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Complete List of Authors:	xu, huilan qin, lu; School of Public Health, Central South University, Department of Social Medicine and Health Management wang, jinhong; xiangya hospital, central south university, Evaluation Office zhou, liang; School of Public Health, Central South University, Department of Social Medicine and Health Management luo, dan; School of Public Health, Central South University, Department of Social Medicine and Health Management hu, mi; School of Public Health, Central South University, Department of Social Medicine and Health Management li, zhenghua; xiangya hospital,Central South University, President's Office Xiao, Shuiyuan; School of Public Health, Central South University, Department of Social Medicine and Health Management
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A study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of central south China, Hunan

Huilan Xu[1], Lulu Qin[1], Jinhong Wang[1], Liang Zhou[1], Dan Luo[1], Mi Hu[1], Zhenhua Li[1], Shuiyuan Xiao[1]

1 Department of Social Medicine and Health Management, School of Public Health, Central South University, Changsha, Hunan 410078, China;

Correspondence author: Huilan Xu, E-Mail: huilanxu1963@sina.com

Tel./Fax: +86-0731-8484-5454.

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Abstract

Objectives: To report risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan and to provide some scientific basis for suicide prevention.

Design, setting and participates:A cross-sectional survey was conducted among the elderly in rural communities in China's Hunan province. 13 areas were selected by multi-staged cluster random sampling and 1,887 rural elders were investigated via face-to-face interviews.

Main outcome measures: Participants were asked general information(including name, sex, age, marital status, education status, annual personal income, chronic disease and living alone or not), suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The non-conditional logistic regression was preformed to explore the influencing factors for suicidal ideation, and the additive interaction was used to analyze the interaction between risk factors.

Results: Incidence of suicidal ideation among the elderly was 14.5% （95% CI:12.9%-16.1%） in rural communities of Hunan. The independent influencing factors of suicidal ideation were annual personal income (OR=3.14; 95% CI:2.15-4.59), MDD (OR=17.04; 95% CI:11.91-24.39), chronic diseases (OR=2.99; 95% CI:1.84-4.85) and ADL（OR=2.00; 95% CI:1.37-2.94）. Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18（95% CI:5.47-36.89）, and between MDD and annual personal income with a RERI of 35.00（95% CI:9.00-61.00）.

Conclusions: The independent risk factors of suicidal ideation are annual personal income（≤￥2,200）, MDD, chronic diseases and disabled activities of daily living. MDD has additive interactions with ADL and annual personal income. These findings have significant implications for the prediction and prevention of suicidal behaviors.

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Strengths and limitations of this study

This is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. In this population-based, large-scale, the high rate of follow-up and multistage with highly standardized methods, these findings are likely to be generalizable to elderly-aged Chinese.

The study provides valuable information on the rate of suicide ideation, the influence factors and the interactions between these factors among the elderly in rural communities.

The additive interactions (RERI, AP and S) were used to analyze the interaction between risk factors and suicide ideation.

The study is limited by its cross-sectional and self-reported design.

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INTRODUCTION

Suicide has become a major public health and social problem.[1] It accounts for 3.6% of all deaths and is the fifth most common cause of death in China.[2] Statistical figures have shown that the suicide rate is about 22/100,000 per year in this country.[3] There is a specific action from suicidal ideation to ultimately death[4], 60% of transitions from ideation to plan and attempt occur within the first year after ideation onset[5]. Suicidal ideation means one has the thought of suicide or want to take action to end one's own life. It is one of the most important risk factors for suicide[6] and an evaluation index recommended by the WHO.

Despite the worldwide attention to suicide recently, most studies of suicidal behaviors have been conducted in Western and high-income countries.[7-9] However, this is rare in China. With the coming of the aging society in China, the prevalence of suicide among the elderly is pressing. The prevalence of suicide ideation among Chinese elders ranged from 2.2% to 21.5%, which was relatively high.[10] The rate of suicide in rural areas was 3 times of the city[11], and the rate of suicide among the rural elderly was the highest compared with other age groups[12], thus, more attention to the prevalence of suicide among the rural elderly should be paid. Suicide ideation is the key period of suicide intervention,which was considered as the most effective measure to prevent suicide.[13] And the risk factors of suicidal behaviors were categorized into three groups: psychosocia, social-environmental and socio-demographic.[14] But their interaction is indicated rarely.

This study was executed Hunan, a typical south central province in China. The geographical position of Hunan is from 24° 38` to 30° 08`N in latitude and from 108° 47` to 114° 15` E in longitude. A study showed that the prevalence of suicide among the rural elderly in Hunan was at a high level in the 1990's[15], and a recent study showed there was a high prevalence of suicide ideation among the rural elderly[16]. We carried this study to investigate risk factors and their additive interactions with suicidal ideation among the elderly in rural communities of Hunan. Besides, we hope this study can provide some scientific basis for suicide prevention.

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METHODS

Participants

A cross-sectional survey was conducted among the elderly in rural communities of Hunan province of China. By multi-staged cluster sampling, 2 counties (Hengyang and Liuyang) were randomly selected from 72 counties in Hunan province. Next, 3 townships (Yanshan，Qulou and Qulan) were randomly selected from 26 townships in Hengyang and 3 villages were respectively chosen from the selected townships. Concurrently, 2 townships (Gaoping and Yongan) were randomly selected from 24 townships in Liuyang and 2 villages were respectively chosen from the selected townships and two teams were randomly selected from each village. In total , 13 areas were selected for our study. The elderly (age ≥ 60 years) resident population (who had achieved registered permanent residence or not achieved registered permanent residence but have resided for six months) were identified as our subjects but those who had severe physical or mental illness were excluded. There were 2,235 elderly residents in the 13 selected areas, among which 198 individuals were excluded for severe physical or mental illness. The theoretical sample size was 2,037 people, with 150 not investigated for various reasons (Fig. 1). The response rate was 92.6%. Among the remaining 1,887 individuals, 8 were excluded for incomplete data. In total, 1,879 elderly were brought into statistical analysis and the efficient was 99.5%. Our pre-trained interviewers went to the elderly subject's home and interviewed them face to face. If the individual was not at home, we would ask and record the reason. Each day, our interviewers were required to check their questionnaires seriously,.and the survey was carried out from 2009 to 2011

Measures

Participants were asked general information, suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The components of the questionnaire relevant to this study are detailed below.

General information

Name, sex, age, marital status, education status, annual personal income, chronic disease and whether the subject lived alone or not were measured by a self-designed inventory. Chronic diseases, referring to chronic non-communicable diseases, include cardiovascular disease (CVD),

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some cancers, chronic obstructive pulmonary disease (COPD), and type 2 diabetes and others (namely, diseases according to classification standards included in the ICD-10). And living alone was defined as a social situation where a person lives in a dwelling without a cohabitant, children or other household members.

Suicidal ideation

According to the concept and classification of suicidal behavior, we developed a self-made suicidal behavior questionnaire which contained four items: suicidal ideation (Have you ever seriously considered suicide in the last 12 months?), suicidal plan (Have you ever made a plan for committing suicide in the last 12 months?), suicidal preparation (Have you ever prepare any tool to kill yourself in the last 12 months?), and attempted suicide (Have you ever attempted to suicide?). The response option was yes and no.

Activities of daily living (ADL)

ADL of the elderly was measured by Lawton and Brody's activities of daily living scale, which includes 14 items.[17] It consists of a physical self-maintenance scale (PSMS） and an instrumental activities of daily living scale （IADL）. Each item was scored from 1 to 4. And the total score which is higher than 14 was defined as disabled; otherwise the individual was considered normal.

Major depression disorder (MDD)

MDD was measured by the Chinese version of the patient health questionnaire-9 (PHQ-9) whose reliability and validity are high.[18-19] PHQ-9 is constituted of two parts. The first part consists of 9 items for assessing the frequency of depression symptoms; each item was scored from "0" (not at all) to "3" (nearly every day). The second part contained an additional Item: "How difficult it was for you to do your work, take care of things at home, or get along with other people?" It was also scored from "0" (not difficult at all) to "3" (extremely difficult). Diagnosis of MDD had to simultaneously satisfy three of the following requirements: 1) at least five items with scores ≥ 2 in the first part (including if the ninth item scored ≥ 1); 2) at least one of the first or second items with a score ≥ 2; and 3) the second part with scores ≥2.[20]

Drinking

AUDIT developed by the World Health Organization (WHO) was considered as a simple method

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of screening for excessive drinking. This 10 items scale's reliability and validity have been established in research conducted in a variety of settings and in many different nations.[21] For Chinese, the AUDIT scores with 7 was defined as dividing line, above which was regarded as hazardous and harmful Drinking.

Stressful life events

Referenced the formerly scales,[22-23] we listed 38 life events and summarized into three aspects: health related problems, marital and family life related problems, social and other problems. If any events occurred in the last year and the subjects was considered stressful, and we defined this kind of subject suffering from the stressful life events.

Social supports

The Social Support Rating scale (Xiao S, 1999)[24] had been proved high reliability and validity in China. The scale included three parts: objective support, subjective support and availability of social support. If one's social support score was lower than the mean，we defined the person as bad social support, otherwise the individual was considered in a well social support.

Statistical analysis

Data was created and analyzed by using SPSS statistical software 16.0. Significance threshold of group differences were set at $P < 0.05$ (bilateral) .There were six age categories (60-64, 65-69, 70-74, 75-79, 80-84, 85 and above), two annual personal income categories(0-2,200, 2,201 and above)，four education status categories (illiterate, primary school, junior high school, senior high school and/or above),and two marital status categories (stable marriage, unstable marriage). Stable marriage includes complete marriage, while unstable marriage consists of widowed, unmarried and divorce. The univariate and multivariate non-conditional logistic regression were used to explore the influencing factors for suicidal ideation. In order to examine the relationships between risk factors and suicidal ideation, odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by using univariate and multivariate non-conditional logistic regression. There are three measures of additive interaction: the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index（S）. There is no additive interaction if RERI and AP are equal to 0 or S is equal to 1. We inputted the regression coefficients and covariance matrix drawn from the logistic regression into the Excel sheet made

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by Andersson so as to calculate the interaction of risk factors（annual personal income, chronic disease，MDD, ADL）and their confidence intervals.[25]

RESULTS

A total of 1,879 aged 60 to 97 years old individuals were included in this study. The participants were with a median age of 69 years old, and 891 (47.4%) of them were female. The median of annual personal income was ￥2,200. 1, 331 (70.8%) had stable marriages. There were four education levels: 650 (34.6%) were illiterate, 1,034(70.8%) finished primary school, 161 (8.6%) finished junior high school, and 34（1.8%）finished senior high school and/or above. 232 (12.3%) elderly subjects were living alone, 236（12.6%）had MDD, 1,316 (70.0%) had chronic diseases, 119 (54.2%) had disabilities in their activities of daily living, 177（9.4%）were suffered from hazardous and harmful drinking, 1637（87.1%）experienced negative life events in the last year. The social support scores were from 17 to 61 with the mean of 40.

The Incidence of Suicide Ideation

The incidence of suicidal ideation was 14.5%（95% CI:12.9%-16.1%）;and the data from the Chinese census in 2000 shows that it dropped to 14.1% after standardization . The incidence of suicidal plan, suicidal preparation and attempted suicide respectively were 4.0%, 1.9% and 0.8%. 27.6% (75/272) suicidal ideation elders made the suicidal plan, 12.9% (35/272) prepared suicide and 5.6% (15/272) end in attempted suicide.

The Influencing Factors for Suicidal Ideation

There were no statistical significance in sex, age, drinking and social supports between the suicidal ideation group and controlled group. (All significant at P＞0.05).As was indicated in Table 1, the univariate non-conditional logistic regression revealed that the influencing factors for suicidal ideation among the elderly were having a major depression disorder （OR=19.53; 95% CI: 14.19-26.88）, suffering from chronic diseases （OR=4.93; 95% CI: 3.25-7.60）, activities of daily living（OR=3.96; 95% CI: 2.90-5.41）, annual personal income（OR=4.44; 95% CI: 3.26-6.04）, unstable marriage (OR=1.846; 95% CI:1.42-2.41）,finishing primary school(OR=0.59;95% CI:0.45-0.78) and junior high school (OR=0.37; 95% CI:0.20-0.67）, Living alone(OR=2.50;95% CI:1.80-3.45）and suffering from negative life events in the last

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year(OR=2.02; 95% CI:1.25-3.25). Controlling for sex, age, marital status, education background, annual personal income, history of chronic disease, living status, history of a major depression disorder, activities of daily living , drinking，stressful life events and social supports ,the multivariate non-conditional logistic regression analysis showed that the independent risk factors of suicidal ideation were the annual personal income ￥≤2,200（OR=3.14; 95% CI:2.15-4.59）, having a major depression disorder （OR=17.04; 95% CI:11.91-24.39）, suffering from chronic diseases（OR=2.99; 95% CI:1.84-4.85）and ADL status（OR=2.00; 95% CI:1.37-2.94）.

Table 1 Influencing factors for suicidal ideation

Variables	Crude OR（95% CI）	Adjust OR（95% CI）
Annual personal income (RMB)		
2,201 and above	1.00 (reference)	1.00 (reference)
0-2,200	4.44（3.26-6.04）†	3.14（2.15-4.59）†
MDD status		
No	1.00 (reference)	1.00 (reference)
Yes	19.53（14.19-26.88）†	17.04（11.91-24.39）†
History of chronic diseases		
No	1.00 (reference)	1.00 (reference)
Yes	4.93（3.25-7.60）†	2.99（1.84-4.85）†
ADL status		
Normal	1.00 (reference)	1.00 (reference)
Disabled	3.96（2.90-5.41）†	2.00（1.37-2.94）†
marital status		
Stable marriage	1.00 (reference)	1.00 (reference)
Unstable marriage	1.846（1.42-2.41）†	1.28（0.85-1.93）
Educational status		
Illiterate	1.00 (reference)	1.00 (reference)

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Primary school	0.59（0.45-0.78）‡	0.75（0.52-1.09）
Junior high school	0.37（0.20-0.67）‡	0.69（0.326-1.45）
Senior high school and/or above	0.55（0.19-1.61）	0.49（0.13-1.90）
Living alone		
No	1.00 (reference)	1.00 (reference)
Yes	2.50（1.80-3.45）†	1.36（0.84-2.20）
Stressful life events		
No	1.00 (reference)	1.00 (reference)
Yes	2.02(1.25-3.25)†	0.84(0.48-1.48)

*Adjusted for sex, age, drinking, social supports, as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

The interaction of risk factors （annual personal income, MDD, ADL and chronic di seases）with suicidal ideation

In this study, the multivariate non-conditional logistic regression was used to calculate the regression coefficients and covariance matrix after adjustment. The adjusted factors include all the factors mentioned above except for the two factors that would examine the interaction between them. Microsoft Excel was used to calculate RERI, AP, S and their confidence intervals based on the results from the logistic regression. Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18（95% CI:5.47-36.89）, AP of 0.63 (95% CI:0.39-0.88) , and S of 2.84 (95 CI%:1.40-5.85). Additive interactions were detected between MDD and annual personal income with RERI of 35.00（95% CI:9.00-61.00）, AP of 0.66 (95% CI:0.46-0.85) , and S of 3.03 (95 CI%:1.68-5.47) (Table 2).

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Table 2 Interaction of risk factor on suicidal ideation

Factor1	Factor 2	OR *	RERI	AP	S
MDD status	ADL status		21.18 (5.47-36.89)	0.63 (0.39-0.88)	2.84 (1.40-5.85)
+	+	33.55 (20.05-56.14)†			
-	+	1.73 (1.12-2.69)‡			
+	-	11.64 (5.76-23.52)†			
-	-	1.00			
MDD status	Annual personal income		35.00 (9.00-61.00)	0.66 (0.46-0.85)	3.03 (1.68-5.47)
+	+	53.25 (30.27-93.66) †			
-	+	3.05 (1.92-4.85) †			
+	-	16.20 (8.66-30.30) †			
-	-	1.00			

*Adjusted for sex, age, marital status, education background, history of chronic disease, living status, drinking， stressful life events ,social supports ,as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

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DISCUSSION

For this study, we used multi-staged cluster sampling, with the selected sample in Hengyang and Liuyang representing the situation of suicidal ideation among the elderly in rural communities of Hunan. We complied with severe quality controlled to maintain the verity of the data. There is low non-response rate (7.4%) but high data efficient rate (99.5%). We used a cross-sectional study with unavoidable recall bias because suicidal ideation is innately according to the memory of subjects and can be influenced by recent events. However, we believe the effect of recall bias could be ignored since it exists in both the suicidal ideation group and non-suicidal ideation group.

The incidence of suicidal ideation among the elderly is 14.5% in rural communities of Hunan and fell to 14.1% after standardization . The incidence of suicidal ideation in rural communities is higher than that of other districts in Hunan.[26-28] We didn't detect hazardous and harmful drinking, stressful life events and social supports as the independent risk of suicidal ideation, but some studies [29-30] discovered the opposite conclusion. This perhaps because different districts have different cultures and features, and the design method and scales existed disparity.

An annual personal income of ￥≤2,200 is an independent risk of suicidal ideation. The incidence of suicidal ideation among people with an annual personal income of ≤￥2,200 is 3.14 times higher than those with annual personal incomes of ＞￥2,200. One reason is that people with low incomes may have more family conflicts and diseases and may not be treated in time. Some studies have also demonstrated that people with lower incomes have greater fear than those high-income groups. Activities of daily living is also an independent risk of suicidal ideation; the incidence of suicidal ideation among people with disabled activities of daily living is 2.00 times greater than those with normal activities of daily living. The study from Awata S also demonstrated the same result.[31]

MDD being an independent risk of suicidal ideation has been accepted previously[32-33]. We discovered, though, that MDD is not only an independent risk of suicidal ideation but also has additive interactions between annual personal income and ADL. The incidence of suicidal ideation among people with MDD is 17.04 times greater than those without it. This means that some people who are MDD have low annual personal income and disabled ADL would have

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higher rates of suicidal ideation; therefore we should give more attention to these people.

To the best of our knowledge, this is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. In this population-based, large-scale, the high rate of follow-up and multistage with highly standardized methods, these findings are likely to be generalizable to elderly-aged Chinese. We provide some advice for suicide prevention among the elderly in rural communities: first, owing to the high incidence of suicidal ideation among rural community elderly individuals , our government should give more attention to suicidal ideation among them; second, to reduce the rate of suicidal ideation and strengthen suicide prevention, we should strengthen MDD screening and pay close attention to people whose income are low and ADL is disabled. This can not only reduce the rate of suicidal ideation, but also reduce the rate of suicidal ideation caused by the interaction of risk factors. While the study is limited by its cross-sectional design, therefore causation cannot be inferred. Moreover we cannot reject the bias for the self-reported design,thus further studies are needed to confirm the findings.

CONCLUSION

The incidence of suicidal ideation among the rural elderly in China is high. And the independent risk factors of suicidal ideation are annual personal income（≤￥2,200）, MDD, chronic diseases and disabled activity of daily living. MDD has additive interactions with ADL and annual personal income. These findings have significant implications for the prediction and prevention of suicidal behaviors.

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Contributors All the authors made substantial contribution to this study in the whole process. This work was charged by Huilan Xu, Shuiyuan Xiao, Liang Zhou, and Dan Luo. All the authors took part in the conception and design, Huilan Xu, Lulu Qin and Jinhong Wang mainly analyzed, interpretated the data and draft this article.

Competing interests None declared.

Ethics approval: The study was approved by the medical ethics committee of the clinical pharmacology institute at Central South University.

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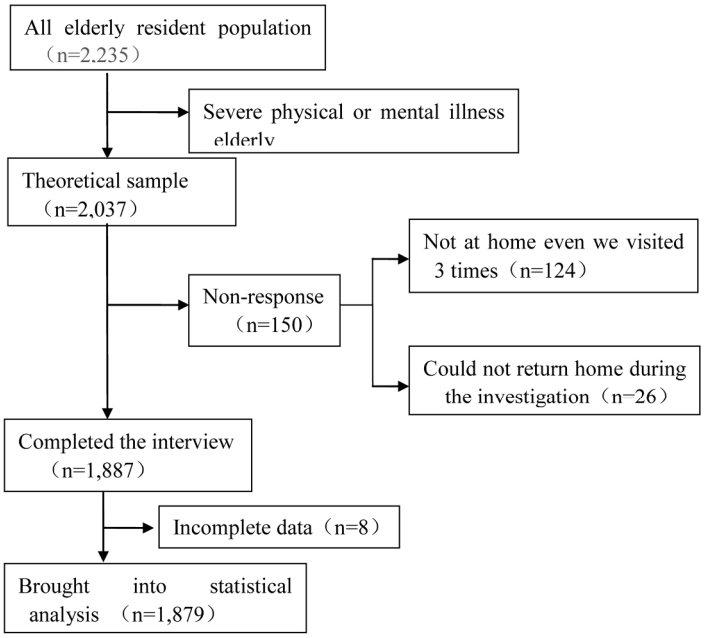
Figure 1 Response of subjects



209x296mm (300 x 300 DPI)

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7
Bias	9	Describe any efforts to address potential sources of bias	5

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Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5,6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	No.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	YES. See it in the last page.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	8,9,10,11
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8,9
		(*b*) Report category boundaries when continuous variables were categorized	7

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		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	9
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	10
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12,13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

Huilan Xu[1], Lulu Qin[1], Jinhong Wang[1], Liang Zhou[1], Dan Luo[1], Mi Hu[1], Zhenhua Li[1], Shuiyuan Xiao[1]

1 Department of Social Medicine and Health Management, School of Public Health, Central South University, Changsha, Hunan 410078, China;

Correspondence author: Huilan Xu, E-Mail: huilanxu1963@sina.com

Tel./Fax: +86-0731-8484-5454.

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Abstract

Objectives: To report risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan and to provide some scientific basis for suicide prevention.

Design, setting and participants:A cross-sectional survey was conducted among the elderly in rural communities in China's Hunan province. 13 areas were selected by multi-staged cluster random sampling and 1,887 rural elders were investigated via face-to-face interviews.

Main outcome measures: Participants were asked general information(including name, sex, age, marital status, education status, annual personal income, chronic disease and living alone or not), suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The non-conditional logistic regression was preformed to explore the influencing factors for suicidal ideation, and the additive interaction was used to analyze the interaction between risk factors.

Results: Incidence of suicidal ideation among the elderly was 14.5%(95% CI:12.9%-16.1%)in rural communities of Hunan. The independent influencing factors of suicidal ideation were annual personal income (OR=3.14; 95% CI:2.15-4.59), MDD (OR=17.04; 95% CI:11.91-24.39), chronic diseases (OR=2.99; 95% CI:1.84-4.85) and ADL(OR=2.00; 95% CI:1.37-2.94). Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18(95% CI:5.47-36.89), and between MDD and annual personal income with a RERI of 35.00(95% CI:9.00-61.00).

Conclusions: The independent risk factors of suicidal ideation are annual personal income(≤￥2,200), MDD, chronic diseases and disabled activities of daily living. MDD has additive interactions with ADL and annual personal income. These findings have significant implications for the prediction and prevention of suicidal behaviors.

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Strengths and limitations of this study

This is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. In this population-based, large-scale, the high rate of follow-up and multistage with highly standardized methods, these findings are helpful for prevention of suicide for the rural elderly Chinese.

The study provides valuable information on the rate of suicide ideation, the influencing factors and the interactions between these factors among the elderly in rural communities.

The additive interactions (the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index(S)) were used to analyze the interaction between risk factors and suicide ideation.

The study is limited by its cross-sectional and self-reported design.

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INTRODUCTION

Suicide has become a major public health and social problem.[1] It accounts for 3.6% of all deaths and is the fifth most common cause of death in China.[2] Statistical figures have shown that the suicide rate is about 22/100,000 per year in this country.[3] There is a specific action from suicidal ideation to ultimately death,[4] 60% of transitions from ideation to plan and attempt occur within the first year after ideation onset[5]. Suicide ideation is one of the most important risk factors for suicide[6] and an evaluation index recommended by the WHO.

Despite the worldwide attention has been paid to suicide recently, and most studies of suicidal behaviors have been conducted in Western and high-income countries,[7-9] the suicidal problems are also under studied in China. With the coming of the aging society in China, the prevalence of suicide among the elderly is pressing. The prevalence of suicide ideation among Chinese elders ranged from 2.2% to 21.5%, which was relatively high, and the rate of suicide among the rural elderly was higher compared with urban areas and other age groups.[10] Thus, more attention to the prevalence of suicide among the rural elderly should be paid.

Suicide ideation is the key period of suicide intervention,which was considered as the most effective measure to prevent suicide.[4,10] Studies showed that there were many influence factors of suicide ideation among the elderly such as gender, disease, economic status, physical health, activities of daily living, mental health and so on,[9-11] and those factors could be categorized into three groups: psychosocia, social-environmental and socio-demographic.[11] There may be interrelationships between them. Studies have showed that activities of daily living had a strong association with depression disorder.[12] Factors such as negative life events, low social support, weak physical constitution, low income, and with chronic diseases were both the risk factors of depression and suicide ideation among the elderly.[11,13]Capron DM et al. Found that AS(anxity sensitivity, AS) physical scores had an interaction with AS cognitive scores.[14] The interaction of risk factors are useful and effective for prevention suicide ideation. But only few studies focused on their interactions. There is a lack of research on risk factors and their interactions with suicide ideation.among rural elderly Chinese.

This study was executed in Hunan, a typical south central province in China. The geographical position of Hunan is from 24° 38` to 30° 08`N in latitude and from 108° 47` to

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114° 15` E in longitude. Until 2011, there were 7. 14 billion people in Hunan, China totally. The elderly aged 65 years and above accounted for 9.99%, and the proption would increase year by year. The GDP(gross domestic product, GDP) of Hunan was the 10th in China in 2011 with a average GDP of 29,800REM per person, which was a medium level in China. A study showed that the average suicide rate among the elderly in rural areas (88.3/100thousands) was four times that of the urban areas(24.4/100thousands),[15] and recent studies have showed that the prevalence of suicide ideation among the elderly was from 8.7% to 21.5% in rural areas in Hunan, China,[16] and suicide is becoming an important public health problem in the rural elderly in Hunan, China. Therefore we carried this study to investigate risk factors and their additive interactions with suicidal ideation among the elderly in rural communities of Hunan. Besides, we hope this study can provide some scientific basis for suicide prevention for rural elderly in Chinese.

METHODS

Sample size calculation

Sample size calculation was done by using the formula for cross-sectional studies with count data: α=0.05 , n= 400×(1-P)/P(P was the prevalence of a disease). A suicide ideation prevalence of 21.5% was used according to a previous article.[16] The theory sample was 1,753 after increasing 20% observed subjects taken account of lost during investigation.

Participants

A cross-sectional survey was conducted among the elderly in rural communities of Hunan province of China. By multi-staged cluster sampling, 2 counties (Hengyang and Liuyang) were randomly selected from 72 counties in Hunan province. Next, 3 townships (Yanshan , Qulou and Qulan) were randomly selected from 26 townships in Hengyang and 3 villages were respectively chosen from the selected townships. Concurrently, 2 townships(Gaoping and Yongan)were randomly selected from 24 townships in Liuyang and 2 villages were respectively chosen from the selected townships and two teams were randomly selected from each village. In total , 13 areas were selected for our study. The elderly (age ≥ 60 years) resident population (who had achieved registered permanent residence or not achieved registered permanent residence but have resided for six months) were identified as our subjects but those who had severe physical or

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mental illness were excluded. There were 2,235 elderly residents in the 13 selected areas, among which 198 individuals were excluded for severe physical or mental illness. The theoretical sample size was 2,037 people, with 150 not investigated for various reasons (Fig. 1). The response rate was 92.6%(1,887/2,037). Among the remaining 1,887 individuals, 8 were excluded for incomplete data. In total, 1,879 elderly were brought into statistical analysis and the efficient was 99.6%(1,879/1,887). Our pre-trained interviewers went to the elderly subject's home to introduce the aim, plan, interest and the right of participant in this study carefully. Then they interviewed participants face to face after each participant gave written, informed consent to them. If the participants were illiteracy, the written consent was signed by their family members. All procedures were performed in accordance with ethical standards. If the individual was not at home, we would ask and record the reason. Each day, our interviewers were required to check their questionnaires seriously, and the survey was carried out from 2009 to 2011.

Measures

Participants were asked general information, suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The components of the questionnaire relevant to this study are detailed below.

General information

Name, sex, age, marital status, education status, annual personal income, chronic disease and whether the subject lived alone or not were measured by a self-designed inventory. Chronic diseases, referring to chronic non-communicable diseases, include cardiovascular disease (CVD), some cancers, chronic obstructive pulmonary disease (COPD), and type 2 diabetes and others (namely, diseases according to classification standards included in the ICD-10). And living alone was defined as a social situation where a person lives in a dwelling without a cohabitant, children or other household members.

Suicidal ideation

According to the concept and classification of suicidal behavior,[17] suicidal ideation means one has the thought of suicide or want to take action to end one's own life. We developed a self-made suicidal behavior questionnaire which contained four items: suicidal ideation (Have you ever seriously considered suicide in the last 12 months?), suicidal plan (Have you ever made

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a plan for committing suicide in the last 12 months?), suicidal preparation (Have you ever prepare any tool to kill yourself in the last 12 months?), and attempted suicide (Have you ever attempted to suicide?). The response options were yes and no.

Activities of daily living (ADL)

ADL of the elderly was measured by Lawton and Brody's activities of daily living scale, which includes 14 items.[18] It consists of a physical self-maintenance scale (PSMS)and an instrumental activities of daily living scale(IADL). Each item was scored from 1 to 4. And the total score higher than 14 was defined as disabled; otherwise the individual was considered normal.

Major depression disorder (MDD)

MDD was measured by the Chinese version of the patient health questionnaire-9 (PHQ-9) whose reliability and validity are high.[19-20] PHQ-9 is constituted of two parts. The first part consists of 9 items for assessing the frequency of depression symptoms; each item was scored from "0" (not at all) to "3" (nearly every day). The second part contained an additional Item: "How difficult it was for you to do your work, take care of things at home, or get along with other people?" It was also scored from "0" (not difficult at all) to "3" (extremely difficult). Diagnosis of MDD had to simultaneously satisfy three of the following requirements: 1) at least five items with scores ≥ 2 in the first part (including if the ninth item scored ≥ 1); 2) at least one of the first or second items with a score ≥ 2; and 3) the second part with scores ≥2.[21]

Drinking

AUDIT developed by the World Health Organization (WHO) was considered as a simple method of screening for excessive drinking. This 10 items scale's reliability and validity have been established in research conducted in a variety of settings and in many different nations.[22] For Chinese, the AUDIT scores with 7 was defined as dividing line, above which was regarded as hazardous and harmful drinking.

Stressful life events

Refering to the formerly scales,[23-24] we listed 38 life events and summarized them into three aspects: health related problems, marital and family life related problems, social and other problems. If any events occurred in the last year and the subjects felt stressful, we defined the

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subject suffered from the stressful life events.

Social supports

The Social Support Rating scale (Xiao S, 1999)[25] had been proved high reliability and validity in China. The scale included three parts: objective support, subjective support and availability of social support. If one's social support score was lower than the mean，we defined the person as bad social support, otherwise the individual was considered in a well social support.

Statistical analysis

Data was created and analyzed by using SPSS statistical software 16.0. Significance threshold of group differences were set at $P < 0.05$ (bilateral) .There were six age categories (60-64, 65-69, 70-74, 75-79, 80-84, 85 and above), two annual personal income categories(0-2,200, 2,201 and above), four education status categories (illiterate, primary school, junior high school, senior high school and/or above),and two marital status categories (stable marriage, unstable marriage). Stable marriage includes complete marriage, while unstable marriage consists of widowed, unmarried and divorce. The univariate and multivariate non-conditional logistic regression were used to explore the influencing factors for suicidal ideation. In order to examine the relationships between risk factors and suicidal ideation, odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by using univariate and multivariate non-conditional logistic regression. There are three measures of additive interaction: the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index（S）. There is no additive interaction if RERI and AP are equal to 0 or S is equal to 1. We inputted the regression coefficients and covariance matrix drawn from the logistic regression into the Excel sheet made by Andersson so as to calculate the interaction of risk factors（annual personal income, chronic disease，MDD, ADL）and their confidence intervals.[26]

RESULTS

A total of individuals1,879 aged from 60 to 97 years old were included in this study. The participants were with a median age of 69 years old, and 891 (47.4%) of them were female.

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According to the poverty line(≦2,200 RMB/year) in rural areas in Hunan, 953(50.7%) of them was with low income. 1, 331 (70.8%) had stable marriages. There were four education levels: 650 (34.6%) were illiterate, 1,034(70.8%) finished primary school, 161 (8.6%) finished junior high school, and 34（1.8%）finished senior high school and/or above. 232 (12.3%) elderly subjects were living alone, 236（12.6%）had MDD, 1,316 (70.0%) had chronic diseases, 1,019 (54.2%) had disabilities in their activities of daily living, 177（9.4%）were suffered from hazardous and harmful drinking, 1637（87.1%）experienced negative life events in the last year. The social support scores were from 17 to 61 with the mean of 40, 997(53.1%) were with bad social support. (Table 1)

Table 1 The demographic characteristics of the sample

Variables	n	%
Age		
60-69	993	52.8
70-79	681	36.2
≧80	205	11.0
Gender		
Male	988	52.6
Female	891	47.4
Annual personal income (RMB)		
2,201 and above	926	49.3
0-2,200	953	50.7
MDD status		
No	1,643	87.4
Yes	236	12.6
History of chronic diseases		
No	563	30.0
Yes	1,316	70.0
ADL status		
Normal	860	45.8

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Disabled	1,019	54.2
marital status	548	29.2
Stable marriage	1, 331	70.8
Unstable marriage		
Educational status		
Illiterate	650	34.6
Primary school	1,034	70.8
Junior high school	161	8.6
Senior high school and/or above	34	1.8
Living alone		
No	1,647	87.7
Yes	232	12.3
Stressful life events		
No	242	12.9
Yes	1,637	87.1
Hazardous and harmful drinking		
No	1,702	90.6
Yes	177	9.4
Social support scores		
Well (>40)	882	46.9
Bad (≦40)	997	53.1

The Incidence of Suicide Ideation

The incidence of suicidal ideation was 14.5%（95% CI:12.9%-16.1%）;and the data from the Chinese census in 2000 shows that it dropped to 14.1% after standardization . The incidence of suicidal plan, suicidal preparation and attempted suicide respectively were 4.0%, 1.9% and 0.8%. 27.6% (75/272) suicidal ideation elders made the suicidal plan, 12.9% (35/272) prepared suicide and 5.6% (15/272) end in attempted suicide.

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The Influencing Factors for Suicidal Ideation

There were no statistical significance in sex, age, drinking and social supports between the suicidal ideation group and controlled group. (All significant at P＞0.05).As was indicated in Table 2, the univariate non-conditional logistic regression revealed that the influencing factors for suicidal ideation among the elderly were having a major depression disorder （OR=19.53; 95% CI: 14.19-26.88）, suffering from chronic diseases （OR=4.93; 95% CI: 3.25-7.60）, activities of daily living（OR=3.96; 95% CI: 2.90-5.41）, annual personal income（OR=4.44; 95% CI: 3.26-6.04）, unstable marriage (OR=1.846; 95% CI:1.42-2.41）,finishing primary school(OR=0.59;95% CI:0.45-0.78) and junior high school (OR=0.37; 95% CI:0.20-0.67）, Living alone(OR=2.50;95% CI:1.80-3.45）and suffering from negative life events in the last year(OR=2.02; 95% CI:1.25-3.25). Controlling for sex, age, marital status, education background, annual personal income, history of chronic disease, living status, history of a major depression disorder, activities of daily living , drinking，stressful life events and social supports ,the multivariate non-conditional logistic regression analysis showed that the independent risk factors of suicidal ideation were the annual personal income ￥≤2,200 （OR=3.14; 95% CI:2.15-4.59）, having a major depression disorder （OR=17.04; 95% CI:11.91-24.39）, suffering from chronic diseases（OR=2.99; 95% CI:1.84-4.85）and ADL status （OR=2.00; 95% CI:1.37-2.94）.

Table 2 Influencing factors for suicidal ideation

Variables	Participants (n)	Prevelance of SI(%)	Crude OR （95% CI）	Adjust OR （95% CI）
Annual personal income (RMB)				
2,201 and above	926	6.2	1.00 (reference)	1.00 (reference)
0-2,200	953	22.6	4.44（3.26-6.04）†	3.14（2.15-4.59）†
MDD status				
No	1,643	7.7	1.00 (reference)	1.00 (reference)
Yes	236	61.9	19.53（14.19-26.88）†	17.04（11.91-24.39）†

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History of chronic diseases				
No	563	10.7	1.00 (reference)	1.00 (reference)
Yes	1,316	15.9	4.93（3.25-7.60）†	2.99（1.84-4.85）†
ADL status				
Normal	860	6.4	1.00 (reference)	1.00 (reference)
Disabled	1,019	21.3	3.96（2.90-5.41）†	2.00（1.37-2.94）†
marital status				
Stable marriage	1,331	12.1	1.00 (reference)	1.00 (reference)
Unstable marriage	548	20.3	1.846（1.42-2.41）†	1.28（0.85-1.93）
Educational status				
Illiterate	650	19.4	1.00 (reference)	1.00 (reference)
Primary school	1,034	12.5	0.59（0.45-0.78）‡	0.75（0.52-1.09）
Junior high school	161	8.1	0.37（0.20-0.67）‡	0.69（0.326-1.45）
Senior high school and/or above	34	11.8	0.55（0.19-1.61）	0.49（0.13-1.90）
Living alone				
No	1,647	14.1	1.00 (reference)	1.00 (reference)
Yes	232	17.2	2.50（1.80-3.45）†	1.36（0.84-2.20）
Stressful life events				
No	242	8.3	1.00 (reference)	1.00 (reference)
Yes	1,637	15.4	2.02(1.25-3.25)†	0.84(0.48-1.48)

*Adjusted for sex, age, drinking, social supports, as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

The interaction of risk factors （annual personal income, MDD, ADL and chronic di seases）with suicidal ideation

In this study, the multivariate non-conditional logistic regression was used to calculate the

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regression coefficients and covariance matrix after adjustment. The adjusted factors include all the factors mentioned above except for the two factors that would examine the interaction between them. Microsoft Excel was used to calculate RERI, AP, S and their confidence intervals based on the results from the logistic regression. Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18（95% CI:5.47-36.89）, AP of 0.63 (95% CI:0.39-0.88) , and S of 2.84 (95 CI%:1.40-5.85). Additive interactions were detected between MDD and annual personal income with RERI of 35.00（95% CI:9.00-61.00）, AP of 0.66 (95% CI:0.46-0.85) , and S of 3.03 (95 CI%:1.68-5.47) (Table 3).

Table 3 Interaction of risk factor on suicidal ideation

Factor1	Factor 2	OR *	RERI	AP	S
MDD status	ADL status		21.18 (5.47-36.89)	0.63 (0.39-0.88)	2.84 (1.40-5.85)
+	+	33.55 (20.05-56.14)†			
-	+	1.73 (1.12-2.69)‡			
+	-	11.64 (5.76-23.52)†			
-	-	1.00			
MDD status	Annual personal income		35.00 (9.00-61.00）	0.66 (0.46-0.85）	3.03 (1.68-5.47）
+	+	53.25 (30.27-93.66）†			
-	+	3.05 (1.92-4.85）†			
+	-	16.20			

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			(8.66-30.30) †
-		-	1.00

*Adjusted for sex, age, marital status, education background, history of chronic disease, living status, drinking， stressful life events ,social supports ,as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

DISCUSSION

For this study, we used multi-staged cluster sampling, with the selected sample in Hengyang and Liuyang representing the situation of suicidal ideation among the elderly in rural communities of Hunan, China. We complied with severe quality controlled to maintain the verity of the data. There is low non-response rate (7.4%) but high data efficient rate (99.5%). We used a cross-sectional study with unavoidable recall bias because suicidal ideation is innately according to the memory of subjects and can be influenced by recent events.

The incidence of suicidal ideation among the elderly is 14.5% in rural communities of Hunan and fell to 14.1% after standardization. Kjoller M et al. reported a prevelance of 6.9% of adults had suicidal thoughts within the past years in Denmark,[27] Goldney RD et al. found that 5.6% of men and 5.3% of women had suicide ideation in south Australia,[28] Henry C et al.the prevalence of the suicide ideation in elderly people varies from 1.2% to 17%.[29] Compared to previous studies, we conclude that the incidence of suicidal ideation among the elderly in rural communities is high.We didn't detect hazardous and harmful drinking, stressful life events and social supports as the independent risk of suicidal ideation, but some studies [30-31] discovered the opposite conclusion perhaps because different districts have different cultures and features, and the design method and scales existed disparity.

Low annual personal income is an independent risk of suicidal ideation, which is in agreement with previous study.[32] In this study, people with an annual personal income of ≤ 2,200 are likely to have suicidal ideation than those with annual personal incomes of >2,200(adjOR=3.14; 95% CI:2.15-4.59). One reason is that people with low incomes may have more family conflicts and diseases and may not be treated in time. And study also has demonstrated that people with lower

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incomes have greater fear than those high-income groups.[33] Activities of daily living is also an independent risk of suicidal ideation; People with disabled activities of daily living have a higher risk of developing suicidal ideation than those with normal activities of daily living(adjOR=2.00; 95% CI:1.37-2.94). The study from Awata S also demonstrated the same result.[34]Dennis M et al. showed that the strength of association between suicide ideation and activities of daily living limitation increased with the number of domains of activities of daily living affected and was of similar magnitude for most individual domains.[35]

MDD being an independent risk of suicidal ideation has been accepted previously.[36-37] People with MDD had a higher risk of developing suicidal ideation than those without it(adjOR=17.04; 95% CI:11.91-24.39). We discovered that MDD is not only an independent risk of suicidal ideation but also has additive interactions between annual personal income and ADL. This means that some people who are MDD and have low annual personal income and disabled ADL would have higher rates of suicidal ideation; therefore we should pay more attention to these people. Ormel J et al.[12]showed that there were three kinds of the association between ADL and depression: (a) a strong contemporaneous effect of change in ADL on depressive symptoms; (b) a weaker lagged effect of change in depressive symptoms on ADL; and (c) a weak correlation between the trait (or stable) components of depression and ADL. This may be reason of the interaction between MDD and ADL. Depression is more commonly seen in people with economically disadvantaged.[38] On one hand, people with low income would consider themselves to be a burden of family, friends or society, which will aggravate the depression to some extent.[16] On the other hand, depression patients` treatment would be delayed for the reason of low income. This may explain the interaction between MDD and annual personal income in some way. So it may be a feasible way to prevent suicide behaviors by screening depression and paying more attention to the elderly with low annual personal income and disabled ADL among the elderly.

To the best of our knowledge, this is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. In this population-based, large-scale, the high rate of follow-up and multistage with highly standardized methods, these findings are helpful for prevention of suicide for the rural elderly-aged Chinese. We provide some advice for suicide prevention among the elderly in rural communities: first,

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owing to the high incidence of suicidal ideation among elderly individuals of rural communities , our government should pay more attention to suicidal ideation among them; second, to reduce the rate of suicidal ideation and strengthen suicide prevention, we should strengthen MDD screening and pay close attention to people whose income are low and ADL is disabled. This can not only reduce the rate of suicidal ideation, but also reduce the rate of suicidal ideation caused by the interaction of risk factors. Since the study is limited by its cross-sectional design, the causation cannot be inferred. Moreover suicidal ideation is a complex psychological phenomenon, there may be a limitation in measurement accuracy or classification for using a single simple question to capture suicidal ideation. And we cannot reject the bias for the self-reported design,thus further studies are needed to confirm the findings.

CONCLUSION

The incidence of suicidal ideation among the rural elderly in China is high. And the independent risk factors of suicidal ideation are annual personal income（≤￥2,200）, MDD, chronic diseases and disabled activity of daily living. MDD has additive interactions with ADL and annual personal income. These findings above have significant implications for the prediction and prevention of suicidal behaviors.

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Competing interests None declared.

Ethics approval: The study was approved by the medical ethics committee of the clinical pharmacology institute at Central South University.

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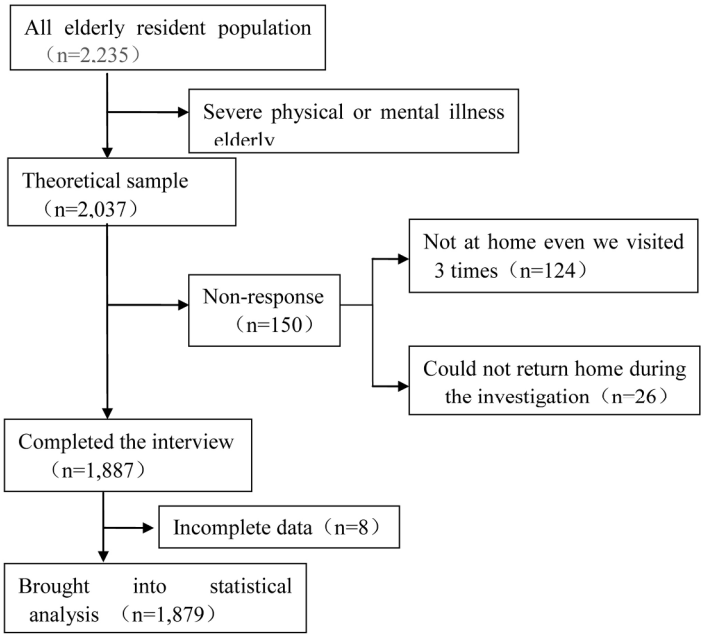
Figure 1 Response of subjects



209x296mm (300 x 300 DPI)

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5,6,7,8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7,8
Bias	9	Describe any efforts to address potential sources of bias	6

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Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7,8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	No.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	YES. See it in the last page.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9,10
		(b) Indicate number of participants with missing data for each variable of interest	9,10
Outcome data	15*	Report numbers of outcome events or summary measures	9,10,11,12,13,14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12

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		(*b*) Report category boundaries when continuous variables were categorized	9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13,14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14,15,16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

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Secondary Subject Heading:	Public health
Keywords:	suicide ideation, risk factors, interactions, elderly

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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

Huilan Xu[1], Lulu Qin[1], Jinhong Wang[1], Liang Zhou[1], Dan Luo[1], Mi Hu[1], Zhenhua Li[1], Shuiyuan Xiao[1]

1 Department of Social Medicine and Health Management, School of Public Health, Central South University, Changsha, Hunan 410078, China;

Correspondence author: Huilan Xu, E-Mail: huilanxu1963@sina.com

Tel./Fax: +86-0731-8484-5454.

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Abstract

Objectives: To report risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan and to provide some scientific basis for suicide prevention.

Design, setting and participants:A cross-sectional survey was conducted among the elderly in rural communities in China's Hunan province. 13 areas were selected by multi-staged cluster random sampling and 1,887 rural elders were investigated via face-to-face interviews.

Main outcome measures: Participants were asked general information(including name, sex, age, marital status, education status, annual personal income, chronic disease and living alone or not), suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The non-conditional logistic regression was preformed to explore the influencing factors for suicidal ideation, and the additive interaction was used to analyze the interaction between risk factors.

Results: Incidence of suicidal ideation among the elderly was 14.5%(95% CI:12.9%-16.1%)in rural communities of Hunan. The independent influencing factors of suicidal ideation were annual personal income (OR=3.14; 95% CI:2.15-4.59), MDD (OR=17.04; 95% CI:11.91-24.39), chronic diseases (OR=2.99; 95% CI:1.84-4.85) and ADL(OR=2.00; 95% CI:1.37-2.94). Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18(95% CI:5.47-36.89), and between MDD and annual personal income with a RERI of 35.00(95% CI:9.00-61.00).

Conclusions: The independent risk factors of suicidal ideation are annual personal income(≤2,200CNY), MDD, chronic diseases and disabled activities of daily living. MDD has additive interactions with ADL and annual personal income. These findings have significant implications for the prediction and prevention of suicidal behaviors.

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Strengths and limitations of this study

This is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. With this population-based, large-scale, high rate of follow-up and highly standardized methods, these findings are helpful for prevention of suicide for the rural elderly Chinese.

The study provides valuable information on the rate of suicide ideation, the influencing factors and the interactions between these factors among the elderly in rural communities.

The additive interactions (the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index(S)) are used to analyze the interaction between risk factors and suicide ideation.

The study is limited by its cross-sectional and self-reported design.

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INTRODUCTION

Suicide has become a major public health and social problem.[1] It accounts for 3.6% of all deaths and is the fifth most common cause of death in China,[2] besides, statistical figures have shown that the suicide rate is about 22/100,000 per year in our country.[3] There is a specific action from suicidal ideation to ultimately death,[4] and 60% of transitions from ideation to plan and attempt occur within the first year after ideation onset[5]. Suicide ideation is one of the most important risk factors for suicide[6] and also an evaluation index recommended by the World Health Organization.

Under the circumstance of the worldwide attention's having been paid to suicide recently, and many studies on suicidal behaviors' having been conducted in Western and high-income countries,[7-9] studies on suicidal problems have also been worked on in China. With the aging of population in China, the prevalence of suicide among the elderly is severe and its rate ranging from 2.2% to 21.5%, are relatively higher than those in urban areas or other age groups.[10] Thus, more attention to the prevalence of suicide among the rural elderly should be paid.

Intervening suicide ideation is the key process of suicide intervention, which was also considered as the most effective measure to prevent suicide.[4,10] Studies have showed that there are many factors influencing suicide ideation among the elderly, such as gender, disease, economic status, physical health, activities of daily living, mental health and so on,[9-11] and they can be categorized into three groups: psychosocia, social-environmental and socio-demographic,[11] which may also have connections with each other.. Studies have also showed that activities of daily living had a strong association with depression disorder.[12] Moreover, factors such as negative life events, low social support, weak physical constitution, low income, and chronic diseases are both the risk factors of depression and suicide ideation among the elderly.[11,13]Capron DM et al. found that AS(anxeity sensitivity, AS) physical scores had an interaction with AS cognitive scores.[14] The interactions of risk factors are useful and effective for preventing suicide ideation. However, there are only a few studies focusing on the interactions and a lack of research on risk factors and their interactions with suicide ideation.among the rural elderly Chinese.

This study was executed in Hunan, a typical south central province in China. The

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geographical position of Hunan is from 24° 38' to 30° 08' N in latitude and from 108° 47' to 114° 15' E in longitude. Besides, the total population of Hunan is 71 million. and 9.99 percent of them is aged 65 or older, and the proportion of elderly people would rise year by year. Moreover, the GDP(gross domestic product, GDP) of Hunan ranked the tenth in China in 2011 with GDP reaching 29,880 CNY per person, and a medium level in the country. A study has showed that the average suicide rate of the elderly in rural areas (88.3/100thousands) was four times higher than that of those in urban areas(24.4/100thousands),[15] in addition, recent studies have also showed that the prevalence of suicide ideation among the elderly range from 8.7% to 21.5% in rural areas in Hunan, China,[16] from which we can conclude that suicide is becoming an important public health problem among the rural elderly of Hunan. Therefore we carried out this study to investigate risk factors and their additive interactions with suicidal ideation among the elderly in rural communities of Hunan. Additionally, we hope this study can provide some scientific basis for suicide prevention for rural elderly in Chinese.

METHODS

Sample size calculation

In order to address the suicide ideation among the rural elderly, sample size calculation was done by estimating an incidence rate with specified relative precision for cross-sectional studies according World Health Organization recommended tools: a sample of 1,537 would be needed when α=0.05 and ε=0.05.[16] The theoretical sample was 1,844 after increasing the number of observed subjects by 20%,which took account of the lost subjects during investigation.

Participants

A cross-sectional survey was conducted among the elderly in rural communities of Hunan province of China. By multi-staged cluster sampling, 2 counties (Hengyang and Liuyang) were randomly selected from 72 counties in Hunan province. Next, 3 townships (Yanshan，Qulou and Qulan) were randomly selected from 26 townships in Hengyang and 3 villages were respectively chosen from the selected townships. Concurrently, 2 townships(Gaoping and Yongan)were randomly selected from 24 townships in Liuyang and 2 villages were respectively chosen from the selected townships and two teams were randomly selected from each village. In total，13

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areas were selected for our study. The elderly (age ≥ 60 years) resident population (who had achieved registered permanent residence or not achieved registered permanent residence but have resided for six months) were identified as our subjects but those who had severe physical or mental illness were excluded. There were 2,235 elderly residents in the 13 selected areas, among which 198 individuals were excluded for severe physical or mental illness. The theoretical sample size was 2,037 people, with 150 not investigated for various reasons (Fig. 1). The response rate was 92.6%(1,887/2,037). Among the remaining 1,887 individuals, 8 were excluded for incomplete data. In total, 1,879 elderly were brought into statistical analysis and the efficient was 99.6%(1,879/1,887). Our pre-trained interviewers went to the elderly subject's home to introduce the aim, plan, interest and the right of participant in this study carefully. Then they interviewed participants face to face after each participant's being given written, informed consent. If the participants were illiterate, the written consent was signed by their family members. The elderly have the right to decline to participate in the study without any disadvantage, and they can drop out if they have the desire at any time during the whole investigation. Consequently, all procedures were performed in accordance with ethical standards. If the individual was not at home, we would record the reason. And our interviewers were required to check their questionnaires seriously everyday. The survey was carried out from 2009 to 2011.

Measures

Participants were asked general information, suicidal ideation, activities of daily living (ADL), major depression disorder (MDD),drinking, stressful life events and social supports. The components of the questionnaire relevant to this study are detailed below.

General information

Name, sex, age, marital status, education status, annual personal income, chronic disease and whether the subject lived alone or not were measured by a self-designed inventory. Chronic diseases, referring to chronic non-communicable diseases, include cardiovascular disease (CVD), some cancers, chronic obstructive pulmonary disease (COPD), and type 2 diabetes and others (namely, diseases according to classification standards included in the ICD-10). And living alone was defined as a social situation where a person lives in a dwelling without a cohabitant, children

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or other household members.According to the international poverty line standard(take the median income or 50% of the average income as the poverty line in a country or region), the poverty line of rural areas in Hunan, China was 2,200 CNY/year per person in 2011, so we defined the low income people as those with income lower than 2,200 CNY/year per person.

Suicidal ideation

According to the concept and classification of suicidal behavior,[17] we can conclude that suicidal ideation means the thought of suicide or wanting to take actions to end one's own life. We developed a self-made suicidal behavior questionnaire which contained four items: suicidal ideation (Have you ever seriously considered suicide in the last 12 months?), suicidal plan (Have you ever made a plan for committing suicide in the last 12 months?), suicidal preparation (Have you ever prepared any tool to kill yourself in the last 12 months?), and attempted suicide (Have you ever attempted to suicide?). The response options were yes and no.

Activities of daily living (ADL)

ADL of the elderly was measured by Lawton and Brody's activities of daily living scale, which includes 14 items.[18] It consists of a physical self-maintenance scale (PSMS)and an instrumental activities of daily living scale(IADL). Each item was scored from 1 to 4. And the total score higher than 14 was defined as disabled; otherwise the individual was considered normal.

Major depression disorder (MDD)

MDD was measured by the Chinese version of the patient health questionnaire-9 (PHQ-9) whose reliability and validity are high.[19-20] PHQ-9 is constituted of two parts. The first part consists of 9 items for assessing the frequency of depression symptoms; each item was scored from "0" (not at all) to "3" (nearly every day). The second part contained an additional Item: "How difficult it was for you to do your work, take care of things at home, or get along with other people?" It was also scored from "0" (not difficult at all) to "3" (extremely difficult). Diagnosis of MDD had to satisfy the following three requirements simultaneously: 1) at least five items with scores ≥ 2 in the first part (including if the ninth item scored ≥ 1); 2) at least one of the first or second items with a score ≥ 2; and 3) the second part with scores ≥2.[21]

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Drinking

AUDIT developed by the World Health Organization is considered as a convenient method of screening for excessive drinking. This contains 10 testing items whose reliability and validity have been established in research conducted in a variety of settings and many different nations.[22] In China, when an individual gets the AUDIT score which is more than 7, he/she will be regarded as hazardous and harmful drinking.

Stressful life events

Referring to the former scales,[23-24] we listed 38 life events and summarized them into three aspects: health related problems, marital and family life related problems, social and other problems. If any of the events occur to the subjects and they feel stressful, we will conclude that the subjects suffer from the stressful life events.

Social supports

The Social Support Rating scale (Xiao S, 1999)[25] has been proved high reliability and validity in China. The scale includes three parts: objective support, subjective support and availability of social support. If an individual's social support score is lower than the mean, we will define the person as bad social support, otherwise the individual will be considered in a good social support.

Statistical analysis

Data was created and analyzed by using SPSS statistical software 16.0. And significance threshold of group differences were set at $P < 0.05$ (bilateral). There were six age categories (60-64, 65-69, 70-74, 75-79, 80-84, 85 and above), two annual personal income categories(0-2,200, 2,201 and above), four education status categories (illiterate, primary school, junior high school, senior high school and/or above),and two marital status categories (stable marriage, unstable marriage). Stable marriage includes complete marriage, while unstable marriage consists of widowed, unmarried and divorce. The univariate and multivariate non-conditional logistic regression were used to explore the factors influencing suicidal ideation. And in order to examine the relationships between risk factors and suicidal ideation, odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by using univariate and multivariate non-conditional logistic regression. There are three measures of testing additive interaction: the

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relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index（S）. There is no additive interaction if RERI and AP are equal to 0 or S is equal to 1. We inputted the regression coefficients and covariance matrix drawn from the logistic regression into the Excel sheet made by Andersson, so as to calculate the interaction of risk factors（annual personal income, chronic disease, MDD, ADL）and their confidence intervals.[26]

RESULTS

A total of 1,879 individuals aged from 60 to 97 years old were included in the study. The participants were at a median age of 69 years old, and 891 (47.4%) of them were female. According to the poverty line(≦2,200 CNY) in rural areas in Hunan, 953(50.7%) of them with low income. 1, 331 (70.8%) had stable marriages. There were four education levels: 650 (34.6%) were illiterate, 1,034(70.8%) had finished primary school, 161 (8.6%) had finished junior high school, and 34(1.8%) had finished senior high school and/or above. And 232 (12.3%) elderly subjects were living alone, 236(12.6%)had MDD, 1,316 (70.0%) had chronic diseases, 1,019 (54.2%) had disabilities in their activities of daily living, 177(9.4%)were suffered from hazardous and harmful drinking, 1637(87.1%)experienced negative life events in the last year. The social support scores ranged from 17 to 61 with the mean of 40, 997(53.1%) were with bad social support. (Table 1)

Table 1 The demographic characteristics of the sample

Variables	n	%
Age		
60-69	993	52.8
70-79	681	36.2
≧80	205	11.0
Gender		
Male	988	52.6
Female	891	47.4
Annual personal income (CNY)		
2,201 and above	926	49.3

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0-2,200	953	50.7
MDD status		
No	1,643	87.4
Yes	236	12.6
History of chronic diseases		
No	563	30.0
Yes	1,316	70.0
ADL status		
Normal	860	45.8
Disabled	1,019	54.2
marital status	548	29.2
Stable marriage	1, 331	70.8
Unstable marriage		
Educational status		
Illiterate	650	34.6
Primary school	1,034	70.8
Junior high school	161	8.6
Senior high school and/or above	34	1.8
Living alone		
No	1,647	87.7
Yes	232	12.3
Stressful life events		
No	242	12.9
Yes	1,637	87.1
Hazardous and harmful drinking		
No	1,702	90.6
Yes	177	9.4
Social support scores		
Well (>40)	882	46.9

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Bad (≦40)	997	53.1

The Incidence of Suicide Ideation

The incidence of suicidal ideation was 14.5%(95% CI:12.9%-16.1%); and the data from the Chinese census in 2000 showed that it dropped to 14.1% after standardization. The incidence of suicidal plan, suicidal preparation and attempted suicide respectively were 4.0%, 1.9% and 0.8%. 27.6% (75/272) elders made the suicidal plan, 12.9% (35/272) prepared suicide and 5.6% (15/272) ended in attempted suicide.

The Influencing Factors for Suicidal Ideation

There were no statistical significance in sex, age, drinking and social supports between the suicidal ideation group and controlled group. (All significant at P＞0.05). As indicated in Table 2, the factors influencing suicidal ideation among the elderly were having a major depression disorder (OR=19.53; 95% CI: 14.19-26.88), suffering from chronic diseases (OR=4.93; 95% CI: 3.25-7.60), activities of daily living(OR=3.96; 95% CI: 2.90-5.41), annual personal income(OR=4.44; 95% CI: 3.26-6.04), unstable marriage (OR=1.846; 95% CI:1.42-2.41), finishing primary school(OR=0.59; 95% CI:0.45-0.78) and junior high school (OR=0.37; 95% CI:0.20-0.67), Living alone(OR=2.50; 95% CI:1.80-3.45)and suffering from negative life events in the last year(OR=2.02; 95% CI:1.25-3.25). The multivariate non-conditional logistic regression analysis showed that the independent risk factors of suicidal ideation were the annual personal income ≤2,200CNY(OR=3.14; 95% CI:2.15-4.59), having a major depression disorder (OR=17.04; 95% CI:11.91-24.39), suffering from chronic diseases(OR=2.99; 95% CI:1.84-4.85) and ADL status(OR=2.00; 95% CI:1.37-2.94), when other variables were controlled such as sex, age, marital status, education background, annual personal income, history of chronic disease, living status, history of a major depression disorder, activities of daily living , drinking, stressful life events and social supports

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Table 2 Influencing factors for suicidal ideation

Variables	Participants (n)	Prevelance of SI(%)	Crude OR (95% CI)	Adjust OR (95% CI)
Annual personal income (CNY)				
2,201 and above	926	6.2	1.00 (reference)	1.00 (reference)
0-2,200	953	22.6	4.44（3.26-6.04）†	3.14（2.15-4.59）†
MDD status				
No	1,643	7.7	1.00 (reference)	1.00 (reference)
Yes	236	61.9	19.53（14.19-26.88）†	17.04（11.91-24.39）†
History of chronic diseases				
No	563	10.7	1.00 (reference)	1.00 (reference)
Yes	1,316	15.9	4.93（3.25-7.60）†	2.99（1.84-4.85）†
ADL status				
Normal	860	6.4	1.00 (reference)	1.00 (reference)
Disabled	1,019	21.3	3.96（2.90-5.41）†	2.00（1.37-2.94）†
marital status				
Stable marriage	1,331	12.1	1.00 (reference)	1.00 (reference)
Unstable marriage	548	20.3	1.846（1.42-2.41）†	1.28（0.85-1.93）
Educational status				
Illiterate	650	19.4	1.00 (reference)	1.00 (reference)
Primary school	1,034	12.5	0.59（0.45-0.78）‡	0.75（0.52-1.09）
Junior high school	161	8.1	0.37（0.20-0.67）‡	0.69（0.326-1.45）
Senior high school and/or above	34	11.8	0.55（0.19-1.61）	0.49（0.13-1.90）
Living alone				
No	1,647	14.1	1.00 (reference)	1.00 (reference)
Yes	232	17.2	2.50（1.80-3.45）†	1.36（0.84-2.20）

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Stressful life events				
No	242	8.3	1.00 (reference)	1.00 (reference)
Yes	1,637	15.4	2.02(1.25-3.25) †	0.84(0.48-1.48)

*Adjusted for sex, age, drinking, social supports, as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

The interaction of risk factors (annual personal income, MDD, ADL and chronic diseases) with suicidal ideation

In this study, the multivariate non-conditional logistic regression was used to calculate the regression coefficients and covariance matrix after adjustment. The adjusted factors include all the factors mentioned above except for the two factors that would examine the interaction between them. Microsoft Excel was used to calculate RERI, AP, S and their confidence intervals were based on the results from the logistic regression. Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18(95% CI:5.47-36.89), AP of 0.63 (95% CI:0.39-0.88) , and S of 2.84 (95 CI%:1.40-5.85). Additive interactions were detected between MDD and annual personal income with RERI of 35.00(95% CI:9.00-61.00), AP of 0.66 (95% CI:0.46-0.85) , and S of 3.03 (95 CI%:1.68-5.47) (Table 3).

Table 3 Interaction of risk factor on suicidal ideation

Factor1	Factor 2	OR *	RERI	AP	S
MDD status	ADL status		21.18 (5.47-36.89)	0.63 (0.39-0.88)	2.84 (1.40-5.85)
+	+	33.55 (20.05-56.14)†			
-	+	1.73 (1.12-2.69)‡			
+	-	11.64 (5.76-23.52)†			

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-	-	1.00			
MDD status	Annual personal income		35.00 (9.00-61.00)	0.66 (0.46-0.85)	3.03 (1.68-5.47)
+	+	53.25 (30.27-93.66) †			
-	+	3.05 (1.92-4.85) †			
+	-	16.20 (8.66-30.30) †			
-	-	1.00			

*Adjusted for sex, age, marital status, education background, history of chronic disease, living status, drinking， stressful life events ,social supports ,as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

DISCUSSION

For this study, we used multi-staged cluster sampling, with the selected sample in Hengyang and Liuyang representing the situation of suicidal ideation among the elderly in rural communities of Hunan, China. In addition, we complied with severe quality controlled to maintain the verity of the data. There is low non-response rate (7.4%) but high data efficient rate (99.5%). We used a cross-sectional study with unavoidable recall bias, because suicidal ideation is innate according to the memory of subjects and can be influenced by recent events.

The incidence of suicidal ideation among the elderly is 14.5% in rural communities of Hunan and fell to 14.1% after standardization. Kjoller M et al. reported 6.9% of adults had suicidal thoughts within the past years in Denmark,[27] Goldney RD et al. found that 5.6% of men and 5.3% of women had suicide ideation in south Australia,[28] Henry C et al. reported the prevalence of the suicide ideation among elderly people varies from 1.2% to 17%.[29] Compared to previous

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studies, we can make a conclusion that the incidence of suicidal ideation among the elderly in rural communities is high. Meanwhile, we didn't detect hazardous and harmful drinking, stressful life events and social supports as the independent risk of suicidal ideation, but some studies [30-31] have discovered the opposite conclusion which perhaps because of different cultures and features in different districts , and the disparity in designed method and scales .

Low annual personal income is an independent risk of suicidal ideation, which is in agreement with conclusions from previous studies.[32] In this study, people with an annual personal income ≤ 2,200CNY are more likely to have suicidal ideation than those with income >2,200 CNY(adjOR=3.14; 95% CI:2.15-4.59). The reasons may be that people with low income may have more family conflicts and diseases which may not be treated in time.[33] Additionally, economic stress is also associated with depression, with evidence showing that financial strain and employment are causally related to depression.[34] Activities of daily living is also an independent risk of suicidal ideation; People with disabled activities of daily living have a higher risk of developing suicidal ideation than those with normal activities (adjOR=2.00; 95% CI:1.37-2.94). And the study from Awata S has also demonstrated the same result.[35] Dennis M et al. showed that the strength of association between suicide ideation and activities of daily living limitation increased with the number of domains of activities of daily living affected and was of similar magnitude for most individual domains.[36]

MDD's being as an independent risk of suicidal ideation has been accepted previously.[37-38] People with MDD had a higher risk of developing suicidal ideation than those without it(adjOR=17.04; 95% CI:11.91-24.39). We have also discovered that MDD is not only an independent risk of suicidal ideation but also has additive interactions between annual personal income and ADL. The adjORs for both MDD and ADL/annual personal income's being present are greater than the adjORs for only one of the three factors' being present, which displays that there will be much stronger association with suicide ideation when both factors are present. The results also indicate that there is a reinforce effect when both MDD and ADL/annual personal income are present. This means that some people who are MDD and have low annual personal income and disabled ADL would have higher rates of suicidal ideation; therefore we should pay more attention to these people. Ormel J et al.[12] have showed that there were three kinds of the

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association between ADL and depression: (a) a strong contemporaneous effect of change in ADL on depressive symptoms; (b) a weaker lagged effect of change in depressive symptoms on ADL; and (c) a weak correlation between the trait (or stable) components of depression and ADL, which indicate that depression and low ADL will reinforce each other, and result in much stronger association when both the two factors are present. Hence the three associations may explain the rationality of the existence of the interaction between MDD and ADL to a certain extent. Depression is more commonly seen in people with economically disadvantages.[39] Low socioeconomic status (SES) slightly increases the risk of episode onset and moderately increases the risk for persistence of depression.[40] Besides, depression may well lead to poor professional and personal outcomes as well as arise from them.[41] And reviews suggest that causation(low SES increases risk of depression) and selection(depression hinders social mobility) are not mutually exclusive explanations and that they may be combined over the life cycle.[42-43] These results show that low personal income and depression will reinforce each other in life time. And this may explain the interaction between MDD and annual personal income in some extent. Therefore, it may be a feasible way to prevent suicide behaviors by venting depression and paying more attention to the elderly with low annual personal income and disabled ADL .

To the best of our knowledge, this is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities of China. With this population-based, large-scale, the high rate of follow-up and highly standardized methods, these findings are helpful for prevention of suicide for the aging population in rural communities of China. We provide some advice for suicide prevention among the elderly in rural communities: first, owing to the high incidence of suicidal ideation among elderly individuals of rural communities , our government should pay more attention to suicidal ideation among them; second, to reduce the rate of suicidal ideation and strengthen suicide prevention, we should strengthen venting of MDD and pay close attention to people whose income are low and ADL is disabled, which can not only reduce the rate of suicidal ideation, but also reduce the rate of suicidal ideation caused by the interactions of risk factors. Since the study is limited by its cross-sectional design, the causation cannot be inferred. And there may be underpowered to address the relationships between factors and suicidal ideation and the multiple regression

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analyses by designed sample size. Moreover suicidal ideation is a complex psychological phenomenon, there may be a limitation in measurement accuracy or classification for we can't use a single simple question to capture suicidal ideation. And we cannot reject the bias for the self-reported design, thus further studies are needed to confirm the findings.

CONCLUSION

The incidence of suicidal ideation among the rural elderly in China is high. And the independent risk factors of suicidal ideation are annual personal income（≤2,200 CNY）, MDD, chronic diseases and disabled activity of daily living. MDD has additive interactions with ADL and annual personal income. These findings above have significant implications for the prediction and prevention of suicidal behaviors.

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Competing interests None declared.

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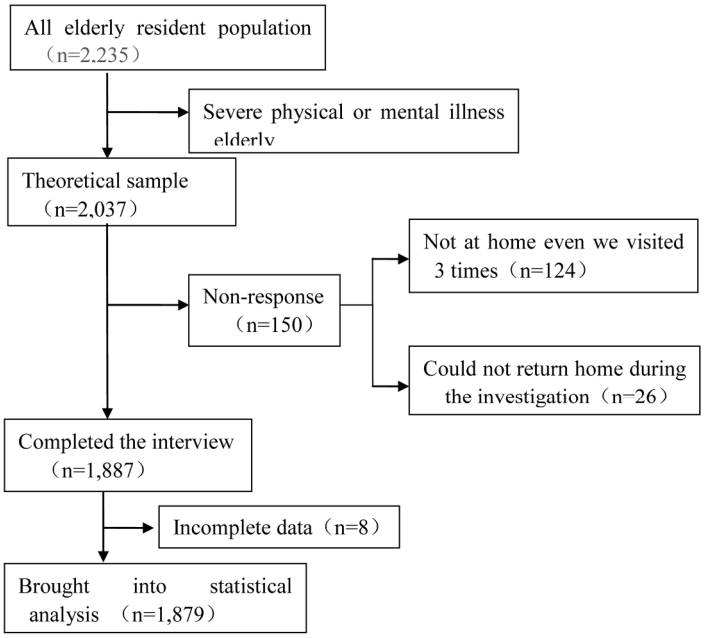
Figure 1 Response of subjects



209x296mm (300 x 300 DPI)

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5,6,7,8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7,8
Bias	9	Describe any efforts to address potential sources of bias	6

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Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7,8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	No.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	YES. See it in the last page.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9,10
		(b) Indicate number of participants with missing data for each variable of interest	9,10
Outcome data	15*	Report numbers of outcome events or summary measures	9,10,11,12,13,14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12

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		(*b*) Report category boundaries when continuous variables were categorized	7,8,9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13,14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14,15,16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16,17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health
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A cross-sectional study on risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan, China

Huilan Xu[1], Lulu Qin[1], Jinhong Wang[1], Liang Zhou[1], Dan Luo[1], Mi Hu[1], Zhenhua Li[1], Shuiyuan Xiao[1]

1 Department of Social Medicine and Health Management, School of Public Health, Central South University, Changsha, Hunan 410078, China;

Correspondence author: Huilan Xu, E-Mail: huilanxu1963@sina.com

Tel./Fax: +86-0731-8484-5454.

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Abstract

Objectives: To identify risk factors and their interactions with suicidal ideation among the elderly in rural communities of Hunan and to provide some scientific basis for suicide prevention.

Design, setting and participants:A cross-sectional survey was conducted among the elderly in rural communities in China's Hunan province. Thirteen areas were selected by multi-staged cluster random sampling and 1,887 rural elders were investigated via face-to-face interviews.

Main outcome measures: Measures included socio-demographic information, suicidal ideation, activities of daily living (ADL), major depression disorder (MDD), drinking, stressful life events and social support. Non-conditional logistic regression was preformed to explore the influencing factors for suicidal ideation, and the additive interaction was used to analyze the interaction between risk factors.

Results: Incidence of suicidal ideation among the elderly was 14.5%(95% CI:12.9%-16.1%)in rural communities of Hunan. The independent influencing factors of suicidal ideation were annual personal income (OR=3.14; 95% CI: 2.15-4.59), MDD (OR=17.04; 95% CI:11.91-24.39), chronic diseases (OR=2.99; 95% CI:1.84-4.85) and ADL(OR=2.00; 95% CI:1.37-2.94). Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18(95% CI: 5.47-36.89), and between MDD and annual personal income with a RERI of 35.00(95% CI: 9.00-61.00).

Conclusions: The independent risk factors of suicidal ideation are annual personal income (≤2,200CNY), MDD, chronic diseases and disabled activities of daily living. MDD has additive interactions with ADL and annual personal income. These findings have significant implications for the prediction and prevention of suicidal behaviors.

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Strengths and limitations of this study

This is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities in China. With this population-based, large-scale design, highly standardized methods, as well as high rate of follow-up, these findings are helpful for prevention of suicide for the rural elderly Chinese.

The study provides valuable information on the rate of suicide ideation, its influencing factors and the interactions between these factors among the elderly in rural communities.

The additive interactions (the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index(S)) are used to analyze the interaction between risk factors and suicide ideation.

The study is limited by its cross-sectional and self-reported design.

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INTRODUCTION

Suicide has become a major public health and social problem worldwide.[1] It accounts for 3.6% of all deaths and is the fifth most common cause of death in China,[2] besides, statistical figures have shown that the suicide rate is about 22/100,000 per year[3] .There is a gradual process of development from suicidal ideation to ultimately suicidal commitment,[4] and 60% of transitions from ideation to plan and attempt occur within the first year after ideation onset[5]. Suicide ideation is one of the most important risk factors for suicide[6] and also an evaluation index recommended by the World Health Organization.

With a worldwide attention to suicide and increasing studies on suicidal behaviors in western and high-income countries,[7-9] studies on suicidal problems have also been springing up in China. With the aging of population in China, the prevalence of suicide among the elderly is severe and its rate ranges from 2.2% to 21.5%, relatively higher than that in urban areas or other age groups.[10] Thus, more attention to the prevalence of suicide among the rural elderly should be paid.

The intervention of suicide ideation is the key process of suicide intervention, which was also considered as the most effective measure to prevent suicide.[4,10] Studies have showed that there are many factors influencing suicide ideation among the elderly, such as gender, disease, economic status, physical health, activities of daily living, mental health and so on,[9-11] and they can be categorized into three groups: psychosocial factors, social-environmental factors and socio-demographical factors,[11] which may also have connections with each other. Studies have also showed that activities of daily living had a strong association with depression disorder.[12] Moreover, factors such as negative life events, low social support, weak physical condition, low income, and chronic diseases are risk factors of both depression and suicide ideation among the elderly.[11,13]Capron DM et al. found that AS (anxeity sensitivity, AS) physical scores had an interaction with AS cognitive scores.[14] The interactions of risk factors are useful and effective for preventing suicide ideation. However, there are only a few studies focusing on the interactions and a lack of research on risk factors and their interactions with suicide ideation among the rural elderly Chinese.

This study was executed in Hunan, a typical south central province in China. The

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geographical position of Hunan is from 24° 38' to 30° 08' N in latitude and from 108° 47' to 114° 15' E in longitude. Besides, the total population of Hunan is 71 million, with 9.99 percent aged 65 or older and an increasing proportion of elderly people. Moreover, the GDP (gross domestic product, GDP) of Hunan ranked the tenth province in China in 2011 with Per Capita GDP is 29,880 CNY per person, a medium level in the country. Previous study has showed that the average suicide rate of the elderly in rural areas (88.3/100,000) was four times higher than that in urban areas (24.4/100,000).[15] In addition, recent studies have also showed that the prevalence of suicide ideation among the elderly increased to a range from 8.7% to 21.5% in rural areas in Hunan, China,[16] from which we can conclude that suicide is becoming an important public health problem among the rural elderly of Hunan. Therefore we carried out this study to investigate risk factors and their additive interactions with suicidal ideation among the elderly in rural communities of Hunan. Additionally, we hope this study can provide some scientific basis for suicide prevention for rural elderly in China.

METHODS

Sample size calculation

In order to address the suicide ideation among the rural elderly, sample size calculation was done by estimating an incidence rate with specified relative precision for cross-sectional studies according World Health Organization recommended tools: a sample of 1,537 would be needed when α=0.05 and ε=0.05.[16] The theoretical sample was 1,844 after increasing the number of observed subjects by 20%, which took account of the lost subjects during investigation.

Participants

A cross-sectional survey was conducted among the elderly in rural communities of Hunan province of China. By multi-staged cluster sampling, 2 counties (Hengyang and Liuyang) were randomly selected from 122 counties in Hunan province. Next, 3 townships (Yanshan ,Qulou and Qulan) were randomly selected from 26 townships in Hengyang and 3 villages were respectively chosen from the selected townships. Concurrently, 2 townships(Gaoping and Yongan)were randomly selected from 24 townships in Liuyang and 2 villages were respectively chosen from the selected townships and two teams were randomly selected from each village. In total , 13

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areas were selected for our study. The elderly (age ≥ 60 years) resident population (who had achieved registered permanent residence or not achieved registered permanent residence but have resided for six months) were identified as our subjects but those who had severe physical or mental illness were excluded. There were 2,235 elderly residents in the 13 selected areas, among which 198 individuals were excluded for severe physical or mental illness. The theoretical sample size was 2,037 people, with 150 not investigated for various reasons (Fig. 1). The response rate was 92.6%(1,887/2,037). Among the remaining 1,887 individuals, 8 were excluded for incomplete data. In total, 1,879 elderly were brought into statistical analysis and the effective rate was 99.6% (1,879/1,887). Our pre-trained interviewers went to the elderly subject's home to introduce the aim, plan, interest and the right of participant in this study carefully. Then they interviewed participants face to face after each participant being given written informed consent. If the participants were illiterate, the written consent was signed by their family members. The elderly have the right to decline to participate in the study without any disadvantage, and they can drop out if they have the desire at any time during the whole investigation. Consequently, all procedures were performed in accordance with ethical standards. If the individual was not at home, we would record the reason. And our interviewers were required to check their questionnaires seriously every day. The survey was carried out from 2009 to 2011.

Measures

Participants were asked general information, suicidal ideation, activities of daily living (ADL), major depression disorder (MDD), drinking, stressful life events and social supports. The components of the questionnaire relevant to this study are detailed below.

General information

Name, sex, age, marital status, education status, annual personal income, chronic disease and whether the subject lived alone or not were measured by a self-designed inventory. Chronic diseases refer to chronic non-communicable diseases, including cardiovascular disease (CVD), cancers, chronic obstructive pulmonary disease (COPD), and type 2 diabetes and others (namely, diseases according to classification standards included in the ICD-10). Living alone is defined as a social situation where a person lives in a dwelling without a cohabitant, children or other household members. According to the international poverty line standard (take the median

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income or 50% of the average income as the poverty line in a country or region), the poverty line of rural areas in Hunan, China was 2,200 CNY/year per person in 2011, so we defined the low income people as those with income lower than 2,200 CNY/year per person.

Suicidal ideation

According to the concept and classification of suicidal behavior,[17] we defined suicidal ideation as the thought of suicide or wanting to take actions to end one's own life. We developed a self-made suicidal behavior questionnaire which contained four items: suicidal ideation (Have you ever seriously considered suicide in the last 12 months?), suicidal plan (Have you ever made a plan for committing suicide in the last 12 months?), suicidal preparation (Have you ever prepared any tool to kill yourself in the last 12 months?), and attempted suicide (Have you ever attempted to suicide?). The response options were yes and no.

Activities of daily living (ADL)

ADL of the elderly was measured by Lawton and Brody's activities of daily living scale, which includes 14 items.[18] It consists of a physical self-maintenance scale (PSMS) and an instrumental activities of daily living scale (IADL). Each item was scored from 1 to 4. A total score higher than 14 was defined as disabled; otherwise the individual was considered normal.

Major depression disorder (MDD)

MDD was measured by the Chinese version of the patient health questionnaire-9 (PHQ-9) whose reliability and validity are high.[19-20] PHQ-9 is constituted of two parts. The first part consists of 9 items for assessing the frequency of depression symptoms; each item was scored from "0" (not at all) to "3" (nearly every day). The second part contained an additional item: "How difficult it was for you to do your work, take care of things at home, or get along with other people?" It was also scored from "0" (not difficult at all) to "3" (extremely difficult). Diagnosis of MDD had to satisfy the following three requirements simultaneously: 1) at least five items with scores ≥ 2 in the first part (including if the ninth item scored ≥ 1); 2) at least one of the first or second items with a score ≥ 2; and 3) the second part with scores ≥2.[21]

Drinking

Alcohol use disorders identification test(AUDIT) developed by the World Health

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Organization is considered as a convenient method of screening for excessive drinking. This contains 10 testing items whose reliability and validity have been established in research conducted in a variety of settings and many different nations.[22] In China, when an individual gets the AUDIT score higher than 7, he/she will be regarded as hazardous and harmful drinking.

Stressful life events

Based on previous scales,[23-24] we listed 38 life events and summarized them into three aspects: health related problems, marital and family life related problems, social and other problems. If any of the events occurs to the subjects and they feel stressful, we will conclude that the subjects suffer from stressful life events.

Social support

The Social Support Rating scale (Xiao S, 1999)[25] has been proved of high reliability and validity in China. The scale includes three parts: objective support, subjective support and availability of social support. If an individual's social support score is lower than the mean, we will define the person as low social support, otherwise the individual will be considered in a high social support.

Statistical analysis

Data was created and analyzed by using SPSS statistical software 16.0. And significance threshold of group differences were set at $P < 0.05$ (bilateral). There were six age categories (60-64, 65-69, 70-74, 75-79, 80-84, 85 and above), two annual personal income categories(0-2,200, 2,201 and above), four education status categories (illiterate, primary school, junior high school, senior high school and/or above), and two marital status categories (stable marriage, unstable marriage). Stable marriage includes complete marriage, while unstable marriage consists of widowed, unmarried and divorce. The univariate and multivariate non-conditional logistic regression were used to explore the factors influencing suicidal ideation. In order to examine the relationships between risk factors and suicidal ideation, odds ratios (ORs) and 95% confidence intervals (CIs) were estimated by using univariate and multivariate non-conditional logistic regression. There are three measures of testing additive interaction: the relative excess risk due to interaction (RERI), the attributable proportion due to interaction (AP) and the synergy index（S）. There is no additive interaction if RERI and AP are equal to 0 or S is

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equal to 1. We input the regression coefficients and covariance matrix drawn from the logistic regression into the Excel sheet made by Andersson, so as to calculate the interaction of risk factors（annual personal income, chronic disease, MDD, ADL）and their confidence intervals.[26]

RESULTS

A total of 1,879 individuals aged from 60 to 97 years old were included in the study. The participants were at a median age of 69 years old, and 891 (47.4%) of them were female.According to the poverty line(≦2,200 CNY) in rural areas in Hunan, 953(50.7%) of them were with low income. 1,331 (70.8%) had stable marriages. There were four education levels: 650 (34.6%) were illiterate, 1,034(70.8%) had finished primary school, 161 (8.6%) had finished junior high school, and 34(1.8%) had finished senior high school and/or above. 232 (12.3%) elderly subjects were living alone, 236(12.6%) had MDD, 1,316 (70.0%) had chronic diseases, 1,019 (54.2%) had disabilities in their activities of daily living, 177(9.4%) suffered from hazardous and harmful drinking, 1637(87.1%)experienced negative life events in the last year. The social support scores ranged from 17 to 61 with the mean score of 40, 997(53.1%) were with low social support. (Table 1)

Table 1 The demographic characteristics of the sample

Variables	n	%
Age		
60-69	993	52.8
70-79	681	36.2
≧80	205	11.0
Gender		
Male	988	52.6
Female	891	47.4
Annual personal income (CNY)		
2,201 and above	926	49.3
0-2,200	953	50.7
MDD status		

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No	1,643	87.4
Yes	236	12.6
History of chronic diseases		
No	563	30.0
Yes	1,316	70.0
ADL status		
Normal	860	45.8
Disabled	1,019	54.2
Marital status		
Stable marriage	1, 331	70.8
Unstable marriage	548	29.2
Educational status		
Illiterate	650	34.6
Primary school	1,034	70.8
Junior high school	161	8.6
Senior high school and/or above	34	1.8
Living alone		
No	1,647	87.7
Yes	232	12.3
Stressful life events		
No	242	12.9
Yes	1,637	87.1
Hazardous and harmful drinking		
No	1,702	90.6
Yes	177	9.4
Social support scores		
Well (>40)	882	46.9
Bad (≦40)	997	53.1

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The Incidence of Suicide Ideation

The incidence of suicidal ideation was 14.5%(95% CI: 12.9%-16.1%); and the data from the Chinese census in 2000 showed that it dropped to 14.1% after standardization. The incidence of suicidal plan, suicidal preparation and attempted suicide were 4.0%, 1.9% and 0.8%, respectively. In the suicide ideation group, 27.6% (75/272) elders made the suicidal plan, 12.9% (35/272) prepared suicide and 5.6% (15/272) ended in attempted suicide.

The Influencing Factors of Suicidal Ideation

There were no statistical significance in sex, age, drinking and social support between the suicidal ideation group and controlled group. (All significant at $P>0.05$). As indicated in Table 2, the factors influencing suicidal ideation among the elderly were having a major depression disorder (OR=19.53; 95% CI: 14.19-26.88), suffering from chronic diseases (OR=4.93; 95% CI: 3.25-7.60), activities of daily living (OR=3.96; 95% CI: 2.90-5.41), annual personal income (OR=4.44; 95% CI: 3.26-6.04), unstable marriage (OR=1.846; 95% CI:1.42-2.41), finishing primary school (OR=0.59; 95% CI:0.45-0.78) and junior high school (OR=0.37; 95% CI:0.20-0.67), Living alone (OR=2.50; 95% CI:1.80-3.45) and suffering from negative life events in the last year (OR=2.02; 95% CI:1.25-3.25). The multivariate non-conditional logistic regression analysis showed that the independent risk factors of suicidal ideation were the annual personal income ≤2,200CNY (OR=3.14; 95% CI:2.15-4.59), having a major depression disorder (OR=17.04; 95% CI:11.91-24.39), suffering from chronic diseases (OR=2.99; 95% CI:1.84-4.85) and ADL status (OR=2.00; 95% CI:1.37-2.94), when other variables were controlled such as sex, age, marital status, education background, annual personal income, history of chronic disease, living status, history of a major depression disorder, activities of daily living , drinking, stressful life events and social support.

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Table 2 Influencing factors for suicidal ideation

Variables	Participants (n)	Prevelance of SI(%)	Crude OR (95% CI)	Adjust OR (95% CI)
Annual personal income (CNY)				
2,201 and above	926	6.2	1.00 (reference)	1.00 (reference)
0-2,200	953	22.6	4.44（3.26-6.04）†	3.14（2.15-4.59）†
MDD status				
No	1,643	7.7	1.00 (reference)	1.00 (reference)
Yes	236	61.9	19.53（14.19-26.88）†	17.04（11.91-24.39）†
History of chronic diseases				
No	563	10.7	1.00 (reference)	1.00 (reference)
Yes	1,316	15.9	4.93（3.25-7.60）†	2.99（1.84-4.85）†
ADL status				
Normal	860	6.4	1.00 (reference)	1.00 (reference)
Disabled	1,019	21.3	3.96（2.90-5.41）†	2.00（1.37-2.94）†
marital status				
Stable marriage	1,331	12.1	1.00 (reference)	1.00 (reference)
Unstable marriage	548	20.3	1.846（1.42-2.41）†	1.28（0.85-1.93）
Educational status				
Illiterate	650	19.4	1.00 (reference)	1.00 (reference)
Primary school	1,034	12.5	0.59（0.45-0.78）‡	0.75（0.52-1.09）
Junior high school	161	8.1	0.37（0.20-0.67）‡	0.69（0.326-1.45）
Senior high school and/or above	34	11.8	0.55（0.19-1.61）	0.49（0.13-1.90）
Living alone				
No	1,647	14.1	1.00 (reference)	1.00 (reference)
Yes	232	17.2	2.50（1.80-3.45）†	1.36（0.84-2.20）

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Stressful life events				
No	242	8.3	1.00 (reference)	1.00 (reference)
Yes	1,637	15.4	2.02(1.25-3.25) †	0.84(0.48-1.48)

*Adjusted for sex, age, drinking, social supports, as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

The interaction of risk factors (annual personal income, MDD, ADL and chronic diseases) with suicidal ideation

In this study, multivariate non-conditional logistic regression was used to calculate the regression coefficients and covariance matrix after adjustment. The adjusted factors include all the factors mentioned above except for two factors that would examine the interaction between them. Microsoft Excel was used to calculate RERI, AP, S and their confidence intervals were based on the results from the logistic regression. Additive interactions were detected between MDD and ADL with a relative excess risk of interaction (RERI) of 21.18(95% CI: 5.47-36.89), AP of 0.63 (95% CI: 0.39-0.88), and S of 2.84 (95 CI%:1.40-5.85). Additive interactions were detected between MDD and annual personal income with RERI of 35.00(95% CI: 9.00-61.00), AP of 0.66 (95% CI: 0.46-0.85) , and S of 3.03 (95 CI%:1.68-5.47) (Table 3).

Table 3 Interaction of risk factor on suicidal ideation

Factor1	Factor 2	OR *	RERI	AP	S
MDD status	ADL status		21.18 (5.47-36.89)	0.63 (0.39-0.88)	2.84 (1.40-5.85)
+	+	33.55 (20.05-56.14)†			
-	+	1.73 (1.12-2.69)‡			
+	-	11.64 (5.76-23.52)†			

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-	-	1.00			
MDD status	Annual personal income		35.00 (9.00-61.00)	0.66 (0.46-0.85)	3.03 (1.68-5.47)
+	+	53.25 (30.27-93.66) †			
-	+	3.05 (1.92-4.85) †			
+	-	16.20 (8.66-30.30) †			
-	-	1.00			

*Adjusted for sex, age, marital status, education background, history of chronic disease, living status, drinking， stressful life events ,social supports ,as well as all variables shown in the table.

†P <0.01.

‡P <0.05.

DISCUSSION

For this study, we used multi-staged cluster sampling, with the selected samples in Hengyang and Liuyang representing the rural communities of Hunan, China. In addition, we complied with severe quality controll to maintain the verity of the data. There is low non-response rate (7.4%) but high data efficient rate (99.5%). We used a cross-sectional study with unavoidable recall bias, because suicidal ideation is innate according to the memory of subjects and can be influenced by recent events.

The incidence of suicidal ideation among the elderly is 14.5% in rural communities of Hunan and fell to 14.1% after standardization. Kjoller M et al. reported 6.9% of adults had suicidal thoughts within the past years in Denmark,[27] Goldney RD et al. found that 5.6% of men and 5.3% of women had suicide ideation in south Australia,[28] Henry C et al. reported the prevalence of the suicide ideation among elderly people varies from 1.2% to 17%.[29] Compared to

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previous studies, we can make a conclusion that the incidence of suicidal ideation among the elderly in rural communities is high. Meanwhile, hazardous and harmful drinking, stressful life events and social support were not detected as the independent risk of suicidal ideation, which is in contradiction with some studies,[30-31] the reason may be different cultures and features in different districts , and the disparity in designed method and scales .

Low annual personal income is an independent risk of suicidal ideation, which is in agreement with conclusions from previous studies.[32] In this study, people with an annual personal income ≤ 2,200CNY are more likely to have suicidal ideation than those with income >2,200 CNY(adj OR=3.14; 95% CI:2.15-4.59). The reason may be that people with low income may have more family conflicts and diseases which may not be treated in time.[33] Additionally, economic stress is also associated with depression, with evidence showing that financial strain and employment are causally related to depression.[34] Activities of daily living is also an independent risk of suicidal ideation; People with disabled activities of daily living have a higher risk of developing suicidal ideation than those with normal activities (adj OR=2.00; 95% CI:1.37-2.94). And the study from Awata S has also demonstrated the same result.[35] Dennis M et al. showed that the strength of association between suicide ideation and activities of daily living limitation increased with the number of daily activity domains affected and was of similar magnitude for most individual domains.[36]

MDD's being as an independent risk of suicidal ideation has been accepted previously.[37-38] People with MDD had a higher risk of developing suicidal ideation than those without (adj OR=17.04; 95% CI: 11.91-24.39). We have also discovered that MDD is not only an independent risk of suicidal ideation but also has additive interactions between annual personal income and ADL. The adj ORs for both MDD and ADL/annual personal income's being present are greater than the adjORs for only one of the three factors' being present, which displays that there will be much stronger association with suicide ideation when both factors are present. The results also indicate that there is a reinforcing effect when both MDD and ADL/annual personal income are present. This means that some people who have MDD and low annual personal income and disabled ADL would have higher rates of suicidal ideation; therefore we should pay more attention to these people. Ormel J et al.[12] have showed that there were three kinds of association

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between ADL and depression: (a) a strong contemporaneous effect of change in ADL on depressive symptoms; (b) a weaker lagged effect of change in depressive symptoms on ADL; and (c) a weak correlation between the trait (or stable) components of depression and ADL, which indicates that depression and low ADL will reinforce each other, and result in much stronger association when both factors are present. Hence the three associations may explain the rationality of the existence of the interaction between MDD and ADL to a certain extent. Depression is more commonly seen in people with economically disadvantages.[39] Low socioeconomic status (SES) slightly increases the risk of episode onset and moderately increases the risk for persistence of depression.[40] Besides, depression may lead to poor professional and personal outcomes.[41] Reviews suggest that causation(low SES increases risk of depression) and selection(depression hinders social mobility) are not mutually exclusive explanations and that they may be combined over the life cycle.[42-43] These results show that low personal income and depression will reinforce each other in life time. And this may explain the interaction between MDD and annual personal income to some extent. Therefore, it may be a feasible way to prevent suicide behaviors by venting depression and paying more attention to the elderly with low annual personal income and disabled ADL .

To the best of our knowledge, this is the first study to examine the risk factors and their interactions with suicidal ideation among the elderly in rural communities of China. With this population-based, large-scaled design, as well as high rate of follow-up and highly standardized methods, these findings are helpful for prevention of suicide for the aging population in rural communities of China. We provide some advice for suicide prevention among the elderly in rural communities: first, due to the high incidence of suicidal ideation among elderly individuals of rural communities, our government should pay more attention to suicidal ideation among them; second, to reduce the rate of suicidal ideation and strengthen suicide prevention, we should strengthen venting of MDD and pay close attention to people whose income are low and ADL is disabled, which can not only reduce the rate of suicidal ideation, but also reduce the rate of suicidal ideation caused by the interactions of risk factors. Since the study is limited by its cross-sectional design, the causation cannot be inferred. It may be underpowered to address the relationships between factors and suicidal ideation and the multiple regression analyses by

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designed sample size. Moreover suicidal ideation is a complex psychological phenomenon, there may be a limitation in measurement accuracy or classification for we can't use a single simple question to capture suicidal ideation. And we cannot deny the potential bias for the self-reported design, thus further studies are needed to confirm the findings.

CONCLUSION

The incidence of suicidal ideation among the rural elderly in China is high. And the independent risk factors of suicidal ideation are annual personal income(≤2,200 CNY), MDD, chronic diseases and disabled activity of daily living. MDD has additive interactions with ADL and annual personal income. These findings above have significant implications for the prediction and prevention of suicidal behaviors.

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Competing interests None declared.

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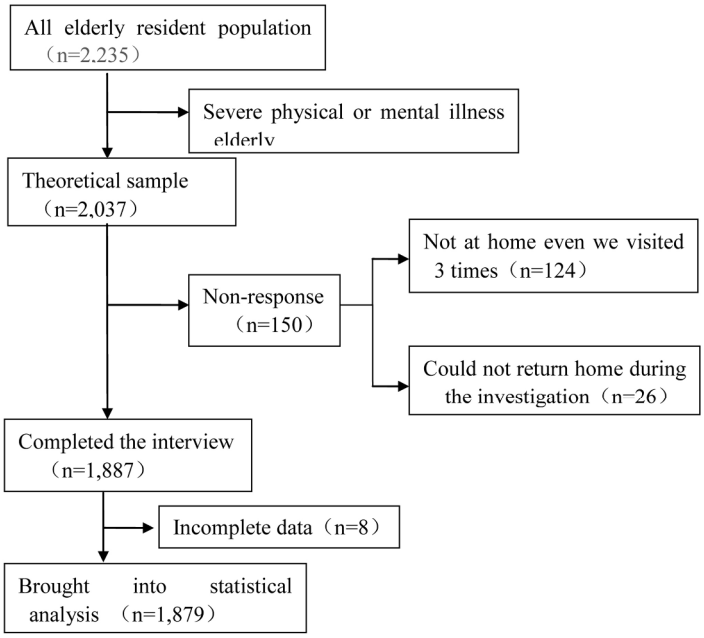
Figure 1 Response of subjects



209x296mm (300 x 300 DPI)

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STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4,5
Objectives	3	State specific objectives, including any prespecified hypotheses	4,5
Methods			
Study design	4	Present key elements of study design early in the paper	5,6,7,8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7,8
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6,7,8
Bias	9	Describe any efforts to address potential sources of bias	6

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Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7,8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8
		(*b*) Describe any methods used to examine subgroups and interactions	8
		(*c*) Explain how missing data were addressed	8
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	8
		(*e*) Describe any sensitivity analyses	No.
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5,6
		(b) Give reasons for non-participation at each stage	5,6
		(c) Consider use of a flow diagram	YES. See it in the last page.
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9,10
		(b) Indicate number of participants with missing data for each variable of interest	9,10
Outcome data	15*	Report numbers of outcome events or summary measures	9,10,11,12,13,14
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11,12

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		(*b*) Report category boundaries when continuous variables were categorized	7,8,9
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13,14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14,15,16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16,17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	15,16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	No.

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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