Case fatality of repeated suicidal acts among suicide attempters in rural China: a retrospective cohort study

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Summary

Background Individuals presenting to hospital due to suicide attempt are at high risk for repeated suicidal act, yet there are meager data on the extent to which repeated suicidal acts result in death.

Methods This retrospective cohort study was based on a general hospital self-harm register system in a rural county in China. Identified individuals who attempted suicide were contacted and followed up for up to 8 years. Main outcomes over follow-up were: 1) suicide death, 2) nonlethal suicide attempt, and 3) suicidal acts including suicide death and nonlethal attempt. Incidence densities, correlates, and case fatality of repeated suicidal acts were estimated.

Findings A total of 1086 individuals (two-thirds females, mean age 40.6 years) with a suicide attempt presenting to hospital (index attempt) were identified and followed up, with most of the index attempts by pesticide ingestion (79%). Over follow-up, there were 116 suicidal acts carried out by 108 individuals (69 females, 39 males), including 34 suicide deaths (21 females, 13 males), yielding a high case-fatality of 29.3%. During follow-up, suicide death rates were also high overall and in the first year of follow-up (846.7 and 1787.2 per 100,000 person years). Over follow-up, pesticide was the most common method (47/116) of repeated suicidal act and yielded a higher case-fatality than other methods (46.8% vs 17.4%, $\chi^2 = 11.68$, $P < 0.001$). The incidence densities of repeated suicidal acts and nonlethal attempts were low compared to rates reported in previous literature.

Interpretation Incidence densities of repeated suicidal acts in a rural China cohort were low compared to previous studies. However, rates of suicide deaths over follow-up were high, a result driven by the high case-fatality of suicidal acts and attributable to the common use of pesticides. Reducing suicidal acts with pesticides is a key target for suicide prevention in rural China.

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Keywords: Suicide; Suicide attempt; Repetition; Case-fatality; Pesticide; Cohort study; China

Introduction

Suicide is a leading cause of death worldwide, with more than 700,000 suicides occurring each year.[1] Approximately 1 in 7 suicides occur in China, making it a critical region for prevention efforts to lower the burden of suicide.[1] Individuals who make a suicide attempt are at high risk for subsequent suicide.[2] In addition, suicide attempts are associated with high disability and healthcare costs.[3]

Repeated suicidal acts are common after a suicide attempt coming to medical attention, particularly in the first year of follow-up.[4,5] Worldwide, among individuals presenting for medical attention with a suicide attempt, in the first year of follow-up an estimated 3.1%–26.8% engage in repetition of nonlethal attempt or self-harm.[6–16] Approximately 0.16%–4.2% of individuals presenting for medical attention with an index attempt die by suicide within 12 months.[2,6–8,17–20] The incidence

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Research in context

Evidence before this study

Fatal and non-fatal repeated suicidal acts are common among individuals who attempted suicide. We searched PubMed and Web of Science for peer-reviewed articles published prior to 31 December 2022 using the terms ("attempted suicide" OR "suicide attempt" OR "self-harm") AND ("repeat*" OR "repetition") AND (suicid*). In 12-month after the index suicide attempt, 0.16%–4.2% of recruited participants died by subsequent suicidal acts, and 3.1%–26.8% of them repeated suicide attempt or self-harm. The incidence densities of fatal and non-fatal repeated suicidal acts varied across different populations. Sex, age, and lethality of methods of index suicide attempts are associated with occurrence of repeated suicidal acts. In rural China, it is still unclear in the incidence, case fatality, and correlates of repeated suicidal acts.

Added value of this study

In this cohort study of individuals who attempted suicide in a rural area of China, the incidence of repeated nonlethal attempt was low but the suicide death rate was high, attributable to the high case-fatality rate of pesticide ingestion, the most common method of suicidal behavior in rural China.

Implications of all the available evidence

Restriction of access to pesticides and improvement of capacity of treating pesticide ingestion are vital in suicide prevention in rural China.

of repeated nonlethal attempt or suicide death over 12-month follow-up varies across different geographical regions. Available data from Asia indicate lower incidence of repetition of nonlethal attempt but higher incidence of suicide death in the first year after an index attempt.[4,5]

Several factors are associated with risk of repeated suicidal acts in China and other countries. After an attempt, males have higher suicide rates than females,[17–19,21,22] but females have higher incidence of repeated nonlethal attempt than males.[7,9,10,13,21] Following an attempt, older adults have higher risk for suicide death,[4,8,18,19,21] and adolescents and adults of middle age have higher risk for repeated nonlethal attempt,[4,7,11,14] compared to young adults. Attempts with lethal methods and multiple methods are associated with higher risk of subsequent suicide death,[6,7,18–20,22,23] and attempts using low lethal methods are associated with higher risk for repeated nonlethal attempt.[11,13,14] Individuals making suicide attempts with a previous suicide attempt history[13,16,17] and mental illness[6,10,13,16–18,21,23] are at increased risk for repetition of suicidal behavior and eventual suicide.

There is meager data on the case fatality of repeated suicidal acts. Only a few previous studies included both fatal and non-fatal repetition as outcomes among individuals who attempted suicide,[8,21] but case fatality of repeated suicidal acts was not estimated. Therefore, data to explain the higher incidence of suicide death and lower incidence of nonlethal repeat attempts among individuals who attempted suicide in Aisa countries including China are needed.[4,5] There have been a few reports of the characteristics of individuals who made repeated suicidal acts from studies of mainland China, Taiwan, and Hong Kong China,[9–12,19] but there are limited data from rural China per se.

This study examined a cohort of individuals who attempted suicide using data (2009–2018) from a general hospital self-harm registry system in a rural county in central west China.[24] Participants were retrospectively followed up to 8 years following the index attempt to identify repeated suicidal acts, both fatal and nonfatal, defined as the first repeated act of suicide registered by the system. These data facilitated the calculation of the incidence densities of suicide death, nonlethal repeated suicide attempt, and the case-fatality of repeated suicidal acts in the cohort of rural Chinese individuals with an index suicide attempt.

Methods

Study design and participants

This retrospective cohort study was conducted in Meixian County in Shaanxi Province, a central western province with middle level per capita Gross Domestic Product (GDP) in mainland China. Meixian county consists of 10 towns with total population of approximately 300,000, with agriculture central to the economy and about 80% of residents earn their living by farming.

A general hospital self-harm registry system has been established in the Meixian County since 2009.[24] The participants of this cohort study were individuals ages 10 and older who attempted suicide and were registered in this system from 1 January 2009 to 31 May 2018. A structured form was used to collect information of registered cases, which included individuals' name, age, sex, and home address, and information about the suicide attempt including the date, method(s), outcome (i.e., resulting in death or not), and suicide intention (i.e., with intention, without intention).

To reduce potential missing cases, all registered possible suicide attempts, including self-harm with suicide intention and self-poisoning without apparent suicide intention (registered accidental pesticide intoxication, accidental carbon monoxide poisoning, etc.), were planned to be contacted. Research personnel,

typically village doctors who received brief training, contacted the case themselves or their family members using a structured interview and follow-up form (described below). Data was collected during the interview.

After the contact and visit, some possible suicide attempts were excluded if the participants denied a self-harm incident took place in the index episode or if they refused to be followed. We further excluded individuals that could not be contacted, due to lack of clear address or use of false name or address, and individuals who died in the index episode. Moreover, duplicated records of the same case were excluded (i.e., recorded by different hospitals within 3 days, which indicated the case was medically treated in more than 1 hospital due to one self-harm episode).[24] For repeated suicidal acts (time interval of more than 3 days between two records) registered in the system, we selected the first registered episode as the index suicide attempt episode, and information of subsequent suicidal acts were treated as outcomes during follow-up period (described below). Cohort entry date was defined as the date of occurrence of the first registered suicide attempt episode (i.e., index suicide attempt).

This study was approved by the ethical review committee of the Beijing Huilongguan Hospital, with approvals obtained in 2005 for establishment of the registry system, in 2015 for follow-up [2015-3], and in 2021 for data analysis [2021-15-science].

Outcomes and data sources

The outcomes in this study were repeated suicidal acts (suicide death or nonlethal suicide attempt) following the index episode. Repeated nonlethal suicide attempt was defined as non-fatal self-harm with suicide intention in the follow-up period. Suicide death was defined as a fatal act of intentional self-harm during follow-up.

Outcomes were identified by three data sources. 1) A database of brief interviews and follow-up based on a structured form collected during visits by trained staff to participants. The form contained information of participants (name and address etc.), confirmation of each registered self-harm episode (methods, medical treatments, whether it was a suicidal act which necessitated at least some suicide intent, and whether the individual died as a result of the act), occurrence of repeated suicidal acts and characteristics (date, methods, and medical treatment due to suicidal act) of the first and the latest repeated suicidal act episodes, and whether the followed participants died by any causes during follow-up period (from entry date to date of follow-up, death, or censoring which is described below). The interview visits were from March 2015 to May 2019, in chronological order of entry date of the participants. The visit was at least 12 months after the entry date for each included participant. 2) Data from the general hospital self-harm registry system in the Meixian County was used (described above).[24] Records of self-harm occurred from 1 January 2009 to 31 May 2019 were included to identify repeated suicidal acts. 3) Data from the death reporting system administered by the Meixian County CDC. If participants died from 1 January 2009 to 31 May 2019 and were assigned ICD-10 codes of X60–X84, Y10–Y34, and Y87, they were identified as suicide death during follow-up period.

We combined the 3 data sources to identify repeated suicidal acts. For participants with same name, sex, and village (in address), assistants would check whether it is same person after interviewing knowledgeable persons in the village. Considering common homophone in Chinese, participants with names of same pronunciation were also carefully checked. In rural China, most residents who live in the same village know each other by name. If any repeated nonlethal attempts in the first or second data sources were identified, it was coded as a repeated nonlethal attempt, and the date of the first act and the method(s) used were included in data analysis. All of repeated nonlethal attempts recorded in general hospital self-harm registry system were also identified by the first database. If participants included in this cohort study were identified as a suicide death in any of the 3 databases, they were identified as suicide death. If any participants were coded as death by causes other than suicide, further visits were used to rule out suicide, with particular attention to individuals with repeated suicide attempts and deaths coded as accidental. The first and third authors would discuss with assistants who conducted the follow-up interviews before arriving at final decisions on cause of death, according to all available information. The date and method of suicide were included in the analysis.

Statistical analysis

We estimated the incidence densities of repeated suicidal acts (including nonlethal suicide attempts and suicide deaths), repeated nonlethal suicide attempt, and suicide death within the first 12-month after the index suicide attempt, and over the entire follow-up period using total person-years of exposure. Stratified estimates by sex, age group, and methods of index attempt episode were also made in each sub-cohort. The Poisson distribution was used to estimate 95% confidence intervals (95% CIs) of the incidence densities of repeated suicidal acts, repeated nonlethal attempts, and suicide death. Case fatalities of repeated suicidal act were computed as the proportions of all repeated suicidal acts that resulted in death [i.e., (suicide deaths)/(all repeated suicidal acts)]. Risks of repeated suicidal acts were estimated using the Kaplan–Meier method. Cox proportional hazard regression analyses were used to assess factors associated with repeated suicidal acts. The endpoint is the date of first repeated suicidal act (attempt or death). Censoring dates are dates of the last contact and interview, moving outside the Meixian County, or death of

other causes, whichever came first, for those without repeated suicidal acts. Sex, age group, education level, and methods of index suicide attempt (pesticide or non-pesticide) were potential predictors. The proportionality of hazards assumption was examined by testing the correlation of Schoenfeld partial residuals and event time, and the results indicated that the assumption could not be rejected (all $P > 0.05$).

Sensitivity analysis was conducted to test the consistency of our findings. Risks of repeated nonlethal attempt or suicide death were estimated using the Kaplan–Meier method and Cox proportional hazard regression model. With the outcome of suicide death, the end point is the date of occurrence of fatal suicidal act, and censoring date are dates of the last contact and interview, moving out, or death of other causes, whichever came first, regardless of whether there were repeated nonlethal attempts.

Role of funding source

The funding institutions had no role in the design, data collection, analysis, interpretation, writing of the report, or the decision to submit for publication.

Results

Detailed flowchart of identification and recruitment of suicide attempters is shown in Fig. 1. In brief, 1893 possible suicide attempts were registered, 112 registered cases were identified as suicide death, and the other 253 and 43 cases, respectively, were identified as duplicated register and repeated suicidal acts. Among the remaining 1485 self-harm cases, 1086 (73.1%) individuals were confirmed to have attempted suicide over follow up. There were 399 (26.9%) cases without follow-up data including 230 unable to contact, 159 contacted but denied, and 10 contacted but refused. Cases without follow-up data were more likely to be males (50.9% vs 36.0%, $\chi^2 = 26.90$, $P < 0.001$) and to have middle school level education (68.9% vs 64.2%, $\chi^2 = 8.62$, $P = 0.035$), compared with followed participants.

Characteristics of individuals with an index suicide attempt with follow-up data are listed in Table 1. Two thirds were females, with mean age 40.6 (S.D. = 17.4) years. Most (78.5%, 853 cases) used pesticide in the index episode. Mean follow-up times for any repeated suicidal acts (suicide death or nonlethal attempt, whichever came first) were 3.5 (S.D. = 1.8) years, with a maximum of 8.5 years. Mean follow-up times for suicide death was 3.7 (S.D. = 1.7) years, with a maximum of 9.8 years.

During the follow-up period, 108 (9.9%) individuals in the cohort made 116 repeated suicidal acts (1 episode for 101 participants, 2 episodes for 6 participants, and 3 episodes for 1 participant). The repeated suicidal acts resulted in 34 suicide deaths (31 in the first repeated suicidal act), yielding a case-fatality rate of 29.3%.

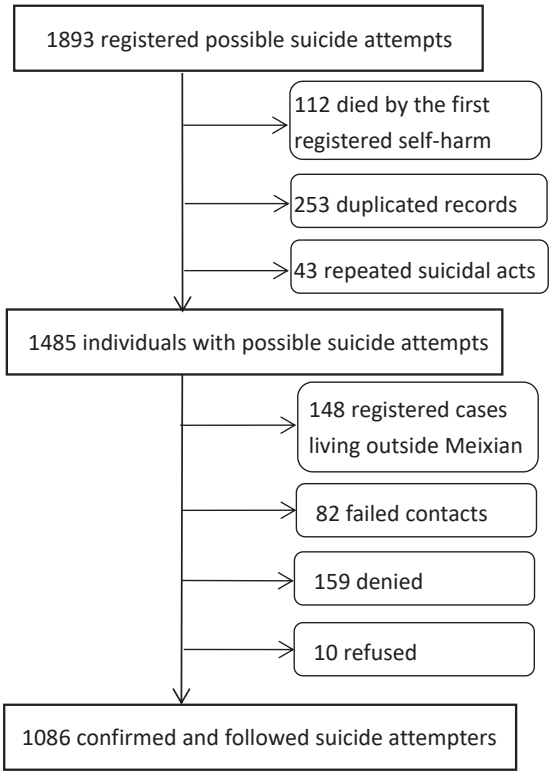

Fig. 1: **Flow chart of followed participants.**

Among 82 episodes of repeated nonlethal suicide attempts, 59 episodes (72.0%) were treated in hospital. Repeated suicidal acts were more likely among individuals who attempted suicide at age 60 years or above than other 3 age groups and were more likely among individuals using medication or cutting in the index episodes than those who used pesticide (see Table 1). Approximately half of repeated nonlethal attempts (34 episodes) and suicide deaths (19 cases) occurred in the 12 months after index suicide attempts, resulting in incidence of repeated non-lethal suicide attempt and suicide death of 3130.8 and 1749.5 per 100,000.

The incidence densities overall and stratified by sex, age groups, and methods used in the index suicide attempt are listed in Table 2. Over the total follow-up period, the incidence densities per 100,000 person years of the outcomes were as follows: suicidal act 3074.3, nonlethal suicide attempt 2173.2, and suicide death 846.7. Over the first year of follow-up, the incidence densities per 100,000 person years of the outcomes were as follows: suicidal act 5105.0, nonlethal attempt 3274.9, and suicide death 1787.2. Compared to younger age groups, individuals who attempted suicide aged 60 years or above had the highest incidence densities of suicidal act, nonlethal attempts, and suicide death over follow-up. Compared with individuals using pesticides in the index episode, those using

Variables	All followed participants (n = 1086)		With repeated suicidal acts (n = 108)		Without repeated suicidal acts (n = 978)		χ^2	P value
	n	%	n	%	n	%		
Sex							0.01	0.930
Female	695	64.0	69	63.9	626	64.0		
Male	391	36.0	39	36.1	352	36.0		
Age groups								
10–17 years	83	7.6	5	4.6	78	8.0	5.54	0.019
18–34 years	366	33.7	33	30.6	333	34.0	5.78	0.016
35–59 years	450	41.4	43	39.8	407	41.6	6.71	0.010
≥60 years	187	17.2	27	25.0	160	16.4	ref	
Education level								
Primary school/illiteracy	249	22.9	28	25.9	221	22.6	ref	
Middle school	697	64.2	65	60.2	632	64.6	0.94	0.333
High school or above	96	8.8	9	8.3	87	8.9	0.60	0.437
Missing	44	4.1	6	5.6	38	3.9	0.85	0.356
Methods of index suicide attempt								
Pesticide	853	78.5	73	67.6	780	79.8	ref	
Medication	162	14.9	24	22.2	138	14.1	8.55	0.003
Cutting	35	3.2	6	5.6	29	3.0	4.29	0.038
Other	36	3.3	5	4.6	31	3.2	1.85	0.174

ref: reference group.

Table 1: **Characteristics of identified and followed-up participants with or without repeated suicidal acts.**

non-pesticide methods had substantially higher incidence densities of repeated suicidal acts, repeated nonlethal attempts, and suicide death over follow-up, and higher incidence density of suicide death in the first year after index episode.

As shown in the Table 3, results of multivariable Cox regression analysis indicated that risk of repeated suicidal acts was associated with using non-pesticide method at the index attempt episode (HR = 1.93, P = 0.002, see also Supplemental Figure S1a), and those who were age 60 or above at the index episode (HR = 2.87, P = 0.038, compared with those aged 10–17 years old). To investigate correlates of repeated suicidal acts further, we re-ran Cox regression analysis using repeated nonlethal attempt and suicide death as outcome separately. When only repeated nonlethal attempts were considered, using non-pesticide at index episode was associated with increased risk for repeated nonlethal attempt (HR = 2.32, P = 0.001, see Supplemental Figure S1b), but being age 60 years or older was not (HR = 1.62, P = 0.377). The fewer number of suicide deaths limited the analyses of suicide deaths, although preliminary results indicated that older suicide attempters were at greater risk for suicide death over follow-up.

We also compared fatal and non-fatal acts of suicide over follow-up. Among individuals with repeated suicidal acts, older (35 years old or above) and less educated (illiteracy or primary school) participants were more likely to die of suicide than younger (10–34 years) and more educated (middle school or above) participants (see Table 4). Pesticide was the most common method of repeated suicidal acts (47/116, 40.5%). Case-fatality rates in repeated acts of suicide differed substantially by method, with 46.8% (22/47) case-fatality with the use of pesticides compared to a case-fatality of 17.4% for non-pesticide acts (χ^2 = 11.68, P < 0.001).

Discussion

In this retrospective cohort study, 1086 individuals in one county of rural China who attempted suicide had been identified and followed up for average 3.5 years, with examinations of risk for repeated suicidal acts, nonlethal attempts, and suicide deaths over 1-year follow-up and over the entire follow-up period. Compared with available data from non-Asia countries,[6,7,13,14,17,18] the incidence density of repeated nonlethal attempt was relatively low in the cohort (over 1-year, overall) but the rate of suicide death was relatively high (over 1-year, overall).

To put the results in context, the incidence density of suicide death over follow-up (846.7 per 100,000 person years) observed in the cohort is about 100-fold the suicide rate in the general population in China (8.1 per 100,000 person-years) and in the region where the study was conducted (8.8 per 100,000 person-years).[1,24] It is also higher than most previous reports.[6,7,17,18] By comparison, the incidence density of repeated nonlethal attempt (2173.2 per 100,000 person-years) is almost

	Exposed person-years	Repeated suicidal acts		Repeated nonlethal attempts		Suicide death		
		Episodes	Incidence densities (95% CI) in 100,000 person-years	Episodes	Incidence densities (95% CI) in 100,000 person-years	Exposed person-years	Cases	Incidence densities (95% CI) in 100,000 person-years
In overall follow-up period								
Overall	3773.2	116	3074.3 (2569.6, 3674.8)	82	2173.2 (1754.4, 2689.5)	4015.6	34	846.7 (606.5, 1180.7)
By sex								
Male	1327.3	41	3089.0 (2285.6, 4164.6)	28	2109.5 (1490.9, 3088.2)	2605.5	21	806.0 (527.7, 1228.8)
Female	2445.9	75	3066.4 (2453.2, 3826.5)	54	2207.8 (1696.0, 2869.3)	1410.2	13	921.9 (539.6, 1571.1)
By age groups								
10–17 years	311.0	5	1607.7 (688.6, 3707.7)	5	1607.7 (688.6, 3707.7)	331.2	0	0 (0, 1147.3)
18–34 years	1302.6	36	2763.7 (2002.3,3801.1)	31	2379.9 (1681.1, 3357.1)	1426.3	5	350.6 (149.9, 818.2)
35–59 years	1619.0	45	2779.5 (2083.7, 3698.8)	30	1853.0 (1301.0, 2632.9)	1690.6	15	887.3 (538.3, 1458.4)
≥60 years	540.5	30	5550.4 (3911.6, 7805.8)	16	2960.2 (1828.5, 4749.8)	567.5	14	2467.0 (1473.8, 4094.4)
By method of index suicide attempt								
Pesticide	3056.2	79	2584.9 (2079.2, 3210.0)	54	1766.9 (1356.8, 2298.3)	3216.8	25	777.2 (526.9, 1144.7)
Non-pesticide	717.0	37	5160.4 (3766.8, 7031.9)	28	3905.2 (2715.5, 5586.1)	798.9	9	1126.5 (593.7, 2126.8)
In first year after index suicide attempt								
Overall	1038.2	53	5105.0 (3924.7, 6618.3)	34	3274.9 (2353.3, 4542.3)	1063.1	19	1787.2 (1147.2, 2774.8)
By sex								
Male	373.0	19	5093.8 (3285.0, 7818.2)	10	2681.0 (1462.6, 4864.0)	380.5	9	2365.3 (1247.6, 4427.8)
Female	665.2	34	5111.2 (3681.6, 7059.6)	24	3607.9 (2437.1, 5313.9)	682.4	10	1465.4 (798.4, 2677.9)
By age groups								
10–17 years	81.1	2	2466.1 (679.8, 8562.7)	2	2466.1 (679.8, 8562.7)	83.0	0	0 (0, 4423.5)
18–34 years	351.3	14	3985.2 (2390.6, 6582.9)	10	2846.6 (1554.7, 5164.2)	362.7	4	1102.8 (429.3, 2798.6)
35–59 years	433.4	24	5537.6 (3752.7, 8114.7)	15	3461.0 (2110.4, 5636.5)	440.2	9	2044.5 (1079.8, 3841.2)
≥60 years	172.3	13	7545.0 (4469.9, 12500.7)	7	4062.7 (1985.2, 8161.2)	177.3	6	3384.1 (1562.7, 7197.2)
By method of index suicide attempt								
Pesticide	818.6	41	5008.6 (3711.4, 6720.9)	28	3420.5 (2375.8, 4896.8)	837.9	13	1551.5 (908.8, 2636.0)
Non-pesticide	219.7	12	5462.0 (3147.4, 9290.6)	6	2731.0 (1255.8, 5821.3)	225.3	6	2663.1 (1227.8, 5694.7)

Table 2: **Overall and stratified incidence densities of repeated suicidal acts, nonlethal attempts, and suicide death over follow-up and in the first year after index suicide attempt among followed participants.**

Variables	HR	95% CI	P value
Female	1.02	0.67–1.51	0.977
Age groups			
10–17 years	1		
18–34 years	1.40	0.54–3.64	0.493
35–59 years	1.67	0.65–4.25	0.285
≧60 years	2.87	1.06–7.74	0.038
Education level			
Primary school/illiteracy	1		
Middle school	1.13	0.65–1.95	0.671
High school or above	1.18	0.52–2.72	0.690
Missing	1.03	0.41–2.61	0.949
Methods of index suicide attempt			
Pesticide	1		
Non-pesticide	1.93	1.27–2.93	0.002

Non-pesticide method includes medication, cutting, jumping, drowning, hanging, and other methods used in repeated suicidal acts.

Table 3: **Associated factors of repeated suicidal acts among individuals who attempted suicide, using Cox regression analysis.**

39-fold of that in general population in the same study site (55.3 per 100,000 person-years).[24] Nonetheless, the incidence density of repeated nonlethal attempts is lower than almost all previous reports of cohorts of individuals who attempted suicide.[7–16] The fact that incidence density of suicide death over follow-up is comparatively high despite comparatively low incidence density of nonlethal suicide attempt is attributable to the common use of pesticides in suicidal acts, a deadly method of suicidal act as borne out by the high case fatality rate (29.3%) for pesticide ingestions observed in the current cohort. Note that in our previous register system-based study in Meixian county, the case fatality of suicidal act was approximately 13.7% for the general population.[24]

Unlike many previous cohort studies,[7,9,10,13,17–19,21] our study did not find any significant sex differences on incidence densities of repeated nonlethal attempts or suicide death, either in whole follow-up or in the first year after the index suicide attempt (see Table 2). In previous study, we argued that high proportion of pesticide ingestion contributed to relatively high female suicide rates in rural China.[24] In terms of association of age and repeated suicidal acts, in our study, participants aged 60 years or above were more likely making repeated suicidal acts (HR = 2.87, compared with adolescent participants), similar with previous studies.[4,8,18,19,21,25] This might be partly attributed to high incidence density of fatal repetition among elderly participants (see Table 2), although age is not associated with repeated nonlethal attempt in our study (HR = 1.62, P = 0.377). Nevertheless, adolescents (10–17 years old) and young adult (18–34 years old) participants in the cohort had lower incidence densities of repeated nonlethal attempts and suicide death compared to participants aged 60 years or above, both in whole follow-up

Variables	Repeated nonlethal attempts		Suicide death		χ2	P value
	n	%	n	%		
Sex					0.10	0.755
Female	48	64.9	21	61.8		
Male	26	35.1	13	38.2		
Age groups					11.80	0.008
10–17 years	5	6.8	0	0.0		
18–34 years	28	37.8	5	14.7		
35–59 years	28	37.8	15	44.1		
≧60 years	13	17.6	14	41.2		
Education level					9.35	0.025
Primary school/illiteracy	14	18.9	14	41.2		
Middle school	46	62.2	19	55.9		
High school or above	9	12.2	0	0.0		
Missing	5	6.8	1	2.9		
Methods of index suicide attempt					0.80	0.372
Pesticide	48	64.9	25	73.5		
Non-pesticide	26	35.1	9	26.5		
Methods of repeated suicidal acts[b,c]					11.68	<0.001
Pesticide	25	30.5	22	64.7		
Non-pesticide	57	69.5	12	35.3		

[a]The sample is 108 participants with repeated suicidal acts. [b]The sample is 116 repeated suicidal act episodes. [c]Non-pesticide method includes medication, cutting, jumping, drowning, hanging, and other methods used in repeated suicidal acts.

Table 4: **Comparisons of characteristics of participants who with repeated nonlethal attempt and who died by repeated suicidal acts.**[a]

and in the first year after index episode (see Table 2). This result also differs from several previous studies.[4,7,11,14] Differences between our study and prior studies in the settings of data collection (e.g., studies of western populations, studies of predominantly urban settings),[25,26] sample characteristics (e.g., studies of adolescents),[7,14] and the methods of case finding (e.g., reliance on medical and coroner records) makes interpretation of the differing results challenging. Thus, large sample, multicenter, and long-term follow-up studies is needed to clarify these issues further.[25,26]

Method used in the index suicide attempt is a strong predictor for repeated nonlethal attempts and suicide death.[6,7,11,13,14,18–20,22,23] Participants using non-pesticide method in the index suicide attempt were more likely to make repeated suicidal acts (HR = 1.93, P = 0.002). A reasonable explanation for our distinctive result is that in China, suicidal acts using pesticide are often with low planning, either in suicide death or in suicide attempt.[27,28] Therefore, persons survived after pesticide suicidal acts are with low intention to die, then were less likely making repeated suicidal acts. The second, high case fatality of pesticide suicidal acts decreases the amounts of individuals with a tendency of multiple episodes of suicidal acts. The third, in present and previous studies,[24,29] only few of registered individuals who attempted suicide in China used violent methods (hanging, jumping, drowning etc.). Hence, our study did not have enough participants with high suicide intention to duplicate previous findings. In addition, social determinants closely associated with mental health outcomes.[30] Disadvantaged individuals are more vulnerable to mental health conditions, and socio-environmental factors including subcultural contexts and urban-rural difference also correlate with suicide method selection. Strategy focusing on reducing socio-economic inequalities should be a key component of suicide prevention.

Implication

Similar to the current results, two meta-analyses reported low non-fatal repetition yet high fatal repetition of suicidal act among individuals with suicide attempt in Aisa countries.[4,5] Thus, the current results from rural China, buoyed by extant data from Asian countries, underscore the necessity of developing suicide prevention strategies that emphasize reducing the incidence rates of suicidal act with the ingestion of pesticides and increasing the survivability of these incidents. Accordingly, prevention efforts are needed that, may include limiting access to pesticides, promoting their safe storage, reducing the toxicity of commonly used pesticides, and improving emergency medical response to increase the capacity to provide lifesaving care to individuals who ingest pesticides, in rural areas in China and other Asia countries. Among the various prevention options, the strongest evidence comes from initiatives in Sri Lanka and India to ban highly toxic pesticides, leading to significant reductions in rates of suicide.[31,32] Similarly, China can be expected to benefit from this approach, considering that half of its people live in rural areas and engage in agricultural production. Although policies targeting pesticides have been issued by China Ministry of Agriculture and Rural Affairs since 2016,[33] the effectiveness of the policies has not been evaluated.

Limitations

There are limitations of the study. First, there is limited statistical power to analyze correlates of suicide deaths. Second, data on several risk factors of repeated suicidal acts including mental illness, medical severity of index suicide attempt etc., were not assessed in the baseline while the cohort was established. Third, all participants recruited in this cohort were registered by hospital medical records, other suicide attempters who were not treated in hospital were not included who may have differing characteristics.[34] Fourth, we did not obtain information of categories of pesticide used in the index and repeated episodes, such as toxicity, lethality, or formulations. Fifth, more than 20% registered patients with self-harm were not included in our cohort, potentially biasing the findings. Sixth, relevance of data outside of rural China is unclear.

Conclusion

To our knowledge, our study is the first cohort study focusing on case fatality of repeated suicidal acts among registered individuals with suicide attempt in rural China. Despite comparatively low incidence densities of repetition of suicidal acts in this population, suicide rates over follow-up are high, attributable to the common use of pesticides, a toxic form of ingestion. Results underscore the importance of targeting pesticides in efforts to lower the incidence densities of subsequent suicide amongst rural Chinese patients presenting for hospital care following a suicide attempt. Restriction of access to pesticide and improvement of capacity of treating pesticide intoxication are vital in suicide prevention in rural China.

Contributors

YT and KC conceived and designed the study. YT and ZL conducted the study and data collection. YT and YY conducted data analysis. YT, YY, and KC drafted the manuscript and all authors contributed to the interpretation of findings and critical revision of the article. YT and ZL verified the data. All authors had full access to the data and accepted responsibility to submit for publication.

Data sharing statement

Study data are available on request to the correspondence author.

Declaration of interests

All authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lanwpc.2024.101068.

References

1 World Health Organization. *Suicide worldwide in 2019: global health estimates*. Geneva: World Health Organization; 2021.
2 Beckman K, Mittendorfer-Rutz E, Lichtenstein P, et al. Mental illness and suicide after self-harm among young adults: long-term follow-up of self-harm patients, admitted to hospital care, in a national cohort. *Psychol Med*. 2016;46:3397–3405. https://doi.org/10.1017/S0033291716002282.
3 Tsiachristas A, Geulayov G, Casey D, et al. Incidence and general hospital costs of self-harm across England: estimates based on the multicentre study of self-harm. *Epidemiol Psychiatr Sci*. 2020;29:e108. https://doi.org/10.1017/S2045796020000189.
4 Liu B, Lunde KB, Jia C, Qin P. The short-term rate of non-fatal and fatal repetition of deliberate self-harm: a systematic review and meta-analysis of longitudinal studies. *J Affect Disord*. 2020;273:597–603. https://doi.org/10.1016/j.jad.2020.05.072.
5 Carroll R, Metcalfe C, Gunnell D. Hospital Presenting self-harm and risk of fatal and non-fatal repetition: systematic review and meta-analysis. *PLoS One*. 2014;9(2):e89944. https://doi.org/10.1371/journal.pone.0089944.
6 Olfson M, Wall M, Wang S, Crystal S, Gerhard T, Blanco C. Suicide following deliberate self-harm. *Am J Psychiatry*. 2017;174(8):765–774. https://doi.org/10.1176/appi.ajp.2017.16111288.
7 Olfson M, Wall M, Wang S, et al. Suicide after deliberate self-harm in adolescents and young adults. *Pediatrics*. 2018;141(4):e20173517. https://doi.org/10.1542/peds.2017-3517.
8 Knipe D, Metcalfe C, Hawton K, et al. Risk of suicide and repeat self-harm after hospital attendance for non-fatal self-harm in Sri Lanka: a cohort study. *Lancet Psychiatry*. 2019;6:659–666. https://doi.org/10.1016/S2215-0366(19)30214-7.
9 Liu X, Liu Z, Jia C. Repeat self-harm among Chinese adolescents: 1-year incidence and psychosocial predictors. *Soc Psychiatry Psychiatr Epidemiol*. 2021;56(11):1979–1992. https://doi.org/10.1007/s00127-021-02085-x.
10 Kwok C, Yip PSF, Gunnell D, Kuo C, Chen Y. Non-fatal repetition of self-harm in Taipei City, Taiwan: cohort study. *Br J Psychiatry*. 2014;204:376–382. https://doi.org/10.1192/bjp.bp.113.130179.
11 Huang Y, Wu Y, Chen C, Wang L. Methods of suicide predict the risks and method-switching of subsequent suicide attempts: a community cohort study in Taiwan. *Neuropsychiatr Dis Treat*. 2014;10:711–718. https://doi.org/10.2147/NDT.S61965.
12 Yip PSF, Hawton K, Liu K, et al. A study of deliberate self-harm and its repetition among patients presenting to an emergency department. *Crisis*. 2011;32(4):217–224. https://doi.org/10.1027/0227-5910/a000069.
13 Bile'n K, Ottosson C, Castre'n M, et al. Deliberate self-harm patients in the emergency department: factors associated with repeated self-harm among 1524 patients. *Emerg Med J*. 2011;28:1019e1025. https://doi.org/10.1136/emj.2010.102616.
14 Bennardi M, McMahon E, Corcoran P, Griffin E, Arensman E. Risk of repeated self-harm and associated factors in children, adolescents and young Adults. *BMC Psychiatry*. 2016;16:421. https://doi.org/10.1186/s12888-016-1120-2.
15 Bertolote JM, Fleischmann A, De Leo D, et al. Repetition of suicide attempts data from emergency care settings in five culturally different low- and middle-income countries participating in the WHO SUPRE-MISS study. *Crisis*. 2010;31(4):194–201. https://doi.org/10.1027/0027-5910/a000052.
16 Kawahara YY, Hashimoto S, Harada M, et al. Predictors of short-term repetition of self-harm among patients admitted to an emergency room following self-harm: a retrospective one-year cohort study. *Psychiatry Res*. 2017;258:421–426. https://doi.org/10.1016/j.psychres.2017.08.077.
17 Finkelstein Y, Macdonald EM, Hollands S, et al. Long-term outcomes following self-poisoning in adolescents: a population-based cohort study. *Lancet Psychiatry*. 2015;2(6):532–539. https://doi.org/10.1016/S2215-0366(15)00170-4.
18 Geulayov G, Casey D, Bale L, et al. Suicide following presentation to hospital for non-fatal self-harm in the Multicentre Study of Self-harm: a long-term follow-up study. *Lancet Psychiatry*. 2019;6(12):1021–1030. https://doi.org/10.1016/S2215-0366(19)30402-X.
19 Chen VCH, Chou J, Hsieh T, et al. Risk and predictors of suicide and non-suicide mortality following non-fatal self-harm in Northern Taiwan. *Soc Psychiatry Psychiatr Epidemiol*. 2013;48:1621–1627. https://doi.org/10.1007/s00127-013-0680-4.
20 Runeson B, Tidemalm D, Dahlin M, Lichtenstein P, Langström N. Method of attempted suicide as predictor of subsequent successful suicide: national long term cohort study. *BMJ*. 2010;340:c3222. https://doi.org/10.1136/bmj.c3222.
21 Fedyszyn IE, Erlangsen A, Hjorthoj C, Madsen T, Nordentoft M. Repeated suicide attempts and suicide among individuals with a first emergency department contact for attempted suicide: a prospective, nationwide, Danish register-based study. *J Clin Psychiatry*. 2016;e1. https://doi.org/10.4088/jcp.15m09793.
22 Carroll R, Thomas KH, Bramley K, et al. Self-cutting and risk of subsequent suicide. *J Affect Disord*. 2016;192:8–10. https://doi.org/10.1016/j.jad.2015.12.007.
23 Runeson B, Haglund A, Lichtenstein P, Tidemalm D. Suicide risk after nonfatal self-harm: a national cohort study, 2000–2008. *J Clin Psychiatry*. 2015;e1. https://doi.org/10.4088/JCP.14m09453.
24 Tong Y, Phillips MR, Yin Y, Lan Z. Relationship of the high proportion of suicidal acts involving ingestion of pesticides to the low male-to-female ratio of suicide rates in China. *Epidemiol Psychiatr Sci*. 2020;9:e114. https://doi.org/10.1017/S2045796020000244.
25 Beghi M, Rosenbaum JF, Cerri C, Cornaggia CM. Risk factors for fatal and nonfatal repetition of suicide attempts: a literature review. *Neuropsychiatr Dis Treat*. 2013;9:1725–1736. https://doi.org/10.2147/NDT.S40213.
26 Lopez-Castroman J, Blasco-Fontecilla H, Courtet P, Baca-Garcia E, Oquendo MA. Are we studying the right populations to understand suicide? *World Psychiatry*. 2015;14:368–369. https://doi.org/10.1002/wps.20261.
27 Sun L, Zhang J. Medically serious suicide attempters with or without plan in rural China. *J Nerv Ment Dis*. 2016;204(11):851–854. https://doi.org/10.1097/NMD.0000000000000397.
28 Conner KR, Phillips MR, Meldrum S, Knox KL, Zhang Y, Yang G. Low-planned suicides in China. *Psychol Med*. 2005;35:1197–1204. https://doi.org/10.1017/S003329170500454X.
29 Li L, Liu C, Tong Y, et al. Comparison of characteristics of suicide attempts registered in urban and rural areas in China. *Front Psychiatry*. 2021;12:805324. https://doi.org/10.3389/fpsyt.2021.805324.
30 Kirkbride JB, Anglin DM, Colman I, et al. The social determinants of mental health and disorder: evidence, prevention and recommendations. *World Psychiatry*. 2024;23:58–90. https://doi.org/10.1002/wps.21160.
31 Buckley NA, Fahim M, Raubenheimer J, et al. Case fatality of agricultural pesticides after self-poisoning in Sri Lanka: a prospective cohort study. *Lancet Glob Health*. 2021;9:e854–e862. https://doi.org/10.1016/S2214-109X(21)00086-3.
32 Arya V, Page A, Gunnell D, Armstrong G. Changes in method specific suicide following a national pesticide ban in India (2011–2014). *J Affect Disord*. 2021;278:592–600. https://doi.org/10.1016/j.jad.2020.09.085.
33 Ministry of agriculture and rural Affairs of the people's Republic of China. Announcement No. 2445. Available online at: http://www.moa.gov.cn/govpublic/ZZYGLS/201609/t20160913_5273423.htm. Accessed September 30, 2023.
34 Mitchell AJ, Hussain S, Leaver J, et al. Is there a difference between hospital-verified and self-reported self-harm? Implications for repetition. *Gen Hosp Psychiatry*. 2016;43:12–16. https://doi.org/10.1016/j.genhosppsych.2016.08.001.