuals who present to hospitals after self-harm are at increased risk of self-harm repetition. Risk profiles for self-harm repetition vary by time periods after the self-harm event and between individuals with different demographic and clinical characteristics. Estimates of the repetition risk also differ by methods of self-harm recording and whether all previous self-harm episodes have been considered. We searched PubMed and PsycINFO for peer-reviewed articles, published between Jan 1, 2001 and May 31, 2020, using the

search terms [(self-harm) OR (selfharm) OR (self-injur*) OR (suicid*)] AND [(repetition) OR (repeat)]. We did not apply any language restrictions. Previous studies have shown that the risk of self-harm repetition was highest within the first year after an index self-harm event. The majority of studies reported cumulative repetition risks only and did not report annual risks. A meta-analysis of hospital-presenting samples conducted in 2014 reported that the one-year rate of non-fatal repeated self-harm was 16•3%. Among the 177 articles included in the meta-analysis, only 15 were from Asian societies and the one-year repetition risk based on these 15 studies was 10•0%. Existing research has suggested that self-harm repetition may be associated with a wide range of demographic, clinical, and psychosocial factors. However, most studies focused only on the first self-harm repetition, rather than all self-harming episodes. There are very few longitudinal studies conducted in Asian societies that have investigated the prevalence and risk factors for repetition of self-harm with a sufficiently large sample and a long follow-up period.

Added value of this study

By linking accident & emergency department and inpatient self-harm records retrieved from a territory-wide public healthcare system currently serving over seven million people, we identified 127,801 self-harm records from 99,116 self-harm patients over 15 years. To our knowledge, this research is the first study with sufficient statistical power and results generalisable to all self-harm patients in Hong Kong. The estimated one-year risk of self-harm repetition was much higher than those in other Asian societies, but close to international figures. Patients with four or more previous self-harm episodes had nearly five times greater risk of repetition than their counterparts without any self-harm history. The strength and direction of associations between self-harm repetition and several putative factors (age, gender, alcohol misuse, anxiety and neurotic disorders, and schizophrenia) observed in this study were considerably different from those reported by previous studies.

Implications of all the available evidence

This study, concurring with earlier investigations, highlights the critical period of the first few months after a hospital presentation of self-harm for the prevention of self-harm repetition, indicating that multipronged preventive measures should be initiated immediately after an index self-harm episode. Our findings also provide a basis for increasing the focus on patients with multiple previous self-harm episodes as a high-risk group for self-harm repetition. Aftercare plans should be strengthened by incorporating detailed self-harm histories, in addition to demographic and clinical characteristics, into risk screening protocols and clinical interventions.

## 1. Introduction

Repetition of self-harm incurs high health resource utilization costs, and is the strongest known predictor of suicide [1–4]. To effectively reduce the subsequent risk of repetition and suicide after an index self-harm event, the timing of post-event interventions is important. Comparing repetition risks of self-harm across different time periods provides opportunities to understand risk variations, and to identify reasons for time-based changing risk profiles.

The estimation of repetition risk is affected by the observational period adopted (cumulative, annual, or monthly risk), and whether only the first self-harm repetition, or all episodes, were considered. Despite regular reporting of cumulative risk, annual and monthly risk of self-harm repetition are rarely reported. In addition, previous studies often considered only the first self-harm repetition. As suggested by a multicentre UK study, when taking all recorded self-harm episodes into account, the annual repetition rate of self-

harm increased from 19% (first-time events only) to 33% [5]. Furthermore, people with histories of multiple self-harm episodes are reported as 2•2 times more likely to complete suicide than those with one self-harm event [6].

Estimating the risk of self-harm also requires a sound understanding of complex interactions between demographic, clinical and psychosocial factors [7]. Consequently, relying only on previous self-harm history for risk screening may not be sufficient for effective risk screening [8,9]. Systematic reviews have demonstrated that self-harm repetition might be influenced by self-harm methods, psychiatric disorders, physical illnesses, hopelessness and previous psychiatric treatment [3,9–11] These reviews have consistently suggested that high-quality longitudinal studies of large samples, with long-term follow-up periods of self-harm events captured from multiple sources (i.e., accident and emergency [A&E] department attendances, inpatient admissions, and community care presentations) are required to reduce estimation biases. Furthermore, although more than half of self-harm events occurred in East and South Asia, only a few studies have investigated risk factors of self-harm repetition in Asian societies [12]. There are uncertainties when applying findings from studies conducted in Western countries to Asian populations.

In Hong Kong, healthcare services are provided by the Department of Health, the Hospital Authority, and the private sector. The Department of Health is responsible for the management of public health, and provides subsidised healthcare services through its community-based centres and health clinics; the Hospital Authority, a statutory body, provides public hospitals and related services to the residents of Hong Kong; and the private sector (regulated by the Department of Health) provides both hospital and primary health care through a number of private hospitals and outpatient clinics. Public hospitals under the Hospital Authority manage all critical emergencies through the A&E departments and approximately 80% of all hospital admissions in Hong Kong [13,14]. Using over 15 years of population-based electronic health records from the Hong Kong Hospital Authority, this paper aims to 1) report on annual counts of self-harm presentations and prevalence of repeated self-harm of all self-harm presentations; 2) estimate the cumulative and annual risks of non-fatal self-harm repetition; and 3) compare the relative importance of demographic and clinical covariates associated with subsequent risk of non-fatal self-harm repetition.

## 2. Methods

### 2.1. Data source and study sample

The Hong Kong Clinical Data Analysis and Reporting System (CDARS) is a territory-wide health registry of admissions to all public hospitals managed by the Hong Kong Hospital Authority. All CDARS records are anonymised and thus there is no risk of patient identification. Previous studies have validated the coding accuracy of case ascertainment in the CDARS and reported high positive predictive values (PPV) of clinical diagnoses, including hip fractures (100%), gastrointestinal bleeding (100%), atrial fibrillation (95%) and stroke (91%) [15–17] Data from the CDARS have been used in several earlier epidemiological studies and have proved to be reliable [13,18].

All electronic health records that contained a diagnosis of self-harm, for people presenting to A&E departments, or hospital inpatient admissions between Jan 1, 2002 and Dec 31, 2016, were identified from the CDARS. This study was approved by the Human Research Ethics Committee (HREC) of the University of Hong Kong (EA1707016). In the A&E records, no diagnostic codes were available, rather an episode was classified as self-harm if either the traumatic type or poison nature indicator was coded as self-
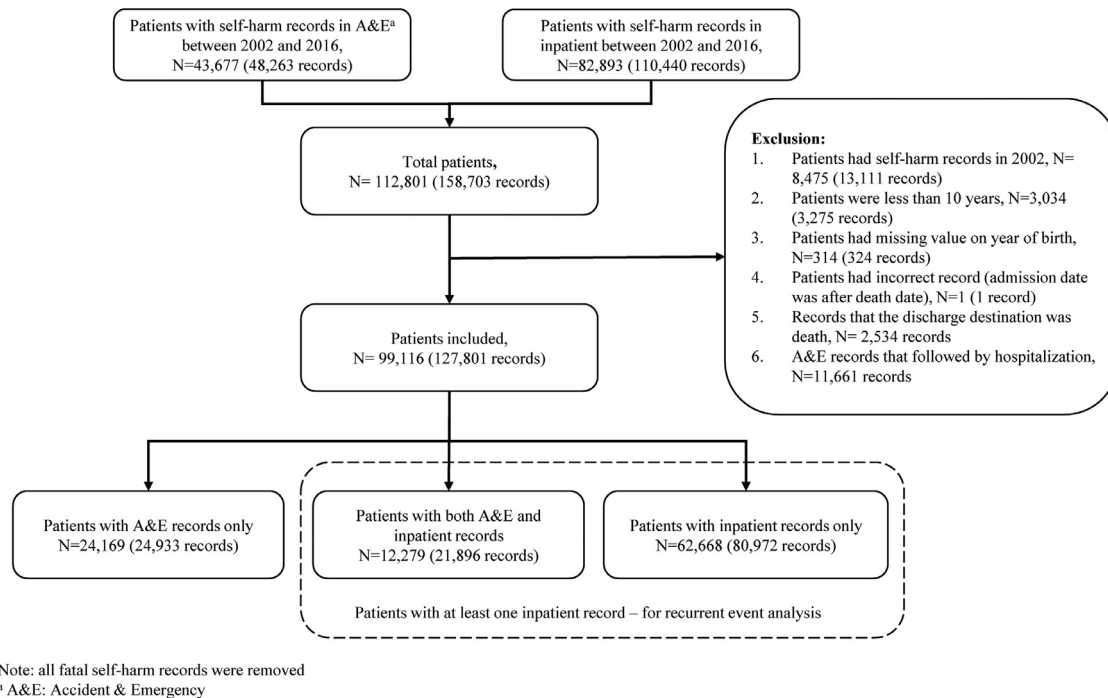
**Fig. 1A.** Study sample identification procedure.

harm by the Hospital Authority. In the inpatient records, self-harm was identified by International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes E950–59 and E980–89. The inpatient and A&E data were linked by unique patient-level identifiers. Since information on cause of death was not available, death by suicide could not be determined. All records with a fatal outcome during the study time period were hence excluded from analysis.

To maximize the probability that the first self-harm record in the study period was indeed the first event, year 2002 was used as a screening year. Only patients without a self-harm diagnosis in 2002 were included for analysis. Patients younger than 10 years, or whose year of birth was not recorded, or who had records with admission date after death date were also excluded. See Fig. 1A for the sample identification procedure.

### 2.2. Procedure

Each episode of a self-harm event in the CDARS was captured through three possible pathways (see Fig. 1B): 1) presented to A&E and discharged directly (Scenario 1); 2) admitted to hospital directly (Scenario 2); and 3) presented to A&E first and then admitted to hospital (Scenario 3). In Scenario 1, demographic and clinical information were retrieved from A&E records only, comprising age, gender, socioeconomic status, admission, discharge, and death dates (in month, year), discharge destination (death, discharge, or transferred to hospital), psychiatric admission and traumatic type and poison nature indicator. In Scenario 2, the same data items were retrieved only from inpatient records except for traumatic type and poison nature indicator, which is unique to A&E. Instead, the diagnostic information in inpatient settings was recorded as ICD-9-CM codes, although only the first three digits were visible. Scenario 3 was ascertained only if the discharge destination was coded as a transfer to hospital and the A&E record preceded the inpatient admission by less than one month. In this case, only one episode of self-harm was counted (Fig. 1A) to avoid potential duplications of individual episodes of self-harm.

Specifically, low socioeconomic status was determined if patients used support from the Comprehensive Social Security Assistance (CSSA) scheme, a means-tested welfare scheme for Hong Kong residents who cannot support themselves financially, for payment [19]. For CSSA recipients, public healthcare expenses can be waived. Due to the data policy of the Hospital Authority, only the year and month of the admission, discharge, and death dates were made available. Self-harm methods were coded as self-poisoning (ICD-9-CM codes: E950–52 and E980–82), self-injury (E953–59 and E983–89), and self-poisoning and self-injury combined. This was extracted from either inpatient diagnostic information or from poisoning nature code and traumatic type code in A&E data when applicable. According to previous evidence concerning risk factors for index and repeated self-harm, [3,18,20] psychiatric disorders and physical illnesses of interest were depression and bipolar disorders (ICD-9-CM code: 296 and 311), alcohol misuse (291 and 303), personality disorders (301), anxiety and neurotic disorders (300, 308, and 309), schizophrenia (295), substance misuse (292, 304, and 305), asthma (493), diabetes (250), migraine (346), epilepsy (345), cancer (140–239), dermatitis and eczema (690–693, and 698), and psoriasis (696).

A patient might have experienced only one self-harm episode, or multiple episodes in different scenarios, resulting in different possible combinations of A&E and inpatient records available at different time points. For the subsample of patients who had at least one inpatient record available over the observational period, comorbidity information of the A&E only episodes (Scenario 1) were imputed using the most proximate inpatient hospital presentation (before or after) since there was no diagnostic information for A&E presentations. A sensitivity analysis was conducted using the same subsample, in which all comorbidities were coded as not present for all episodes with only A&E records available (Scenario 1), to test the robustness of the study results.

### 2.3. Statistical analysis

We firstly coded each self-harm episode as an index event, meaning that each patient could contribute to multiple follow-up
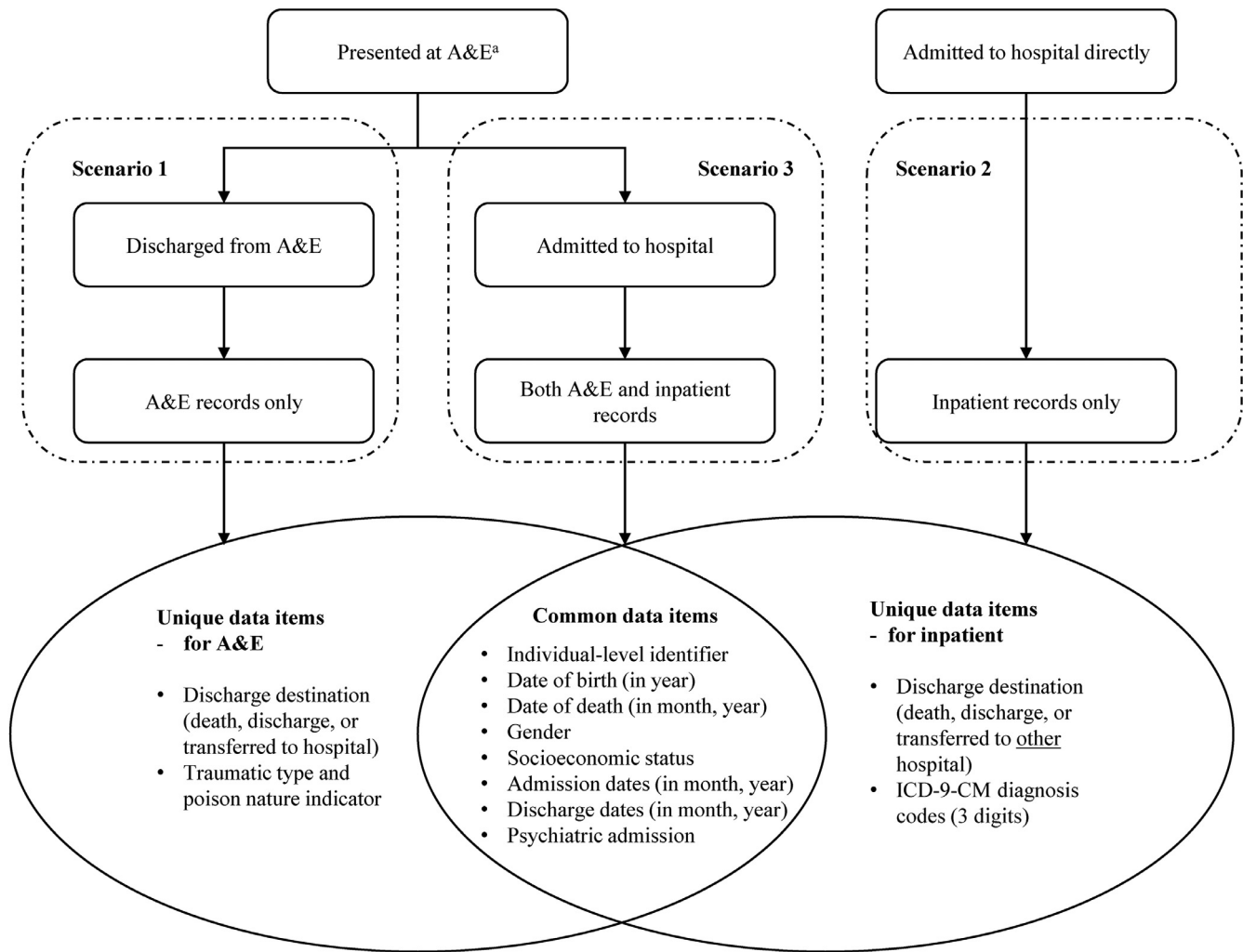
ᵃ A&E: Accident & Emergency

**Fig. 1B.** Possible scenarios for each self-harm episode.

periods corresponding to each index episode. All index episodes were followed until the next self-harm episode, death, or the end of the study period (Dec 31, 2016), whichever came first. We calculated the sum of all self-harm episodes and the proportion of repeated episodes of all episodes for each calendar year. Sample characteristics for no repetition and repetition groups were tabulated, along with $p$ values obtained from Pearson's $\chi^2$ test, using all episodes, and also the first per-patient episode. Cumulative and annual risks of self-harm repetition were calculated. Annual risk was defined as the risk of repetition within the 1st, 2nd, 3rd, until the 14th year after an index event (irrelevant to the calendar year). The same analysis was conducted for gender and age subgroups (i.e., 10–24 years, 25–44 years, 45–64 years, 65+ years). Given the high repetition risk observed within the first year following an index self-harm event by previous studies, [1,5] we also estimated the monthly risk for the total sample. We fitted the Wei-Lin-Weissfeld (WLW) generalization of the Cox model for modeling recurrent events to examine factors associated with repetition of self-harm [21,22]. Only the subsample of patients with at least one inpatient record were included in this recurrent event analysis as detailed information on the psychiatric disorders and physical illnesses of interest were only available for inpatient records (see Fig. 1). Adjusted hazard ratios (HRs) and the 95% Confidence Interval (CI) were estimated to quantify the association between puta-

tive risk factors and self-harm repetition, controlling for covariates. Statistical significance was set at $p < 0.05$ (two-sided). Statistical software R (version 3•5•3) was used for data cleaning and analysis [23].

### 3. Role of the funding source

Nil.

### 4. Results

We included 127,801 self-harm records from 99,116 patients (Fig. 1A), with a total follow-up time of 600,599 person-years (average: 4.70 person-years). Of these, 24,169 (24•38%) patients had A&E records only, 62,668 (63•23%) patients had inpatient records only, and the remainder (12,279 [12•39%]) had both A&E and inpatient records. There were 82,281 patients with only one self-harm episode (83•01% total patients, 64•38% total episodes). The remainder (16,835 patients) had multiple self-harm presentations (45,520 episodes), of which 11,391 (67•66%) repeated self-harm once, 3105 (18•45%) twice, 1083 (6•43%) three times, and 1256 (7•46%) four or more times. By study end, 24,143 (24•36%) patients had died. Between 2003 and 2016, the annual counts of self-harm episodes were relatively constant, with an average number of 9129 (SD,
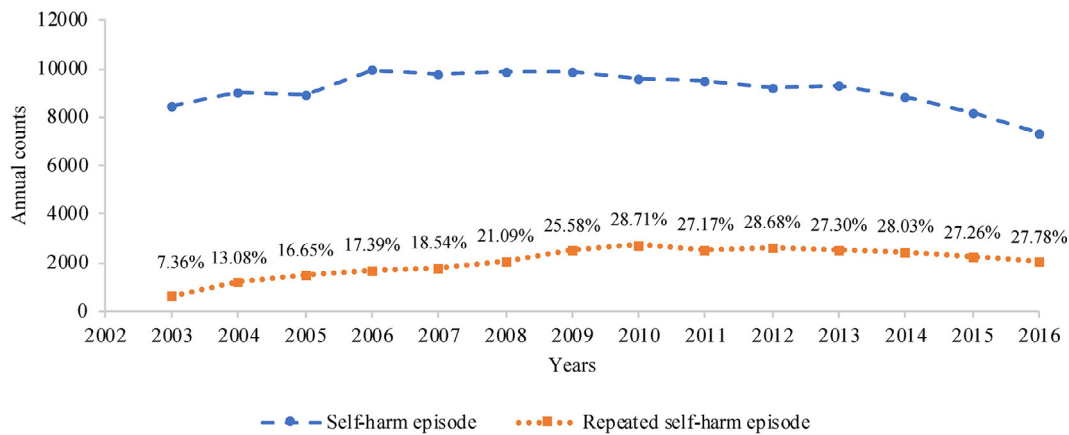
**Fig. 2.** Annual counts of self harm and repeated self harm episodes between 2003 and 2016.

742). However, the annual prevalence of repeated self-harm increased from 7•36% (N=624) in 2003 to 28•71% (2765) in 2010 and remained stable thereafter (Fig. 2). Table 1 summarizes patients' characteristics of all self-harm episodes for no repetition and repetition groups. One-third of the patients were aged between 25–44 years (31•33%), there were relatively equal gender proportions (female, 51•67%), most did not use social welfare for payment (78•47%), and almost all were not admitted to psychiatry speciality (95•92%). The most common method of self-harm was self-poisoning (66•79%). Patients' characteristics at the first episode of self-harm are summarised in Table A1, in subgroups of no further self-harm and self-harm repetition (Appendix pp 1).

During the 14-year follow-up period, the cumulative risk of repeated self-harm (each repeated episode was treated as an index event) was 22•45% (95% CI, 22•19–22•71%) for the total sample (Table 2). Higher cumulative risks were observed in male (23•91% [23•52–24•29%]) and those aged 25–44 years (24•63% [24•15–25•12%]). Figure 3 reports the annual risk of repetition for the total sample and by gender and age groups. The data was right skewed, with the highest risk observed within the first year of the index episode (14•25% [14•04–14•46%]), more than three times higher than the second-highest risk period (3•97% [3•85–4•10%]) (the second year) (Fig. 3A). The same skewed patterns were evident in all subgroupings (Fig. 3C–3H). The first-year risk was much higher for male (15•79% [15•48–16•10%]) than female (12•81% [12•54–13•08%]). For all subgroups, annual risk decreased dramatically after the first two years following an index event, and remained relatively low thereafter. Examining the data by months showed heightened risks of self-harm in the first and the second months post-index event (Fig. 3B) (3•96% [3•86%-4•07%] and 3•50% [3•40%-3•61%], respectively).

For recurrent event analysis, we examined a subset of 74,947 patients with at least one inpatient record for self-harm (comprising 12,279 patients with both A&E and inpatient records, and 62,668 patients with inpatient records only). Table 3 summarizes the characteristics of all self-harm episodes from this subset and estimation results from recurrent event analysis. Risk factors for elevated risk of repetition of self-harm were older age (65 years and above) (adjusted HR 1•07 [95% CI 1•01–1•13]), being male (1•08 [1•05–1•11]), used social welfare for payment (1•30 [1•27–1•34]), and psychiatric admission (1•60 [1•50–1•72]). Compared to people who only self-poisoned, people who used injury only (1•19 [1•15–1•23]) or used both methods (1•38 [1•24–1•53]) had a significantly higher risk of self-harm repetition. The risk of self-harm repetition increased linearly with the number of previous self-harm episodes, with individuals with four or more previous episodes having the highest risk (4•81 [4•46–5•18]). Elevated risks were also found

for comorbidities of depression and bipolar disorder (1•09 [1•04–1•14]), personality disorders (1•18 [1•06–1•32]), substance misuse (1•31 [1•27–1•36]), and asthma (1•18 [1•02–1•36]). However, alcohol misuse (0•84 [0•78–0•89]), anxiety and neurotic disorders (0•85 [0•81–0•89]), schizophrenia (0•85 [0•78–0•92]), and dermatitis and eczema (0•85 [0•76–0•94]) were associated with lower risks of self-harm repetition. Sensitivity analysis did not change the general pattern of results, although two groups of psychiatric disorders (depression and bipolar disorders, personality disorders) and older age (65 years and above) no longer remained significant predictors (Table A2 in Appendix pp 2).

## 5. Discussion

To our knowledge, this is one of the first studies that links A&E and inpatient records in a large-scale longitudinal population dataset, to investigate the cumulative and annual risks of self-harm repetition over a sufficiently long period of 15 years. Significant risk of self-harm repetition (22•45%) was found over the study period, and the highest risk of repetition was observed within the first year of the index self-harm episode, irrespective of gender and age. Four or more previous self-harm events was the strongest risk factor of subsequent repetition of self-harm, followed by psychiatric admission, combined self-poisoning and self-injury method and social welfare for payment.

The cumulative risks of self-harm repetition over specific follow-up periods in this study (one-year risk: 14•3%; two-year risk: 17•2%; five-year risk: 20•7%) were slightly lower than the pooled estimations reported in a meta-analysis with 177 studies of hospital presenting samples (16•3%; 16•8%; 22•4%) [11]. However, when considering only the 15 Asian studies in this review, the same meta-analysis reported a one-year risk of 10•0%, lower than the 14•3% observed in our study. Moreover, our one-year repetition risk in Hong Kong was much higher than Taiwan (5•7%) [1] and Sri Lanka (3•1%), [24] but slightly lower than the 16•7% (half-year risk) as reported in an earlier study of 90 Hong Kong residents [25]. One explanation for this elevated risk of self-harm repetition in Hong Kong may be that the Taiwanese and Sri Lankan studies were based on surveillance systems in specific geographical areas where loss-to-follow-up was more common than in our territory-wide study (where participants moved to other regions, or presented to hospitals outside the study area). The higher risk of self-harm repetition may also be attributable to the pattern of suicide methods. Both this and previous studies showed that patients who physically injured themselves were more likely to repeat self-harm than patients who used poisoning [5,24]. Compared to Taiwan (28•8%) and Sri Lanka (2•0%), the high proportion of self-
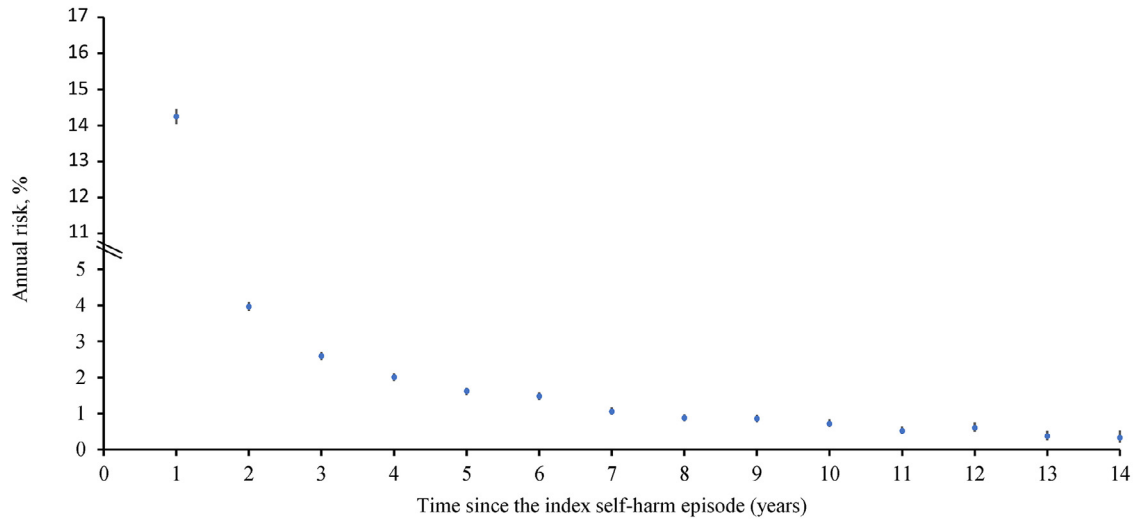
| Annual risk, % | 14·25 | 3·97 | 2·60 | 2·01 | 1·62 | 1·48 | 1·06 | 0·88 | 0·86 | 0·72 | 0·52 | 0·61 | 0·37 | 0·33 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 127801 | 94567 | 80622 | 69509 | 59864 | 51717 | 44115 | 37776 | 31638 | 25741 | 19820 | 14028 | 9173 | 4573 |
| Number of self-harm episodes, N | 18209 | 3758 | 2094 | 1395 | 968 | 764 | 469 | 334 | 271 | 185 | 103 | 86 | 34 | 15 |

**Fig. 3A.** Annual risk of repeated self-harm after the index self-harm episode (total sample).
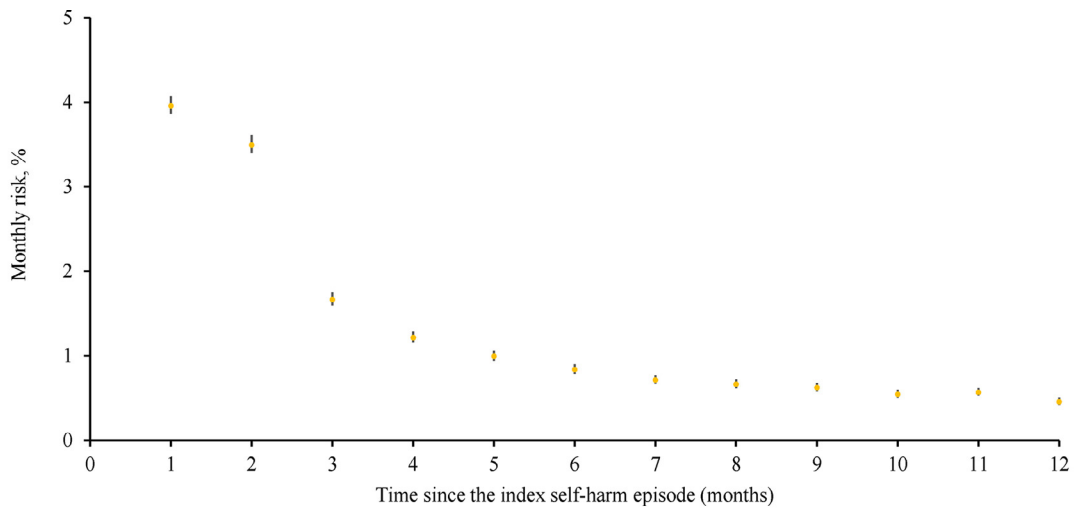


| Monthly risk, % | 3·96 | 3·50 | 1·67 | 1·22 | 1·00 | 0·84 | 0·72 | 0·67 | 0·63 | 0·55 | 0·57 | 0·46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 127801 | 121394 | 115245 | 111520 | 108691 | 106268 | 105295 | 102175 | 100455 | 98839 | 97307 | 95927 |
| Number of self-harm episodes, N | 5065 | 4249 | 1929 | 1364 | 1088 | 893 | 754 | 684 | 633 | 548 | 558 | 444 |

**Fig. 3B.** Monthly risk of repeated self-harm after the index self-harm episode (total sample).

harm episodes in Hong Kong involving self-injury (32•3%) might have contributed to the increased cumulative risk of repetition.

The study findings highlight the critical period immediately after the index event for self-harm repetition prevention (particularly the first few months), which concurs with other studies [1,5,11]. This information is important for the timing of effective suicide prevention programs. Usually in Hong Kong, self-harm patients are provided with a follow-up consultation three to six months after hospital discharge, and the default rate for follow-up consultation is reported as 44•6% [25]. Given our findings, this appears to be too late to be effective. Aftercare plans should be initiated immediately

after the index self-harm episode, comprising interventions with sound evidence for reducing risk of self-harm repetition (pharmacological and psychological treatments, home visits and/or phone contact) [26].

Our findings concur with earlier studies that previous self-harming episodes are significantly associated with subsequent self-harm [3,9]. Our recurrent event analysis of all self-harm episodes found that the risk of repetition increased substantially as the number of previous self-harm events increased. This underscores the importance of incorporating detailed self-harm histories into risk screening protocols, and clinical interventions, particularly to
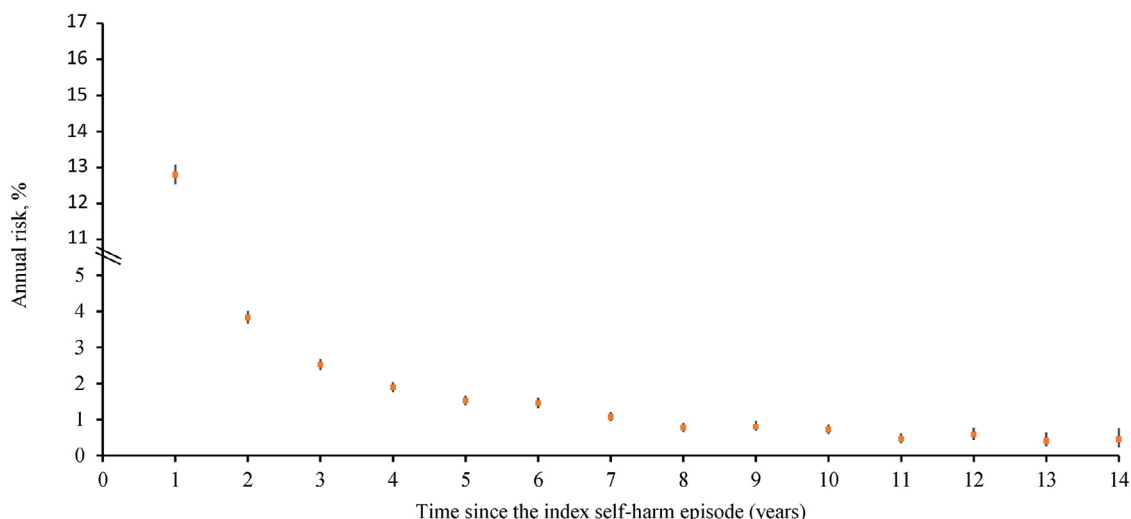
| Annual risk, % | 12·81 | 3·84 | 2·53 | 1·90 | 1·53 | 1·46 | 1·08 | 0·78 | 0·81 | 0·73 | 0·47 | 0·59 | 0·42 | 0·45 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 66029 | 50568 | 43450 | 37644 | 32569 | 28261 | 24210 | 20810 | 17463 | 14178 | 10913 | 7689 | 5005 | 2468 |
| Number of self-harm episodes, N | 8456 | 1942 | 1099 | 715 | 497 | 412 | 261 | 162 | 142 | 103 | 51 | 45 | 21 | 11 |

**Fig. 3C.** Annual risk of repeated self-harm after the index self-harm episode (female).



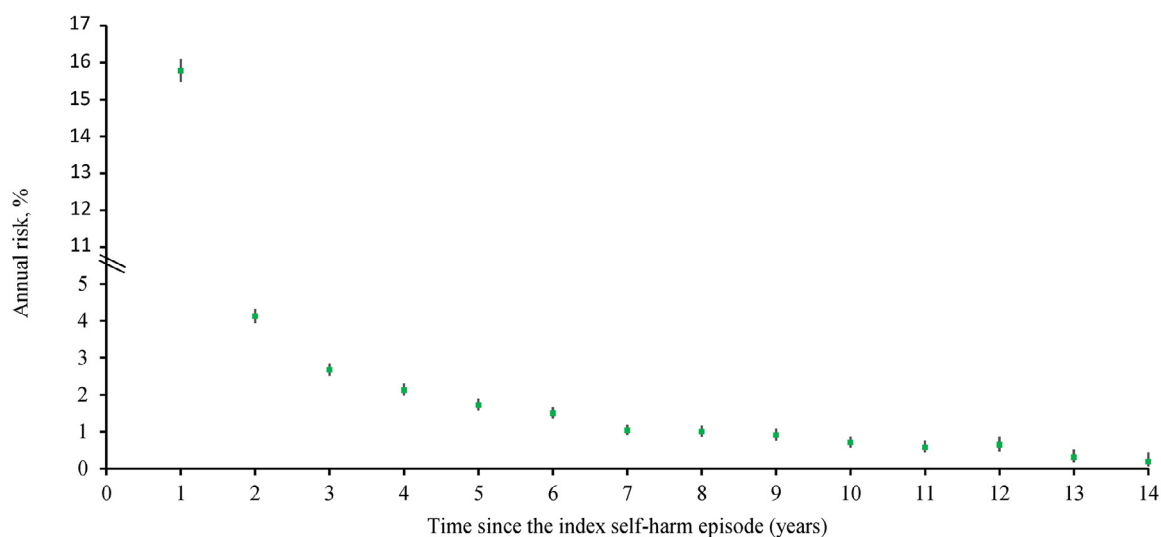| Annual risk, % | 15·79 | 4·13 | 2·68 | 2·13 | 1·73 | 1·50 | 1·04 | 1·01 | 0·91 | 0·71 | 0·58 | 0·65 | 0·31 | 0·19 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 61772 | 43999 | 37172 | 31865 | 27295 | 23456 | 19905 | 16966 | 14175 | 11563 | 8907 | 6339 | 4168 | 2105 |
| Number of self-harm episodes, N | 9753 | 1816 | 995 | 680 | 471 | 352 | 208 | 172 | 129 | 82 | 52 | 41 | 13 | 4 |

**Fig. 3D.** Annual risk of repeated self-harm after the index self-harm episode (male).

identify people quickly whilst they are in care, for elevated risk of self-harming.

Younger age and female gender, are significant risk factors for index self-harm events [7]. However, whether this elevated risk holds true for non-fatal self-harm repetition remains unclear [3]. A community-based Taiwanese study of 970 people who experienced self-harm reported that females (adjusted relative risk 1·9 [95% CI 1·1–3·3]) were more likely to repeat self-harm than males, although no age effect was found [1]. In contrast, a multicentre cohort study in four hospitals in the UK showed that male gender (unadjusted HR 1•12 [95% CI 1•02–1•23]) and older age (ref: 15–24 years; 25–34 years 1•26 [1•12–1•43]; 35–44 years 1•36 [1•20–1•55]; 45–54 years 1•28 [1•08–1•53]) were associated with increased risks of self-harm repetition [27]. Another register-based Irish study found that females aged between 35 and 44 years had the highest repetition risk, while males aged over 65 years had a lower risk [28]. However, neither a US study nor an earlier Hong Kong study using A&E samples found any association between age and gender, and self-harm repetition [25,29]. Our study found increased risks of non-fatal self-harm repetition for male, and older
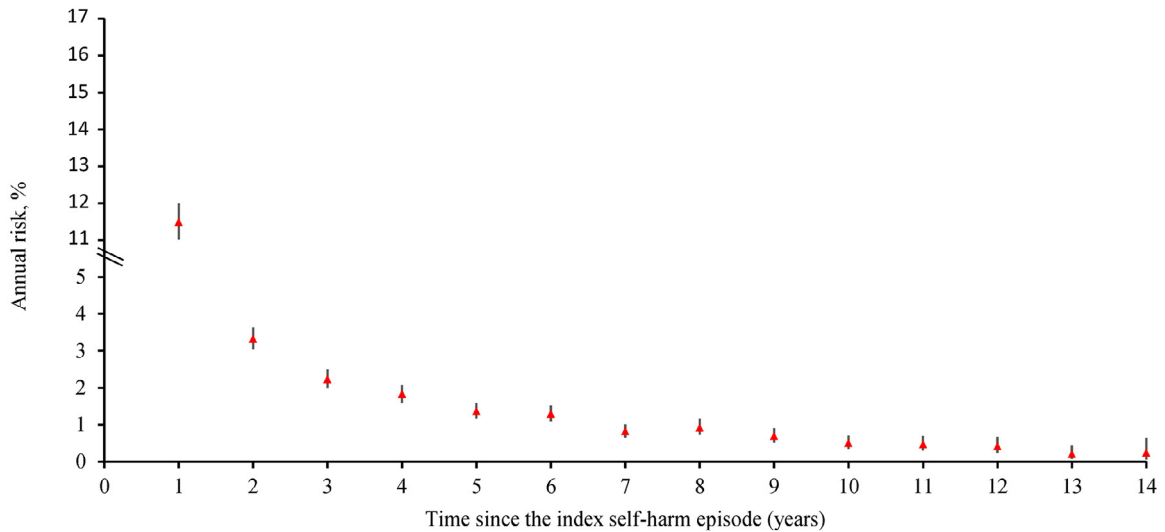
| Annual risk, % | 11·49 | 3·33 | 2·23 | 1·83 | 1·36 | 1·29 | 0·82 | 0·92 | 0·69 | 0·50 | 0·47 | 0·42 | 0·21 | 0·24 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 18827 | 15605 | 14033 | 12794 | 11531 | 10433 | 9310 | 8325 | 7278 | 6144 | 4886 | 3549 | 2416 | 1226 |
| Number of self-harm episodes, N | 2164 | 520 | 313 | 234 | 157 | 135 | 76 | 77 | 50 | 31 | 23 | 15 | 5 | 3 |

**Fig. 3E.** Annual risk of repeated self-harm after the index self-harm episode (10–24 years).
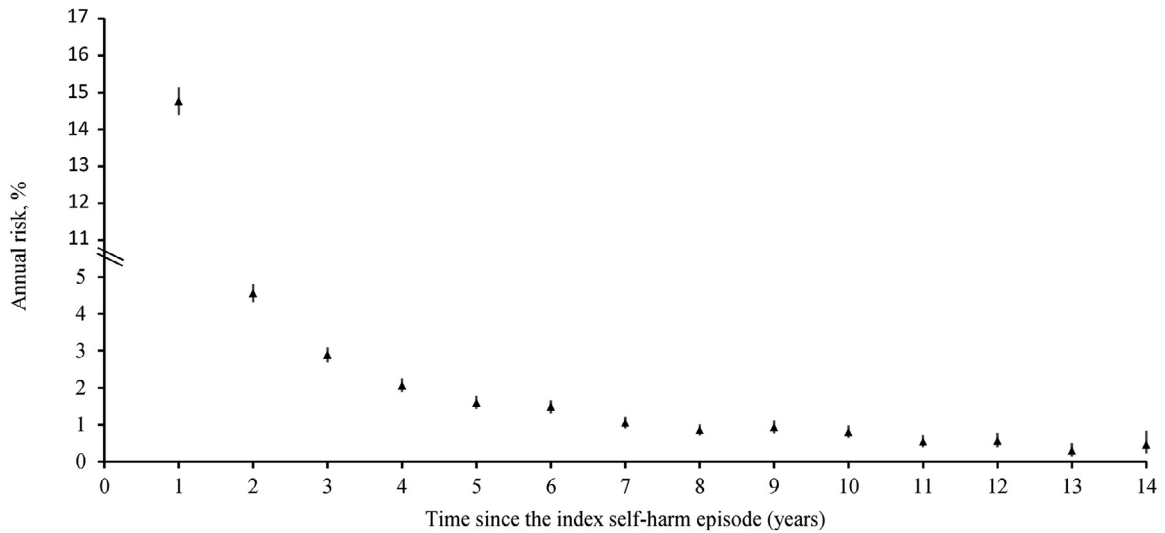


| Annual risk, % | 14·76 | 4·56 | 2·89 | 2·06 | 1·59 | 1·48 | 1·05 | 0·85 | 0·93 | 0·80 | 0·54 | 0·56 | 0·29 | 0·46 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 40045 | 31316 | 27486 | 24370 | 21637 | 19237 | 16860 | 14761 | 12624 | 10487 | 8176 | 5928 | 3853 | 1967 |
| Number of self-harm episodes, N | 5912 | 1427 | 793 | 502 | 345 | 284 | 177 | 126 | 117 | 84 | 44 | 33 | 11 | 9 |

**Fig. 3F.** Annual risk of repeated self-harm after the index self-harm episode (25–44 years).

people, albeit with a small effect size. These results concurred with a recent Sri Lanka cohort study, [24] which found that male gender (HR 2·0 [95% CI 1·3–3·2]) and older age (ref: 10–25 years; 56 years and older: 16·1 [4·3–59·9]) had elevated risk of self-harm repetition. These inconsistent findings suggest that the influence of gender and age on repetitive self-harming behaviours may reflect different cultural backgrounds, population characteristics, and research methodologies. Thus, risk screening for subsequent self-harm events should not be solely based on age and gender.

Financial difficulties is a less-well-researched factor in terms of its association with self-harm repetition [3]. Financial difficulties (measured by Medicaid eligibility or low-income), was not significant predictors for self-harm repetition in studies conducted in Taiwan [30] or the US [29]. Low income groups have been over-represented in Hong Kong self-harm and suicide statistics, [31] and the fact that patients who used welfare for payment were more likely to repeat self-harm in our study perhaps indicates the significant role that financial difficulties may have on mental health
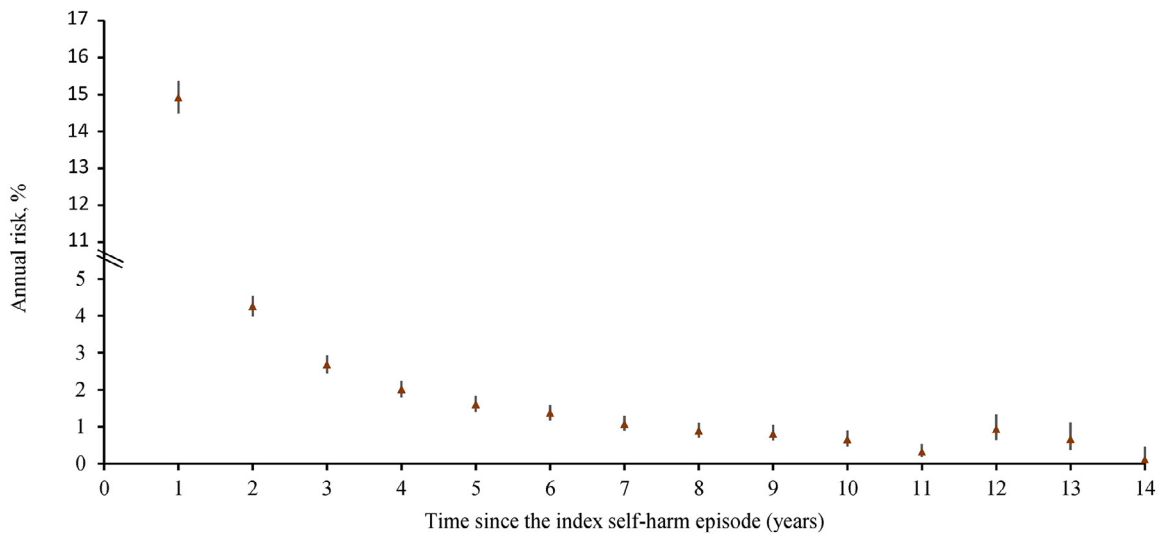
| Annual risk, % | 14·92 | 4·26 | 2·68 | 2·01 | 1·61 | 1·37 | 1·08 | 0·89 | 0·81 | 0·66 | 0·32 | 0·94 | 0·67 | 0·11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 29259 | 21630 | 18448 | 15935 | 13723 | 11825 | 10033 | 8583 | 7131 | 5777 | 4328 | 2976 | 1928 | 952 |
| Number of self-harm episodes, N | 4365 | 922 | 495 | 320 | 221 | 162 | 108 | 76 | 58 | 38 | 14 | 28 | 13 | 1 |

**Fig. 3G.** Annual risk of repeated self-harm after the index self-harm episode (45–64 years).



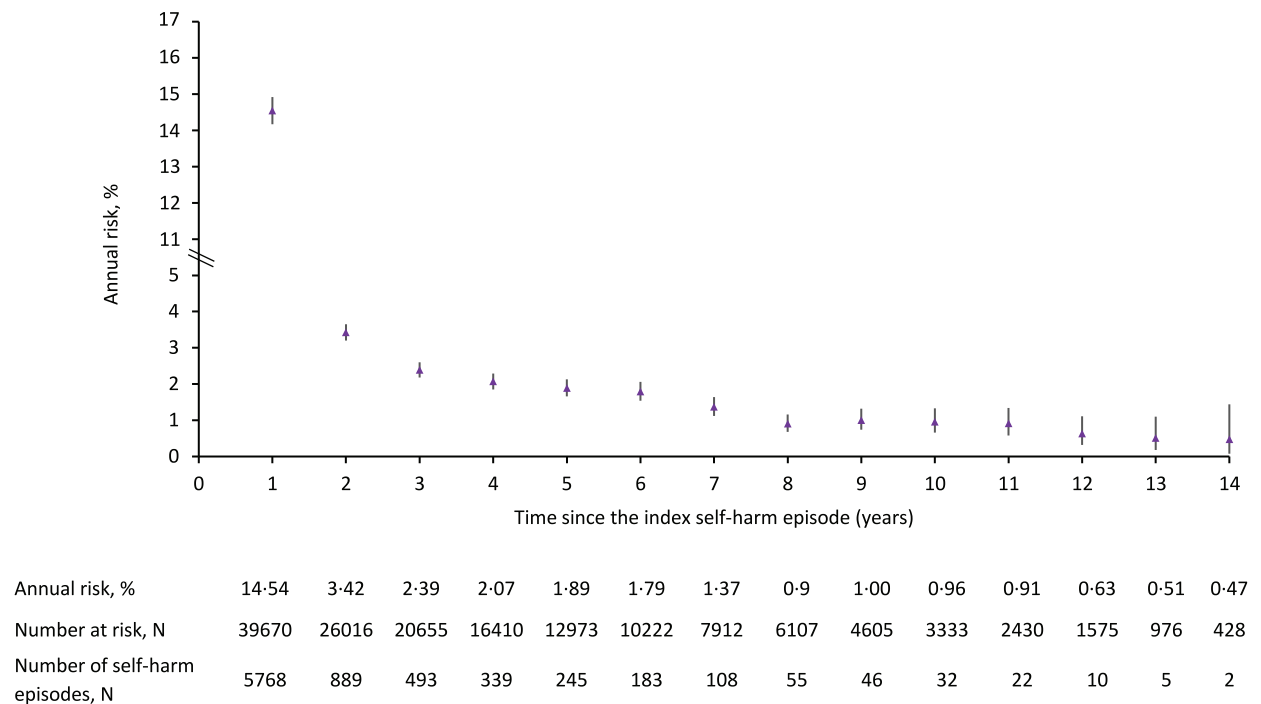| Annual risk, % | 14·54 | 3·42 | 2·39 | 2·07 | 1·89 | 1·79 | 1·37 | 0·9 | 1·00 | 0·96 | 0·91 | 0·63 | 0·51 | 0·47 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number at risk, N | 39670 | 26016 | 20655 | 16410 | 12973 | 10222 | 7912 | 6107 | 4605 | 3333 | 2430 | 1575 | 976 | 428 |
| Number of self-harm episodes, N | 5768 | 889 | 493 | 339 | 245 | 183 | 108 | 55 | 46 | 32 | 22 | 10 | 5 | 2 |

**Fig. 3H.** Annual risk of repeated self-harm after the index self-harm episode (65+ years).

in a relatively high living cost city as in Hong Kong [32]. Further research is required in this area.

Research consistently suggests that people who self-poisoned may have a stronger intention to die than people who self-injured [5,7]. Hospital services may perhaps prioritize support services for this group, which may reduce their subsequent risks of repetition [5]. However, high rates of fatality from self-poisoning may also contribute to lower risks of further self-harm for this group [5],[24]. Our findings support this as self-injury only, and self-

injury and self-poisoning combined, incurred higher risks of self-harm repetition compared with self-poisoning only. Injury was largely represented by cutting, which although may reflect a lower suicide intent[5,30] but is associated with high risk of repetition [8,33]. This evidence collectively highlights the importance of timely aftercare (e.g., psychosocial assessment) for all individuals who engaged in self-harm, irrespective of self-harm methods.

All the psychiatric disorders investigated in this study were significantly associated with repetition of self-harm. However,

**Table 1**

Patient's characteristics of all self-harm episodes from the total sample for no repetition and repetition groups.

| Characteristics, N (%) | Total sample N=127,801 (99,116 patients) | No repetition N=82,281 (82,281 patients) | One or more repetitions N=45,520 (16,835 patients) | P value |
|---|---|---|---|---|
| Age | | | | |
| 10–24 years | 18,827 (14·73) | 13,281 (16·14) | 5546 (12·18) | <0·0001 |
| 25–44 years | 40,045 (31·33) | 24,993 (30·38) | 15,052 (33·07) | |
| 45–64 years | 29,259 (22·89) | 18,433 (22·40) | 10,826 (23·78) | |
| 65+ years | 39,670 (31·04) | 25,574 (31·08) | 14,096 (30·97) | |
| Mean (SD), years | 50·14 (22·60) | 49·77 (22·87) | 50·81 (22·08) | |
| Gender | | | | |
| Female | 66,029 (51·67) | 43,592 (52·98) | 22,437 (49·29) | <0·0001 |
| Male | 61,772 (48·33) | 38,689 (47·02) | 23,083 (50·71) | |
| Used social welfare for payment | | | | |
| No | 100,285 (78·47) | 68,460 (83·20) | 13,695 (30·09) | <0·0001 |
| Yes | 27,516 (21·53) | 13,821 (16·80) | 31,825 (69·91) | |
| Psychiatric admission | | | | |
| No | 122,593 (95·92) | 78,886 (95·87) | 43,707 (96·02) | 0·22 |
| Yes | 5208 (4·08) | 3395 (4·13) | 1813 (3·98) | |
| Method | | | | |
| Self-poisoning | 85,353 (66·79) | 50,987 (61·97) | 34,366 (75·50) | <0·0001 |
| Self-injury | 41,244 (32·27) | 30,572 (37·16) | 10,672 (23·44) | |
| Combined | 1204 (0·94) | 722 (0·88) | 482 (1·06) | |
| Previous self-harm episode | | | | |
| 0 | 99,116 (77·55) | 82,281 (100·00) | 16,835 (36·98) | <0·0001 |
| 1 | 16,835 (13·17) | - | 16,835 (36·98) | |
| 2 | 5444 (4·26) | - | 5444 (11·96) | |
| 3 | 2339 (1·83) | - | 2339 (5·14) | |
| 4+ | 4067 (3·18) | - | 4067 (8·93) | |

**Table 2**

Cumulative risk of self-harm repetition since the index self-harm event (each self-harm episode was treated as an index event).

| | Cumulative risk, % (95% CI) | | | | | | |
|---|---|---|---|---|---|---|---|
| Follow-up time, years | Total sample | Female | Male | 10–24 years | 25–44 years | 45–64 years | 65+ years |
| 1 | 14·25 (14·04–14·46) | 12·81 (12·54–13·08) | 15·79 (15·48–16·10) | 11·49 (11·02–11·99) | 14·76 (14·39–15·14) | 14·92 (14·48–15·37) | 14·54 (14·17–14·92) |
| 2 | 17·19 (16·96–17·42) | 15·75 (15·45–16·05) | 18·73 (18·39–19·07) | 14·26 (13·72–14·80) | 18·33 (17·91–18·75) | 18·07 (17·59–18·56) | 16·78 (16·38–17·19) |
| 3 | 18·83 (18·59–19·07) | 17·41 (17·10–17·73) | 20·34 (19·99–20·70) | 15·92 (15·36–16·50) | 20·31 (19·87–20·75) | 19·76 (19·26–20·28) | 18·02 (17·61–18·44) |
| 4 | 19·92 (19·67–20·16) | 18·49 (18·17–18·82) | 21·44 (21·08–21·81) | 17·16 (16·58–17·76) | 21·56 (21·11–22·02) | 20·86 (20·34–21·38) | 18·88 (18·45–19·31) |
| 5 | 20·68 (20·43–20·93) | 19·25 (18·91–19·58) | 22·20 (21·83–22·58) | 18·00 (18·10–19·34) | 22·42 (21·96–22·89) | 21·61 (21·08–22·15) | 19·50 (19·06–19·93) |
| 6 | 21·27 (21·02–21·53) | 19·87 (19·53–20·22) | 22·77 (22·40–23·15) | 18·71 (18·10–19·34) | 23·13 (22·66–23·61) | 22·16 (21·63–22·71) | 19·96 (19·52–20·40) |
| 7 | 21·64 (21·39–21·90) | 20·27 (19·93–20·61) | 23·11 (22·73–23·49) | 19·12 (18·50–19·75) | 23·57 (23·10–24·05) | 22·53 (21·99–23·08) | 20·23 (19·79–20·68) |
| 8 | 21·90 (21·65–22·16) | 20·51 (20·17–20·86) | 23·39 (23·01–23·77) | 19·53 (18·90–20·16) | 23·89 (23·41–24·37) | 22·79 (22·25–23·34) | 20·37 (19·93–20·82) |
| 9 | 22·11 (21·86–22·37) | 20·73 (20·38–21·08) | 23·60 (23·22–23·98) | 19·79 (19·16–20·43) | 24·18 (23·70–24·67) | 22·99 (22·45–23·55) | 20·48 (20·04–20·93) |
| 10 | 22·26 (22·00–22·52) | 20·88 (20·54–21·23) | 23·73 (23·35–24·12) | 19·96 (19·32–20·60) | 24·39 (23·91–24·88) | 23·12 (22·57–23·68) | 20·56 (20·12–21·01) |
| 11 | 22·40 (22·08–22·60) | 20·96 (20·61–21·31) | 23·81 (23·43–24·20) | 20·08 (19·44–20·72) | 24·50 (24·02–24·99) | 23·17 (22·62–23·72) | 20·62 (20·18–21·07) |
| 12 | 22·41 (22·15–22·67) | 21·03 (20·68–21·38) | 23·88 (23·50–24·27) | 20·16 (19·52–20·81) | 24·58 (24·10–25·07) | 23·26 (22·72–23·82) | 20·65 (20·20–21·10) |
| 13 | 22·43 (22·17–22·69) | 21·06 (20·71–21·41) | 23·90 (23·52–24·29) | 20·18 (19·55–20·83) | 24·61 (24·13–25·10) | 23·31 (22·76–23·87) | 20·66 (20·21–21·11) |
| 14 | 22·45 (22·19–22·71) | 21·08 (20·73–21·43) | 23·91 (23·52–24·29) | 20·20 (19·56–20·85) | 24·63 (24·15–25·12) | 23·31 (22·76–23·87) | 20·66 (20·22–21·11) |

**Table 3**
Characteristics of all self-harm episodes from a subsample of 74,947 self-harm patients who had at least one inpatient record and results from the recurrent event analysis.

| Variables | Sample characteristics, N (%) Total sample N=102,868(74,947 patients) | No repetition N=58,792(58,792 patients)[a] | One or more repetitions N=44,076(16,155 patients)[a] | Risk of repeated self-harm HR (95% CI) | P value |
|---|---|---|---|---|---|
| **Age** | | | | | |
| 10–24 years | 12,749 (12•39) | 7629 (12•98) | 5120 (11•62) | 1•00 (ref) | |
| 25–44 years | 31,190 (30•32) | 16,738 (28•47) | 14,452 (32•79) | 1•01 (0•95–1•06) | 0•82 |
| 45–64 years | 23,426 (22•77) | 12,855 (21•87) | 10,571 (23•98) | 1•03 (0•97–1•09) | 0•36 |
| 65+ years | 35,503 (34•51) | 21,570 (36•69) | 13,933 (31•61) | 1•07 (1•01–1•13) | 0•023 |
| Mean (SD), years | 52•11 (22•53) | 52•77 (22•88) | 51•24 (22•03) | - | - |
| **Gender** | | | | | |
| Female | 52,005 (50•56) | 30,469 (51•83) | 21,536 (48•86) | 1•00 (ref) | |
| Male | 50,863 (49•44) | 28,323 (48•17) | 22,540 (51•14) | 1•08 (1•05–1•11) | <0•0001 |
| **Used social welfare for payment** | | | | | |
| No | 78,532 (76•34) | 10,950 (18•62) | 30,690 (69•63) | 1•00 (ref) | |
| Yes | 24,336 (23•66) | 47,842 (81•38) | 13,386 (30•37) | 1•30 (1•27–1•34) | <0•0001 |
| **Psychiatric admission** | | | | | |
| No | 101,214 (98•39) | 58,576 (99•63) | 42,638 (96•74) | 1•00 (ref) | |
| Yes | 1654 (1•61) | 216 (0•37) | 1438 (3•26) | 1•60 (1•50–1•72) | <0•0001 |
| **Method** | | | | | |
| Self-poisoning | 82,174 (79•88) | 48,032 (81•70) | 34,142 (77•46) | 1•00 (ref) | |
| Self-injury | 19,896 (19•34) | 10,407 (17•70) | 9489 (21•53) | 1•19 (1•15–1•23) | <0•0001 |
| Combined | 798 (0•78) | 353 (0•60) | 445 (1•01) | 1•38 (1•24–1•53) | <0•0001 |
| **Previous self-harm episode** | | | | | |
| 0 | 74,947 (72•86) | 58,792 (100•00) | 16,155 (36•65) | 1•00 (ref) | |
| 1 | 16,155 (15•70) | - | 16,155 (36•65) | 1•69 (1•64–1•74) | <0•0001 |
| 2 | 5386 (5•24) | - | 5386 (12•22) | 2•35 (2•25–2•46) | <0•0001 |
| 3 | 2323 (2•26) | - | 2323 (5•27) | 3•17 (3•00–3•36) | <0•0001 |
| 4+ | 4057 (3•94) | - | 4057 (9•20) | 4•81 (4•46–5•18) | <0•0001 |
| **Comorbidity** | | | | | |
| Depression and bipolar disorders | 7093 (6•90) | 3435 (5•84) | 3658 (8•30) | 1•09 (1•04–1•14) | 0•00,013 |
| Alcohol misuse | 5251 (5•10) | 3242 (5•51) | 2009 (4•56) | 0•84 (0•78–0•89) | <0•0001 |
| Personality disorders | 862 (0•84) | 202 (0•34) | 660 (1•50) | 1•18 (1•06–1•32) | 0•0032 |
| Anxiety and neurotic disorders | 8532 (8•29) | 5129 (8•72) | 3403 (7•72) | 0•85 (0•81–0•89) | <0•0001 |
| Schizophrenia | 1687 (1•64) | 852 (1•45) | 835 (1•89) | 0•85 (0•78–0•92) | 0•00,018 |
| Substance misuse | 16,792 (16•32) | 7201 (12•25) | 9591 (21•76) | 1•31 (1•27–1•36) | <0•0001 |
| Asthma | 570 (0•55) | 242 (0•41) | 328 (0•74) | 1•18 (1•02–1•36) | 0•027 |
| Diabetes | 9065 (8•81) | 4812 (8•18) | 4253 (9•65) | 1•04 (0•99–1•08) | 0•14 |
| Migraine | 41 (0•04) | 17 (0•03) | 24 (0•05) | 0•98 (0•48–1•97) | 0•95 |
| Epilepsy | 1033 (1•00) | 445 (0•76) | 588 (1•33) | 1•09 (0•98–1•21) | 0•11 |
| Cancer | 2743 (2•67) | 1798 (3•06) | 945 (2•14) | 1•06 (0•96–1•16) | 0•25 |
| Dermatitis and eczema | 6049 (5•88) | 4026 (6•85) | 2023 (4•59) | 0•85 (0•76–0•94) | 0•003 |
| Psoriasis | 79 (0•08) | 48 (0•08) | 31 (0•07) | 1•04 (0•71–1•54) | 0•83 |

[a] Sample characteristics for no repetition and repetition groups were all significantly different. All *p* values obtained from Pearson's $\chi^2$ test were less than 0•05

frequently-cited risk factors for repeated self-harm in previous research, including alcohol misuse, anxiety and neurotic disorders, and schizophrenia, were associated with decreased risks of self-harm repetition in our study. Research comparing characteristics of people presenting to hospital following self-harm in Hong Kong, with a UK sample, reported a much lower prevalence of alcohol misuse in the Hong Kong sample with no association between alcohol abuse and self-harm repetition [25]. Different alcohol-intake patterns between Eastern and Western communities may explain this finding. On the other hand, we found substance misuse was associated with an increased risk of repetition, which is in line with an earlier Hong Kong study which, for the first time, identified the highest risk of self-harm (nearly ten times greater risk) in patients with substance misuse or dependence, suggesting a unique pattern of substance misuse in Hong Kong. However the same study examining associations between psychiatric disorders and the first recorded self-harm event, observed an elevated risk for all psychiatric disorders [18]. These inconsistencies suggest that people who self-harm once and those who repeat self-harm may have distinctly-different characteristics, with different risk factors. Further research is required to examine these alcohol and substance misuse patterns in details and their associated risk of self-harm, and repetition of self-harm, in Hong Kong.

Key strengths of our research are the amalgamation of self-harm records from A&E departments and inpatient settings, and a lengthy follow-up (15 year) period. Only 12•4% of patients had self-harm records in both settings, indicating that the prevalence and repetition risk of self-harm will be underestimated if data from only one setting is analysed. In addition, survival analysis based only on the first repetition of self-harm will underestimate the risk of further repetitions over time [5]. To reduce the potential for such bias, we included all non-fatal self-harm repetitions, and applied a robust estimation method (the WLW approach) to account for recurrent events and to estimate independent contribution of multiple comorbidities. Our results are generalizable to all Hong Kong self-harm patients since we included self-harm records from all public hospitals under the Hospital Authority, whose primary, secondary, and tertiary care services are accessible to all Hong Kong residents [34].

This study has several limitations, First, the study was potentially-constrained by not completely compatible clinical data structures of A&E and inpatient records. Since specific diagnostic codes were not available in the A&E dataset, only patients who had at least one inpatient record were included in the survival analysis. This potentially led to biased estimates because the comorbidity status of the A&E episode was imputed using the nearest inpatient record. Whilst sensitivity analysis did not find substantial discrepancies in terms of major findings, the alternative coding approach used to account for absent comorbidity information in A&E records reduced the proportion of patients with comorbidities, resulting in subsequent adjustment of significant findings for depression, bipolar disorders and personality disorders. Additionally, self-harm cases were identified by either the traumatic type/poison nature indicator assigned by the Hospital Authority (A&E), or the ICD codes (inpatient). The reliability of the Hospital Authority's self-harm indicator is yet to be examined, and as suggested by previous studies, using ICD codes for identifying self-harm cases might lead to undercounting problems [35]. Third, our findings were generated from the hospital sample only. Many self-harm cases might be managed by out-patient clinics in the community, and may not necessarily result in hospital presentation; consequently, the annual counts of self-harm and the risk of self-harm repetition may be underestimated. Fourth, the one-year screening period adopted might have caused an underestimation of the prevalence of repeated self-harm in the early years. To further examine the potential effect of the length of screening periods, we plotted the trends in annual prevalence of repeated self-harm using the total sample (Appendix pp3). It is seen that by extending the screening period to 5 years, a 10% increase from 2007 to 2010 was still evident. Given that a repeated event can happen even 14 years after an index event (see Fig. 3), it is difficult to conclude whether the increasing trend is caused by the choice of screening period. Annual prevalence reported for the early years should be interpreted with caution. Fifth, the way the data was provided for research potentially incurred over-time estimation biases, as only the year and month of admission, discharge, and death dates were visible to the researchers. Moreover, only the first three digits of ICD-9-CM code were available; thus, specific risk effects could only be tested for combined illness categories (i.e., depression and bipolar disorders) rather than individual psychiatric disorders. This increases the complexity of clinical risk identification and evaluation. Another concern is that some patients in the no repetition group may have died by suicide. Since all potential fatal self-harm (suicide) cases were excluded due to the absence of cause of death information, the risk of repetition might be underestimated. Finally, although psychosocial assessment plays an important role in self-harm repetition prevention, [29] information on psychosocial assessments is not routinely documented in CDARS, and neither is data on other potentially-relevant psychosocial factors, such as sexual abuse, abnormal behaviours, and living alone [3].

## Conclusion

The risk of repeated self-harm events appears to be higher in Hong Kong than those in other Asian societies, and the risk approximate international figures. This study found important evidence to support providing more timely and multipronged care (including both medical and non-medical support) to people in Hong Kong who have non-fatally self-harmed at least once, and are likely to repeat it. The highest risk period is the first one year following the first event, with risks of repetition being particularly high in the first two months. Post self-harm risk screening and prevention strategies should address important demographic, clinical and psychosocial characteristics, using personalized and multipronged prevention strategies delivered within 1–2 months of a self-harm event.

## Declaration of Competing Interest

We declare no competing interests.

## Acknowledgement

## Data sharing statement

The CDARS dataset is managed by the Hong Kong Hospital Authority (HA). HA Data Sharing Portal provides various access channels to HA data for research purposes. The related information can be found online (https://www3.ha.org.hk/data).

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.lanwpc.2020.100027.

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