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Factors in the Neighborhood as Risks of Suicide in Rural China: A Multilevel Analysis

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Abstract To estimate the effect of social factors in the neighborhood environment on suicide risks, we studied 392 suicides and 416 controls, all aged 15–34 years, consecutively and randomly selected from 16 rural counties in three provinces of China. The social factors in the village neighborhood were measured by the WHO scale of Community Stress and Problems. The individual scores as well as the sum scores of the Community Stress Problems were compared between the suicides and the controls, and multilevel logit regressions were performed for the social structural stresses and community behavioral problems and other confounding variables to test the roles of community stress and problems in Chinese rural young suicide risks. It is found that neighborhood stresses and problems increase rural Chinese suicide risks, while certain problems, such as in health care, alcohol abuse, job security, family dispute, and transportation, play more important roles than others to increase rural Chinese suicide risks. Social risk factors such as the community stresses and problems can be another area to work on for the suicide prevention.

Keywords Suicide · Neighborhood environment · Rural China · Multilevel analysis

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Introduction

Although there has been a decrease of the rates in the past decade in China, suicide remains a big public health issue in that country (Wang et al. 2008; Zhang et al. 2010). A study published in 2002 reported suicide as the fifth leading cause of death with a mean annual rate of 23/100,000, for a total of 287,000 suicide deaths per year (3.6% of all deaths) in China (Phillips et al. 2002). The demographic pattern of Chinese suicide—with rural rates two to three-fold greater than the urban rates, and rates among women slightly higher than among men—is different from that reported in Western countries, where rates in urban and rural areas are roughly equivalent and rates of suicide in men are two- to four-fold higher than in women (Wang et al. 2008). Suicide prevention is one of the World Health Organization's priorities in mental health for developing countries (Malakouti et al. 2009), and it is particularly important in China as its suicide rates were higher than the world average (WHO 2005).

Most of the suicide research has focused on such individual factors as psychiatric and psychological disorders, physical illnesses, personal experiences, attitudes, religiosity, marital status, social economic status, etc., and relatively fewer studies were on the environment by which an suicide was accounted for (Lester 2000). Some recent studies investigated the effects of firearms (Beautrais et al. 2006; Conner and Zhong 2003; Klieve et al. 2009; Miller et al. 2006), pesticides (Hawton et al. 2009; Kong and Zhang 2010), and bridges (Beautrais 2001; De Moore and Robertson 1999) on suicide rates. These studies on the availability and accessibility to the lethal means have contributed to our understanding of suicide as a function of environment (Kanchan et al. 2009). As a matter of fact, social factors, including neighborhood environment characteristics are always the major area of study of the

Durkheimian suicidologists (Durkheim 1951; Gunnell et al. 2000).

As of now, we are not aware of studies that have addressed suicide in relation to neighborhood environments as additional risk or protective factors. The present study aims to estimate the risks of suicide among those rural young Chinese who are living in different neighborhood environments. Because of the social and psychological impact of the community factors to an individual at risk of suicide (Durkheim 1951), it is hypothesized that the larger the community stress and problems, the higher the risk of suicide for the villagers in rural China.

Methods

Subjects and Data Collection

Data for the study were obtained from 16 rural counties from three provinces (Liaoning, Hunan, and Shandong) of China. It was a large psychological autopsy project investigating correlates of completed suicide in comparison with a group of living controls. Face to face interviews were performed at the household in villages. In each selected county, suicides were consecutively enrolled into the study in 2008. Similar numbers of community living controls were recruited in the same counties during the same time periods. A total number of 392 suicide cases and 416 community living controls were recruited for the psychological autopsy study.

For each suicide case and living control, two informants were interviewed. However, recognizing the fact that the type of informants rather than the number of informants in psychological autopsy studies was an important and complex consideration (Kraemer et al. 2003), we selected the informants based on the context or environment (how people observe the target, e.g. home vs. non-home setting). Thus, the following three guidelines were used for the inclusion of informants: (1) Informants had to be 18 years of age or older. Characteristics of the informants for both suicides and controls were noted in a standardized fashion (i.e., most recent contact, number of contacts in the last month, frequency of contacts in the last year, number of years informant has known the target, relationships, and the informant's impression of their familiarity with target persons). (2) For both suicides and controls, informant #1 was always a parent, spouse, or another important family member, and informant #2 was always a friend, co-worker, or a neighbor. (3) Wherever possible we avoided recruiting spouses and in-laws of suicides associated with family disputes. Interviewing these people could result in very biased reports, if marital infidelity and family oppression were possible causes of suicide.

Upon their agreement by written informed consent, the interview was scheduled 2–6 months after the suicide. Interviews with living control informants were scheduled as soon as the control targets and their informants were identified. All the interviewers were trained before the investigation. The face-to-face interview was done in a private place where only the interviewer and interviewee were present. Table 1 presents some demographic characteristics of the sample.

Measures

The case–control status (suicide vs. living) is the dependent variable for studying the effects of neighborhood variables on suicide occurrences. The factors in the neighborhood were assessed with the scale developed by WHO SUPRE-MISS called the Community Stress and Problems (WHO 2002). The scale has 16 items asking respondents about their perception of the social stress and problems in the neighborhood. We did two minor changes to the wording of the 16 items. First, for item 5 (government), we changed it go "governmental corruption," which reflects the current problems in the governments and can be better understood by the respondents. Second, we changed item 10 (racial tension) to "ethnic tension," as Chinese societies are almost completely composed of Asian Chinese, and individuals of certain ethnic groups may live in the same village with *Han* people.

All the 16 items were included in the data collection, and two more questions (gambling and superstition) were added to the scale to reflect something that may be particular to rural China. Respondents were asked to rank each of the 18 stresses or problems from 1 (not serious) to 5 (very serious). This standardized scale was translated into Chinese and back translated for accuracy by bilingual professionals before its implementation. Socio-demographic factors included age, gender, education, personal annual income, marital status, physical illness, mental disorder, and status in the family. Table 1 also presents the distribution of the community stress and problems as well as the socio-demographic factors between the suicides and the controls.

The socio-demographic factors listed above were considered to be individual-level correlates of suicide risks. The community stress and problems (reduced from 18 items) were considered to be contextual-level factors in the multilevel analyses.

Analytic Strategies

Descriptive statistics and factor analyses were calculated with the Stata 10.0 procedure (StataCorp 2009). Multilevel binomial fixed effect models were estimated with HLM 6.02 (LaPlace iterations) (Raudenbush and Bryk 2002).

Table 1 Comparative description of the individual characteristics and neighborhood factors between suicides ($n = 392$) and controls ($n = 416$) in rural China

Items	Control ($n = 416$)	Suicide ($n = 392$)	t	P
Age, years (SD)	25.69 ± 6.16	26.84 ± 6.37	−2.59	0.009
Gender (n, %)			−1.72	0.086
0 (female)	214 (51.44)	178 (45.41)		
1 (male)	202 (48.56)	214 (54.59)		
Education, years (SD)	9.14 ± 2.39	7.39 ± 2.76	9.64	0.000
Personal income (SD)	7,096.47 ± 12,673.54	5,552.55 ± 13,709.78	1.66	0.096
Marital status (n, %)			1.89	0.058
0 (non-single)	272 (65.38)	231 (58.93)		
1 (single)	144 (34.62)	161 (41.07)		
Physical illness (n, %)			8.24	0.000
0 (no)	410 (98.56)	49 (12.76)		
1 (yes)	6 (1.44)	343 (87.24)		
Mental disorder (n, %)			7.76	0.000
0 (no)	405 (97.36)	205 (52.30)		
1 (yes)	11 (2.64)	187 (47.70)		
Status in family (n, %)			6.86	0.000
0 (high)	409 (98.32)	336 (85.71)		
1 (low)	7 (1.68)	56 (14.29)		
Village stress and problems				
1. Housing	1.48 ± 0.89	1.54 ± 0.98	−1.02	0.308
2. Crime	1.47 ± 0.79	1.47 ± 0.81	0.07	0.939
3. Poverty	2.55 ± 1.16	2.61 ± 1.29	−0.75	0.455
4. Education	1.92 ± 1.17	2.03 ± 1.24	−1.30	0.196
5. Corruption	1.95 ± 1.24	1.92 ± 1.27	0.32	0.747
6. Family	1.63 ± 0.80	1.76 ± 0.91	−2.08	0.038
7. Transportation	1.66 ± 1.07	1.82 ± 1.176	−1.99	0.046
8. Health care	1.64 ± 10.01	1.95 ± 1.178	−4.03	0.000
9. Job security	2.14 ± 1.25	2.35 ± 1.35	−2.21	0.028
10. Ethnic tension	1.07 ± 0.44	1.09 ± 0.45	−0.25	0.803
11. Pollution	1.71 ± 1.166	1.46 ± 0.94	3.28	0.001
12. Drug abuse	1.07 ± 0.32	1.11 ± 0.37	−1.45	0.148
13. Alcohol abuse	1.53 ± 0.80	1.69 ± 0.93	−2.62	0.009
14. Child/spouse abuse	1.27 ± 0.59	1.31 ± 0.58	−0.91	0.364
15. Quality of life	1.85 ± 0.97	1.91 ± 1.01	−0.93	0.352
16. Security/safety	1.33 ± 0.72	1.38 ± 0.77	−0.96	0.336
17. Gambling	1.57 ± 0.90	1.65 ± 0.97	−1.15	0.124
18. Superstition	1.62 ± 0.89	1.73 ± 0.89	−1.70	0.088

One of our strategies was to create a multilevel measure of neighborhood risks in a group of pooled items using factor analysis and to investigate neighborhood risk differences in the association of suicide with multi-level modeling.

Factor Analysis

The ''principal factor'' method was used to find the least number of factors to account for the common variance of a large set of neighborhood variables, excluding variable-specific (unique) variance (Gorsuch 1983). Beginning with the 18 indicators used to represent the full range of neighborhood-related variables measured by the Community Stress and Problems scale (WHO 2002), we iteratively reduced the variable set to optimize the analysis. The final variable set for factor analysis included all the original 18 indicators (see Table 1).

The Kaiser criterion (eigenvalues > 1.0), cumulative percent of common variance explained and scree tests were employed to determine the optimal number of factors, and

a standard orthogonal rotation (Varimax) of the original neighborhood variable space was used to achieve a structure with independent (non-overlapping) factors, using the Horst (1965) normalization to eliminate the heavy weight of variables with high initial loadings. Rotated factors were assigned labels to describe the pattern of highly-loading variables (Horst 1965). Factor scores were generated by the Bartlett method (Gorsuch 1983), which calculates, for each individual, the ''weighted sum'' of their standardized value for every variable multiplied by the corresponding factor loading of the variable.

Multilevel Fixed Effect Logit Modeling

Because suicide is a binominal variable and the independent variables are located in two levels (individual level and neighborhood context level), multilevel binomial fixed effect models (one of Hierarchical Generalized Linear Models, HGLM) were used in this study to estimate the relative risk of young adult suicide associated with the demographics of individuals and the neighborhood factor scores.

Much social research involves hierarchical data structures in which a lower-level unit nested in a higher-level unit. In organizational studies for suicidal behavior, researchers might investigate how workplace or neighborhood characteristics influence the individuals' behaviors. Both individuals and neighborhoods are units in the analysis; variables are measured at both levels. Such data have a hierarchical structure with suicide individuals nested within neighborhoods. Individual behaviors or outcomes may be influenced not only by the characteristics of their own, but also by their social contexts.

Conventional single-level statistical models, such as ordinary linear regression or analysis of variance (ANOVA) are not suitable for multi-level data analysis, due to the standard deviation biased and the parameter estimation not consistency. In addition, conventional analysis could not properly assess the contextual effects. Analysis of multi-level data, appropriate statistical analysis model is multilevel models, also known as HGLMs (Raudenbush and Bryk 2002) or generalized linear mixed models (Breslow and Clayton 1993), which not only to correctly handle the hierarchical structural data with parameters estimation, but also to analyze the effects of micro and macro variables, and the cross-level interaction.

HGLM offers a coherent modeling framework for multilevel data with nonlinear structural models and non-normally distributed errors (Raudenbush and Bryk 2002). Normalized grand sample weights are applied so that findings can be generalized to the rural China. The contextual-level variable is grand mean-centered. HGLM takes the following equations:

Level-1 model:

$$\log\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1(\text{age}) + \beta_2(\text{education}) + \beta_3(\text{marital status}) + \beta_4(\text{physical disease}) + \beta_5(\text{mental disorder}) + \beta_6(\text{personal status}) + \varepsilon_0 \quad (1)$$

Level-2 model:

$$\begin{aligned} \beta_0 &= \gamma_{00} + \gamma_{01}(\text{community stresses}) + \gamma_{02}(\text{community behaviors}) + \mu_0 \\ \beta_1 &= \gamma_{10} \\ \beta_2 &= \gamma_{20} \\ \beta_3 &= \gamma_{30} \\ \beta_4 &= \gamma_{40} \\ \beta_5 &= \gamma_{50} \\ \beta_6 &= \gamma_{60} \end{aligned} \quad (2)$$

Mixed model:

$$\log\left(\frac{p}{1-p}\right) = \gamma_{00} + \gamma_{01}(\text{community stresses}) + \gamma_{02}(\text{community behaviors}) + \gamma_{10}(\text{age}) + \gamma_{20}(\text{education}) + \gamma_{30}(\text{marital status}) + \gamma_{40}(\text{physical disease}) + \gamma_{50}(\text{mental disorder}) + \gamma_{60}(\text{personal status}) + \mu_0 \quad (3)$$

The level-1 model is basically a binomial logit model regressing suicide outcomes on several individual level control variables, where "non-suicide" as control is the reference group. But the interpretation does not require specifying a given level of suicide outcomes which is compared to a specific reference group (Long and Freese 2005). Instead, the interpretation can be put in this way: how the odds of suicide are changed by a one unit increase in the explanatory variable. The level-2 model is a linear regression model which assumes a normally distributed error term μ_0. It regresses the intercept β_0 in the level-1 model on income inequality. The effects of the regressors (except the intercept β_0) in both models are treated as fixed rather than random effects. The intercept β_0 is a random coefficient which is associated with periods, such as the period attributable variation in suicide μ_0. Neighborhood risks are used to explain this period-attributable variation in suicide.

Results

Descriptive and Bi-Variate Analysis of the Community Stress and Problems

The 16 items of the standardized WHO SUPRE-MISS Community Stress and Problems Scale plus the two added

for this study were ranked by the respondents from 1 (not serious) to 5 (very serious). Table 1 describes the distribution of each of the 18 items between the villages with a suicide occurrence and the villages without a suicide occurrence. It shows that the villages that have had a suicide case tend to have more problems than those villages that did not have a suicide occurrence. Only two out of the 18 community stress and problems were more likely to exist in a no-suicide village. They are officials' corruption and pollution. The problems significantly stronger (with a P value lower than 0.05) in a village where there has been a recent suicide than in a no-suicide village include the following, ranked by the t test from high to low: (1) health care, (2) alcohol abuse, (3) job security, (4) family dispute, and (5) transportation.

Factor Distribution of the Community Stress and Problems Scale

The rotation method of Quartimax with Kaiser Normalization yielded two components of the 18 community stress and problem items. As can be seen in Table 2, factor 1 can be summarized as social structural stresses and factor 2 can be understood as community behavioral problems.

As shown in Table 2, the two identified factors can be used as two variables by summing up the totals of their respective items for more advanced analyses. The social structural stresses (Factor 1) include items 1 through 11, 15, and 16. The community behavioral problems (Factor 2) include items 12 through 14, 17, and 18.

Table 2 Rotated component matrix of the community stress and problems scale on the case control sample ($n = 808$) in rural China

Village stress and problems	Component	
	1	2
1. Housing	0.547	−0.122
2. Crime	0.419	0.258
3. Poverty	0.635	−0.096
4. Education	0.677	−0.014
5. Corruption	0.548	0.028
6. Family	0.569	0.206
7. Transportation	0.563	−0.021
8. Health care	0.663	0.038
9. Job security	0.653	−0.026
10. Ethnic tension	0.445	0.186
11. Pollution	0.438	0.108
12. Drug abuse	0.442	0.533
13. Alcohol abuse	0.251	0.573
14. Child/spouse abuse	0.003	0.637
15. Quality of life	0.606	0.046
16. Security/safety	0.439	0.333
17. Gambling	0.382	0.612
18. Superstition	0.395	0.548

Extraction method: principle component analysis

Rotation method: Quartimax with Kaiser Normalization

Multilevel Fixed Effect Logit Modeling Predicting Suicide Risks

In order to assess the effect of the community stress and problems on suicide risks in the villages, we ran a multilevel logit model with the two neighborhood factors (Social Structural and Community Behavioral) as our major predictors and the selected demographic and personal variables as confounding correlates. Results of the analyses are shown in Table 3.

As shown in Table 3, the unconditional model indicates the log odds of suicide across the neighborhood factors does vary significantly ($\tau_{00} = 0.25$; $P = 0.000$). As shown in the conditional model selected by LR test, there is a nearly significant ($\tau_{00} = 0.19$; $P = 0.000$) positive association between neighborhood-level factors (level-2 model) and suicide, where about 19% of the variance in the log odds of suicide across neighborhoods is explained. The individual-level model (level-1 model) shows that suicide is associated with being older, having fewer education years, being single, having poor physical condition, having mental disorder, and having lower status in family. As can be seen from Table 3, gender and personal income did not come into the final multilevel fixed effect logit regression model.

We can noticed that the intercept variance, τ_{00}, was reduced from 0.25 to 0.19 after the variables of social stresses and social climate were introduced into the model. Not surprisingly, over 24% of the variance in adjusted community log-odds of suicide incidence was accounted for by the structural stresses and behavioral problems in the community. Even so, substantial between-community variability in both community average incidence ratios and differentiating effects of community still remain unexplained. This suggests possible differences among communities in their internal structures and policies, which might account for some of these effects.

In level-2 model, as controlling other variables, the more community stresses, the more odds of suicide ($\exp^{0.22} = 1.10$). That is, the odds of suicide increased 10% resulted from the each unit of community stresses increased. On the same time, the more serious the behavioral problems in a neighborhood, the more odds of suicide ($\exp^{0.22} = 1.25$). That is, each increased unit of the factor consisting of community substance abuse, child/wife abuse, gambling, prostitution, and the extent of the deterioration will lead to the odds of suicide multiplied by 1.25.

Table 3 Multilevel fixed effect logit regression predicting suicide risks in rural China ($n = 808$)

Fixed effects parameter		(a) Unconditional model				(b) Conditional model			
		Coef.	SE	*t* ratio	*P*	Coef.	SE	*t* ratio	*P*
Neighborhood level variables (level-2)									
Intercept, β_0	Intercept, γ_{00}	0.48	0.02	25.57	0.000	0.49	0.02	31.32	0.000
	Structural stresses, γ_{01}					0.09	0.04	2.54	0.012
	Behavioral problems, γ_{02}					0.22	0.04	3.16	0.002
Individual level variables (level-1)									
Age slope, β_1	γ_{10}					0.06	0.01	7.32	0.000
Education years slope, β_2	γ_{20}					−0.28	0.02	−17.09	0.000
Marital status slope, β_3	γ_{30}					1.01	0.10	9.66	0.000
Physical illness slope, β_4	γ_{40}					1.65	0.29	12.91	0.000
Mental disorderβ_5	γ_{50}					1.89	0.21	9.17	0.000
Status in family slope, β_6	γ_{60}					1.98	0.19	10.34	0.000
Intercept variance component between-group, τ_{00}		0.25			0.000	0.19			0.000

Control group as reference group in dependent variable

All estimates are based on the unit-specific models

All predictors have been centered on their grand mean

Conclusion

As of now we are not aware of much literature in the effects of neighborhood community factors on suicide risks, this study might contribute to the suicide literature relating specific environmental issues to suicide. We selected the scale of Community Stress and Problems from the WHO SUPRE-MISS project (WHO 2002) to assess the neighborhood factors as it has been an internationally well known and validated scale. We selected a Chinese sample to conduct the study because of the comparatively large number of suicides accumulated within a short period of time due to China's large and concentrated populations. More important, findings in the effects of neighborhood factors on suicide from this international sample should be able to generate similar studies in other societies such as the United States so as to promote suicide prevention at the community level.

With data from 392 completed young suicides and 416 living controls from China, it was found that community stress and problems increase rural young Chinese suicide risks, with the individual behavioral problems (odds = 1.25) in the community playing a stronger role in increasing suicide risk in a Chinese village than the social structural stresses (odds = 1.10) in the community. Certain community stresses and problems such as those in health care, alcohol abuse, job security, family dispute, and transportation, play more important roles than others to increase rural Chinese suicide risks. Social factors such as the community stress and problems can be another area to work on for the suicide prevention.

One limitation of the study is the size of the sample. With 18 items in the community stress and problems, a sample of 392 suicides and 416 controls is limited to its ability to explore the effect of each item separately. Although we solved the problem by collapsing the 18 items into two factors (social structural stresses and individual behavioral problems), we have lost much information that can be obtained from each item of the community factors. Future studies with larger samples are expected to employ Linear Equation Modeling to provide more specific knowledge of the effect of each social factor on the suicide risk in Chinese rural communities.

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