

Effect of smoking on suicide in adolescents with major depressive disorder

Xinglian Zhang¹, Jiaquan Liang^{1,*}

¹The Third People's Hospital of Foshan, Foshan, Guangdong, 528000, China

*Corresponding author

Keywords: Adolescents; Major depressive disorder; Suicide; Smoking; Behavior

Abstract: The prevalence of major depressive disorder (MDD) has increased in all age groups, and adolescents are growing faster than adults. Many adolescents with MDD have smoking behavior, which may be a risk factor for suicidal behavior. Methods Adolescents with MDD (AMDD, 12≤age≤18 years old) were from 16 mental health centers in 9 provinces in China. They were divided into never smoking, previous smoking and current smoking, assessed with Generalized Anxiety Disore-7 (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) scales, as well as suicidal ideation and suicide behavior records. Thenspearman correlation and binary logistic regression were used to analyze the relationship between smoking and suicide. The incidence of suicide in never, previous and current smoking groups were 41.74%, 66.67% and 62.50%. Most of the suicide methods used by AMDD were cutting skin or blood vessels (50.13%), taking poisons, drugs or alcohol (30.42%) and falling to death (11.64%). Spearman correlation analysis showed that the occurrence of suicidal behavior was positively correlated with smoking ($r_s = 0.139$, $p < 0.001$) and the score of GAD-7 ($r_s = 0.172$, $p < 0.001$) / PHQ-9 ($r_s = 0.238$, $p < 0.001$). Binary logistic regression results determined that current smoking (OR = 2.227, $p < 0.001$) and previous smoking (OR = 2.337, $p < 0.001$) were the risk factors for suicide. Each unit of PHQ-9 score increased the suicide risk by 8.2%.Smoking is the risk factor for suicidal behavior. In the treatment of AMDD, strengthen the education on smoking prohibition is essential.

1. Introduction

Considered to be the second leading cause of disability, MDD is a common mental disease[1]. It seriously limits psychosocial function and reduces the quality of life[1]. According to China's epidemiological statistics, the annual prevalence of depression is 3.2-4.1%[2]. At present, the prevalence of MDD has increased in all age groups, but adolescents are growing faster than adults[3, 4]. This has brought a serious problem: adolescent suicide. It has become one of the main causes of adult death and deserves our attention [5, 6].

It is widely accepted that mental illness is closely related to the risk of suicide[7, 8]. At the same time, the impact of smoking on suicide is still worth exploring. Many adolescents have smoking habits[9], especially for patients with depression[10]. Smoking is easy to cause nicotine dependence. Teenagers' brains are still developing, exposure to nicotine while they are still adolescence can

damage the developing brain [11], cognition, attention and emotion[12, 13]. It is considered as a risk factor of suicidal behavior. While some studies suggested that smoking can alleviate acute negative emotions, which may help improving depression, stress, and anxiety.

In order to explore the effect of smoking on suicidal behavior in adolescents with AMDD, we collected patients from 19 mental health centers over China to analyze the relationship between smoking and suicide.

2. Method

2.1 Participants and Assessments

MDD ($12 \leq \text{age} \leq 18$ years old), meeting the diagnostic criteria of the fourth edition of the diagnostic and Statistical Manual of mental disorders (DSM-IV), were from 19 mental health centers in 9 provinces in China, from July 2019 to December 2021.

The definition of smoking category includes tobacco cigarettes, e-cigarettes, and waterpipe smoking. According to the smoking situation, they were divided into never smoking, previous smoking (less than 20 cigarettes in total, or smoking regularly in the past), current smoking (at least 1 cigarette per day, more than 5 days a week). Through the interviews, their names, gender, age and education were collected. Then, they would be required to complete Generalized Anxiety Disorder 7-Item Scale (GAD-7) and Patient Health Questionnaire-9 (PHQ-9) assessments, as well as suicidal ideation and suicide behavior records.

Exclusion criteria: Firstly, it is the comorbidity of other mental disorders, including mental retardation or other cognitive impairment; the second is patients with severe and unstable physical diseases, including severe kidney or liver function damage, cardiac insufficiency, etc; Thirdly, those who didn't cooperate with scale evaluation; Fourthly, it is drinking habits or other substance abuse.

The protocol of this study was approved by the ethicscommittee of the Third People's Hospital of Foshan. The experiments were conducted following the declaration of Helsinki. We obtained notice in writing consents from all patients and their legal guardian(s).

2.2 Data analyses

We used Statistical Product and Service Solutions 21 software (<https://www.ibm.com/analytics/spss-statistics-software>) to analyze the data. One way ANOVA and chi square test were used to compare the differences between general demographic data and clinical evaluation data.

The relationships of suicide and various indicators were analyzed by Spearman correlation. Then Binary logistic regression was used to analyze the influence of each index component on suicidal behavior.

3. Result

3.1 Comparison of demographic characteristics, clinical scale scores and suicide methods

2343 participants were included in this study. There were no significant differences in age, habitation, gender and education. The results of one-way ANOVA showed that there were significant differences in GAD-7 and PHQ-9 scores among different smoking groups. Bonferroni post-hoc analyses determined that previous smoking group was higher than never smoking group ($p < 0.05$) in GAD-7 scores. Previous smoking group was higher than never smoking group ($p < 0.05$) and current smoking group ($p < 0.05$) in PHQ-9 scores. The incidence of suicide in different groups were 41.74%, 66.67% and 62.50%, which means the incidence of suicide increases regardless of

current smoking or previous smoking. (Table 1)

Most of the suicide behavior used by AMDD were cutting skin or blood vessels (50.13%), taking poisons, drug or alcohol (30.42%) and falling to death (11.64%). (Table 2)

Table 1: Comparison of demographic characteristics in AMDD

		AMDD			Statistics (F/ χ^2)	p
		Never smoking n=2089	Previous smoking n=102	Current smoking n=152		
Age (year)		14.98 \pm 1.65	15.17 \pm 1.54	15.07 \pm 1.69	0.805	0.447
Habitation (Urban / rural)		1406/683	65/37	109/43	1.921	0.383
Gender (male/female)		454/1635	28/74	35/117	1.936	0.380
Education (year)		9.14 \pm 1.75	9.48 \pm 1.67	9.33 \pm 1.89	2.544	0.079
GAD-7 ^a		11.90 \pm 6.29	14.84 \pm 5.52	13.11 \pm 6.17	12.901	<0.001*
PHQ-9 ^{ac}		16.60 \pm 7.24	20.19 \pm 6.84	17.97 \pm 6.83	14.073	<0.001*
Negative thoughts and behaviors	No suicidal ideation (n)	138	3	6	46.785	<0.001*
	Suicidal ideation (n)	1079	31	51		
	Suicidal behavior (n) ^{ab}	872	68	95		
	Suicidal ideation (%)	51.65	30.39	33.55	-	-
	Suicidal behavior (%)	41.74	66.67	62.50	-	-

Note: AMDD adolescents with major depressive disorder; GAD-7 Generalized Anxiety Disorder 7-Item Scale; PHQ-9 Patient Health Questionnaire-9; a: never smoking vs previous smoking, b: never smoking vs current smoking, c: previous smoking vs current smoking, p<0.05; * means the comparison among groups (p<0.05); Values are expressed as mean \pm standard deviation.

Table 2: Suicide methods in AMDD

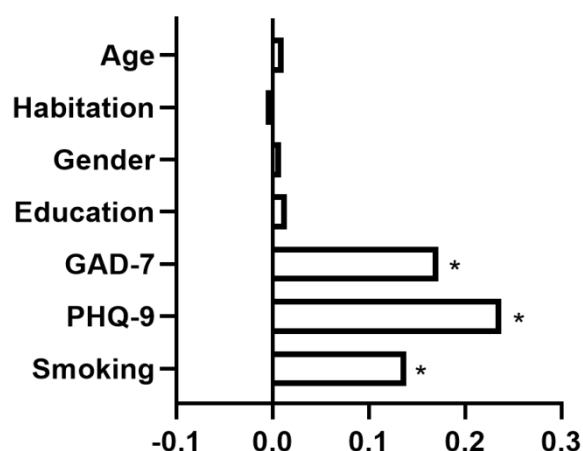
Suicide	Cut skin or blood vessels	Take poisons, drugs or alcohol	Fall to death	Drown	Hang	Hit the head	traffic accident	carbon monoxide poisoning	fasting	others	total
n	982	596	228	51	48	32	8	7	3	4	1959
n%	50.13	30.42	11.64	2.60	2.45	1.63	0.41	0.36	0.15	0.20	100

Note: Others included tongue biting, self-immolation and suffocation with plastic bags.

3.2 Spearman correlation between suicide and various indexes

Spearman correlation analysis showed that the occurrence of suicidal behavior was positively correlated with smoking ($r_s = 0.139$, $p < 0.001$) and the score of GAD-7 ($r_s = 0.172$, $p < 0.001$) / PHQ-9 ($r_s = 0.238$, $p < 0.001$). Age ($r_s = 0.012$, $p = 0.563$), habitation ($r_s = -0.007$, $p = 0.719$), gender ($r_s = 0.009$, $p = 0.661$) and education ($r_s = 0.015$, $p = 0.462$) had no correlation with suicide. (Figure 1)

Occurrence of suicidal behavior

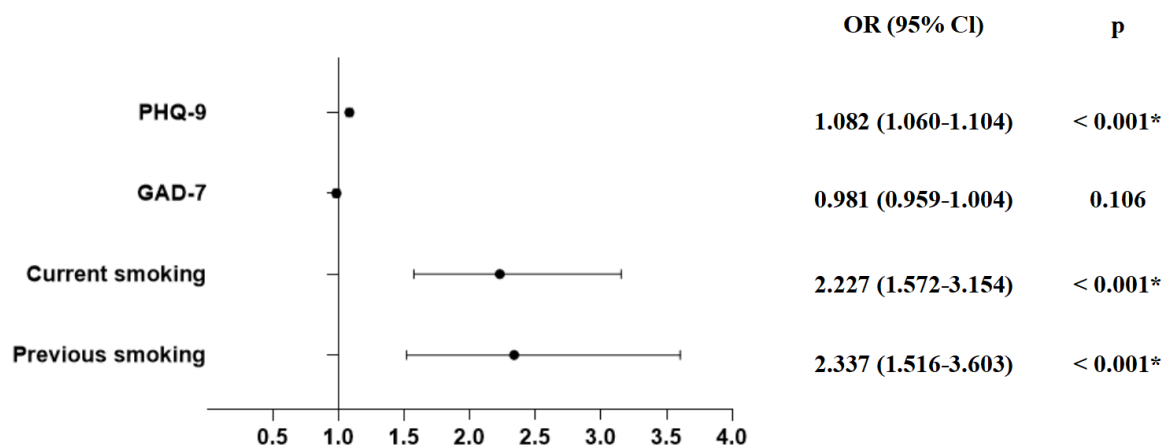


* meant significant correlation, $p < 0.05$; the occurrence of suicidal behavior was positively correlated with smoking ($r_s = 0.139$, $p < 0.001$) and the score of GAD-7 ($r_s = 0.172$, $p < 0.001$) / PHQ-9 ($r_s = 0.238$, $p < 0.001$); Age ($r_s = 0.012$, $p = 0.563$), habitation ($r_s = -0.007$, $p = 0.719$), gender ($r_s = 0.009$, $p = 0.661$) and education ($r_s = 0.015$, $p = 0.462$) had no correlation with suicide.

Figure 1: Spearman correlation between suicide and various indexes.

3.3 Binary logistic regression analysis of suicide influencing factors

With suicide as dependent variable (Y), smoking, GAD-7 and PHQ-9 as independent variables (X), age, habitation, gender, education as covariates, a binary logistic regression model (Hosmer-Lemeshow test, $p > 0.05$) was established. Both current smoking (OR = 2.227, $p < 0.001$) and previous smoking (OR = 2.337, $p < 0.001$) were the risk factors for suicide. For every additional unit of PHQ-9 score, the risk of suicidal behavior increased by 8.2%. It can be shown in Figure 2.



PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder 7-Item Scale; OR, Odds ratio; * meant $p < 0.05$; Binary logistic regression model (Hosmer lemeshow test, $P > 0.05$); current smoking (OR = 2.227, $p < 0.001$) and previous smoking (OR = 2.337, $p < 0.001$) were the risk factors for suicide. Each unit of PHQ-9 score increased the suicide risk by 8.2%.

Figure 2: Binary logistic regression analysis of suicide influencing factors.

4. Discussion

Our study collected adolescent patients with depressive disorder from 16 mental health centers across China. By assessing their smoking and suicide, we concluded that smoking was a risk factor for suicide.

Through the investigation, we found that the most of the suicide methods used by AMDD was cutting skin or blood vessels. The second was taking poisons, drugs or alcohol. And the third was dying. Such results remind us that as clinicians, we need to notice the suicide mode of patients and urge their guardians to strengthen prevention, so as to achieve early intervention.

In addition, our study showed that PHQ-9 score in previous smoking group was higher than current smoking and never smoking groups in AMDD. Previous studies have shown that people's emotional reactions, including loss of pleasure, anxiety sensitivity and pain tolerance, were related to smoking behavior. In the withdrawal period after smoking cessation, the human body will experience nicotine withdrawal symptoms such as irritability, anxiety and confusion, which further deepens the depression state. For patients who smoke regularly at present, they often try to maintain a good mood by constantly smoking, which may also be the inducement of smoking in patients with MDD. Of course, never smoking people have the lowest level of depression among of them.

When people smoke, nicotine quickly enters the brain, which can promote long-term sensitization and short-term impulse, weakens behavioral regulation and is prone to negative effects, continuous smoking and suicidal behavior, especially for adolescent with mental illness. Besides, intermittent hypoxia caused by cigarettes or e-cigarettes can synergistically promote impulse and aggravate suicidal behavior. Combined with the results of our correlation analysis, smoking was positively correlated with the degree of anxiety and depression in AMDD, which indicated that our results were consistent with those of predecessors. Moreover, our results suggest that not only current smoking is related to suicide, but also previous smoking. Therefore, in the treatment of AMDD, we should pay attention to health education to keep adolescents away from tobacco.

However, our study has limitations that the determination of suicidal ideation and behavior can only be defined by interviewing subjects, and our study does not include death by suicide, which may cause deviation. Therefore, caution is still needed in deriving the conclusion.

In summary, both previous smoking and current smoking are the risk factors for suicidal behavior. In the treatment of AMDD, strengthen the education on smoking prohibition is essential.

Acknowledgements

This study was supported by the project of Foshan Science and Technology Bureau (2020001005782).

References

- [1] Lu J, Xu X, Huang Y, Li T, Ma C, Xu G, Yin H, Xu X, Ma Y, Wang L et al. Prevalence of depressive disorders and treatment in China. a cross-sectional epidemiological study. *The lancet Psychiatry* 2021, 8(11).981-990.
- [2] Huang Y, Wang Y, Wang H, Liu Z, Yu X, Yan J, Yu Y, Kou C, Xu X, Lu J et al. Prevalence of mental disorders in China. a cross-sectional epidemiological study. *The lancet Psychiatry* 2019, 6(3).211-224.
- [3] Weinberger AH, Gbedemah M, Martinez AM, Nash D, Galea S, Goodwin RD. Trends in depression prevalence in the USA from 2005 to 2015. widening disparities in vulnerable groups. *Psychological medicine* 2018, 48(8).1308-1315.
- [4] Miller L, Campo JV. Depression in Adolescents. *The New England journal of medicine* 2021, 385(5).445-449.
- [5] Kim S, Rush BS, Rice TR. A systematic review of therapeutic ketamine use in children and adolescents with treatment-resistant mood disorders. *European child & adolescent psychiatry* 2021, 30(10).1485-1501.
- [6] Breslin K, Balaban J, Shubkin CD. Adolescent suicide. what can pediatricians do? *Current opinion in pediatrics* 2020, 32(4).595-600.
- [7] Yates K, Lång U, Cederlöf M, Boland F, Taylor P, Cannon M, McNicholas F, DeVlyder J, Kelleher I. Association of

- Psychotic Experiences With Subsequent Risk of Suicidal Ideation, Suicide Attempts, and Suicide Deaths. A Systematic Review and Meta-analysis of Longitudinal Population Studies. JAMA psychiatry* 2019, 76(2).180-189.
- [8] Oh H, Lee J, Kim S, Rufino KA, Fonagy P, Oldham JM, Schanzer B, Patriquin MA. Time in treatment. Examining mental illness trajectories across inpatient psychiatric treatment. *Journal of psychiatric research* 2020, 130.22-30.
- [9] Ho SY, Chen J, Leung LT, Mok HY, Wang L, Wang MP, Lam TH. Adolescent Smoking in Hong Kong. Prevalence, Psychosocial Correlates, and Prevention. *The Journal of adolescent health. Official publication of the Society for Adolescent Medicine* 2019, 64(6s).S19-s27.
- [10] Thomas KH, Martin RM, Davies NM, Metcalfe C, Windmeijer F, Gunnell D. Smoking cessation treatment and risk of depression, suicide, and self harm in the Clinical Practice Research Datalink. prospective cohort study. *BMJ (Clinical research ed)* 2013, 347.f5704.
- [11] Zorlu N, Cropley VL, Zorlu PK, Delibas DH, Adibelli ZH, Baskin EP, Esen Ö S, Bora E, Pantelis C. Effects of cigarette smoking on cortical thickness in major depressive disorder. *Journal of psychiatric research* 2017, 84.1-8.
- [12] Perry BI, Stochl J, Upthegrove R, Zammit S, Wareham N, Langenberg C, Winpenny E, Dunger D, Jones PB, Khandaker GM. Longitudinal Trends in Childhood Insulin Levels and Body Mass Index and Associations With Risks of Psychosis and Depression in Young Adults. *JAMA psychiatry* 2021, 78(4).416-425.
- [13] Owens DK, Davidson KW, Krist AH, Barry MJ, Cabana M, Caughey AB, Curry SJ, Donahue K, Doubeni CA, Epling JW, Jr. et al. Primary Care Interventions for Prevention and Cessation of Tobacco Use in Children and Adolescents. *US Preventive Services Task Force Recommendation Statement. Jama* 2020, 323(16).1590-1598.