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Assessment of executive functions of poisoning following suicide

Nastaran Eizadi-Mood[1], Parisa Pourabadei[2], Farzad Yousefinia[3], Masoud Ashraf-Isfahani[4], Gholamali Dorooshi[1], Mohammad Mahdi Zakeri[5], Rokhsareh Meamar[6]

1 Department of Clinical Toxicology, School of Medicine AND Clinical Toxicology Research Center, Isfahan University of Medical Sciences, Isfahan, Iran
2 Department of Psychology, School of Literature and Humanities, Lorestan University, Khorramabad, Iran
3 Department of Neuroscience, School of Modern Medical Sciences and Technologies, Shiraz University of Medical Sciences, Shiraz, Iran
4 Department of Psychology, School of Education and Psychology, Shiraz University of Medical Sciences, Shiraz, Iran
5 Department of Clinical Psychology, School of Psychology and Education, Kharazmi University, Tehran, Iran
6 Department of Clinical Toxicology, School of Medicine AND Isfahan Clinical Toxicology Research Center, Khorshid Hospital, Isfahan University of Medical Sciences, Isfahan, Iran

Original Article

Abstract

BACKGROUND: In the present study, we investigated the executive functions (EFs) following suicide with acute poisoning.

METHODS: In this cross-sectional study from April to August 2020 in Khorshid Hospital affiliated with Isfahan University of Medical Sciences, Isfahan, Iran, adult poisoned patients (n = 120) suffering from suicide were selected by convenience sampling method and divided into three groups: recurrent suicide attempts, and suicide attempts for the first time with and without previous psychiatric disorders. Continuous performance tests (CPTs) including commission error components, omission response, correct response, and response time were used to evaluate EFs. Chi-square and Fisher's exact test were used to analyze qualitative variables. Moreover, multi-dimensional regression analysis was used to find the predictors of recurrent suicide in SPSS software.

RESULTS: A significant difference among the patients of the three groups regarding their all-subgroup CPT scores was observed (P < 0.05). The omission response and response time components were higher in patients with a history of psychiatric disorder than in the other two groups. However, in the commission error component, the mean scores were higher in the patients with recurrent suicide. There was also a significant difference in the omission response (P = 0.008), the response time (P = 0.04), and the correct answer (P = 0.016) concerning patients' education. In multivariate regression analysis, the education level predicted recurrent suicide attempts. Patients with education less than high school [odds ratio (OR): 13.23, 95% confidence interval (CI): 1.5-115.7, P = 0.02] and diploma (OR: 11.35, 95% CI: 1.30-96.88, P = 0.026) had more chance of recurrent suicide.

CONCLUSION: This study provides important information regarding the interventions with an education that can help prevent suicide.

KEYWORDS: Executive Function; Impulse-Control Disorders; Poisoning; Attention; Suicide

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Introduction

Suicide is globally a leading cause of death with the World Health Organization (WHO) estimating that one person dies by suicide every 40 seconds.[1] This public health concern may seem more disturbing and confusing among young people about suicidal deaths. In 2017, suicide was estimated to be the second leading cause of death among individuals aged 10-24.[1,2] In Iran, a 20-year trend designates

Corresponding Author:
Rokhsareh Meamar; Department of Clinical Toxicology, School of Medicine, Isfahan Clinical Toxicology Research Center, Khorshid Hospital, Isfahan University of Medical Sciences, Isfahan, Iran
Email: meamar@med.mui.ac.ir

enhanced suicidal deaths with an estimated average rate of 9.9 per 100000 persons per year.[3]

Many factors are presented as suicidal behavior in people. Results recommend that religious belief is related to lessening suicide attempts.[4] Each population has specific cultural and social features directly affecting suicidal manners and thoughts.[5]

Low income, unemployment, and financial difficulties were recognized as risk factors for all suicidal manners.[6] According to WHO data, in 2016, the global male/female ratio of age-standardized suicide rates was 1.8, meaning that worldwide, men complete suicide almost twice as often as women.[7] On the other hand, educational attainment causally reduces the risk of suicide attempts.[8]

Mental disorders are considered a risk factor for suicidal behaviors among young people.[9] In addition, a large percentage of people who die by suicide had at least one type of psychiatric disorder at the time of death, including mood disorders, anxiety disorders, and antisocial behaviors.[10] Most people who attempt suicide have a previous history, and if it is the first time to attempt suicide, they are more likely to attempt suicide next time because it is estimated that attempting suicide increases the risk of completed suicide by 32%.[11]

Studies have demonstrated that neuropsychological disorders in psychiatric disorders may be associated with a risk of suicidal behavior.[12] The prefrontal cortex (PFC) and its neural circuits play a key role in the underlying executive functions (EFs) and automatic emotion regulation.[13] EFs are mainly conceptualized as a set of cognitive processes necessary to form the basis of purposeful behaviors, behavior organization, response inhibition control, cognitive flexibility, and problem-solving.[14]

In 2017, a systematic review provided experimental support for the relationship between EF and suicide. But most importantly, it may be moderated by other factors.[15]

Fernández-Sevillano et al. proposed that executive dysfunction could be a risk factor for suicide.[16]

A study planned in Iran indicated that individuals with suicidal ideation or previous attempts had poorer cognitive control and cognitive emotion regulation than controls.[17]

Due to the prevalence of suicide in patients with acute poisoning, we investigated the EFs based on having a history of mental illness or recurrent suicide attempts for the first time in Iran.

Methods

This cross-sectional study was performed in the poisoning referral center in Isfahan, Iran. Adult patients with acute intentional poisoning who were hospitalized in Khorshid Hospital affiliated with Isfahan University of Medical Sciences from April until August 2020 were included in the study. The sample size was calculated.

$$n_A = \frac{2(Z_{1-\alpha/2} + Z_{1-\beta})^2}{\Delta^2} + \frac{Z^2_{1-\alpha/2}}{4}$$

To detect standardized differences for EF variables between the compared groups, it was necessary to examine 34 patients, but due to the small number of cases of patients with repeated suicide and homogenization between groups, the number of samples in all groups was limited to 30 patients ($\alpha = 0.05$, $1-\beta = 0.80$, $\Delta = 1$ [۱۷]). Patients were selected by convenience sampling and assigned into three groups: recurrent suicide attempts, and suicide attempts for the first time with and without a previous diagnosis of psychiatric disorder. All patients filled out consent forms for inclusion in our study.

Previous diagnosis of psychiatric disorders means people who have been diagnosed with any mood and personality disorder by a psychiatrist during the past year and have been prescribed any psychiatric medication by a general practitioner or psychiatrist. Inclusion

criteria were as follows: giving consent to participate in the study, having no diagnosis of confirmed psychosis, and being 20-40 years old. Moreover, exclusion criteria were: dissatisfaction with the patients or their families, not cooperating enough to complete the test, and lack of patient consciousness and ability to perform it. A questionnaire consisted of demographic information given to the patients to fill out and the previous history of psychiatric patients as well as their suicide motives. One experienced psychologist filled out all the questionnaires regarding included patients. Labeling suicide and filling out the relevant questionnaire was one of the essential factors in dropping samples. A continuous performance test (CPT) was used to evaluate the executive control of attention.[18] Components of CPT are commission error, omission response, correct response, and response time. This test is used to assess attention and impulsivity. It includes four variables of commission error, omission response, response time, and correct response. The reliability coefficients of the different sections of the test were conducted on 43 elementary school boys with an interval of 20 days, ranging from 0.59 to 0.93. The calculated coefficients had a significant correlation at the P = 0.001 level. The validity of the test was performed by comparing the normal group to the attention deficit and hyperactivity group. It was noticed that there was a significant difference between the performances of the two groups in Iran.[18] In addition, this result was obtained in another study.[19]

Statistical analysis: The statistical analysis of the data was based on central and dispersion indices, multivariate analysis of variance (MANOVA), and Tukey's post hoc test. Chi-square and Fisher's exact test were used to analyze qualitative variables. Moreover, multi-dimensional regression analysis was used to find the predictors of recurrent suicide. In this analysis, the data related to repeated suicide and suicide for the first time with or without a previous diagnosis of psychiatric disorder were entered into the model as inter-subject factors and the scores of the components of the CPT as dependent variables. P-values less than 0.05 were considered significant differences. Data were analyzed using SPSS software (version 20, IBM Corporation, Armonk, NY, USA). In this research, compliance with the ethical principles of the research included obtaining informed consent from the research participants, ensuring the privacy of the participants and the confidentiality of the information, having the right to withdraw from the research, and respecting the privacy of the participants. This study was approved by the Research Ethics Committee of Isfahan University of Medical Sciences (Ethical number: IR.MUI.MED.REC.1397.347) and adhered to the Declaration of Helsinki and APA ethical standards.

Results

The demographic characteristics of the three study groups are presented in table 1. Ninety patients were equally divided into groups, each group including 30 patients (female/male = 1:1). There was no significant difference between defined groups based on gender, marital status, and suicide motivation. 46 (51%) patients were single. Eight (9%) of total patients were divorced. There were significant differences between the education level (P = 0.001) and employment status (P = 0.017) between defined groups. Among patients in the group with recurrent suicide, diploma (n = 15, 50%) and also high school education (n = 14, 46.7%) were more observed than in other groups. On the other hand, higher education than a diploma in recurrent suicide group (n = 1, 3.3%) was less indicated.

In employment status, unemployed patients (n = 13, 43.3%) were seen in groups with suicide attempts for the first time with a previous diagnosis of psychiatric disorder.

Table 1. Demographic information of studied groups

Variable		Patients with recurrent suicide	Patients with first-time suicide		P
			Suicide without a previous diagnosis of a psychiatric disorder	Suicide with a previous diagnosis of a psychiatric disorder	
Gender	Women	15 (50.0)	15 (50.0)	15 (50.0)	NS
	Men	15 (50.0)	15 (50.0)	15 (50.0)	
	Total	30 (100)	30 (100)	30 (100)	
Marital status	Single	16 (53.3)	15 (50.0)	15 (50.0)	0.910
	Married	12 (40.0)	11 (36.7)	13 (43.3)	
	Divorced	2 (6.7)	4 (13.3)	2 (6.7)	
	Total	30 (100)	30 (100)	30 (100)	
Education	High school	14 (46.7)	5 (16.7)	9 (30.0)	0.001
	Diploma	15 (50.0)	14 (46.7)	6 (20.0)	
	Associate degree	-	5 (16.7)	7 (23.3)	
	Bachelor	1 (3.3)	6 (20.0)	8 (26.7)	
	Total	30 (100)	30 (100)	30 (100)	
Employment status	Unemployed	6 (20.0)	7 (23.3)	13 (43.3)	0.017
	Housewife	4 (13.3)	7 (23.3)	6 (20.0)	
	Self-employed	12 (40.0)	7 (23.3)	11 (36.7)	
	Student	7 (23.3)	4 (13.3)	-	
	Employee	1 (3.3)	4 (13.3)	-	
	Total	30 (100)	30 (100)	30 (100)	
Suicide motivation	Ending life	24 (80.0)	22 (73.3)	24 (80.0)	0.850
	Asking for help	6 (20.0)	8 (26.7)	6 (20.0)	
	Total	30 (100)	30 (100)	30 (100)	

Data are presented as number (percent)
NS: Not significant

However, employee patients (n = 4, 13.3%) were more common in groups with suicide attempts for the first time without a previous diagnosis of psychiatric disorder. The highest and lowest number of patients was in the housewife (n = 30, 33.3%) and employee (n = 5, 5.5%) groups, respectively. On the other hand, ending life was the main suicide motivation in all groups. Indeed, ending life was the main cause for suicide motivation in 24 (80%), 22 (73.3%), and 24 (80%) individuals in recurrent suicide attempts and suicide attempts for the first time with and without a previous diagnosis of psychiatric disorder, respectively.

The individuals' scores by the group in the components of CPT are shown in table 2. There was a significant difference in all variables among the three groups.

The mean ± standard deviation (SD) in omission response (6.67 ± 5.65, P = 0.003) and response time (567.07 ± 127.60, P = 0.030) components of the suicide group with a history of psychiatric disorder was higher than those of the other two groups.

Table 2. The scores of the components of the continuous performance test (CPT) in the studied groups

Variable	Patients with recurrent suicide	Patients with first-time suicide		P
		Suicide without a previous diagnosis of a psychiatric disorder	Suicide with a previous diagnosis of a psychiatric disorder	
	Mean ± SD	Mean ± SD	Mean ± SD	
Commission	3.27 ± 3.85	1.50 ± 1.54	2.60 ± 2.11	0.042
Omission	3.90 ± 4.85	2.50 ± 3.35	6.67 ± 5.65	0.003
Correct response	142.90 ± 6.83	145.80 ± 4.38	140.97 ± 6.29	0.008
Response time	497.53 ± 89.05	510.00 ± 110.17	567.07 ± 127.60	0.038

SD: Standard deviation

In addition, in the commission error component, the mean scores of the recurrent suicide group (3.27 ± 3.85, P = 0.04), and in the correct response component, the mean scores of the suicide group without a history of psychiatric disorder were higher than those of the other groups (145.80 ± 4.38, P = 0.008) (Table 2).

In addition, there was a significant difference in response omission (P = 0.008), response time (P = 0.04), and correct response (P = 0.016) regarding patient education. Regression analysis showed that low education level could be considered a risk factor for recurrent suicide; therefore, in the group with education less than a high school diploma [odds ratio (OR): 14.0, 95% confidence interval (CI): 1.60-121.37, P: 0.017] and the group with high school diploma (OR: 10.5, 95% CI: 1.20-88.90, P: 0.03), there was a significant increase in the risk of recurrent suicide.

The results of the Levene's test showed that the assumption of homogeneity of variance was confirmed (P < 0.05). Pillai's trace test and Wilks' lambda test were performed to evaluate the significance of multivariate effects. In this analysis, the groups (repeated suicide, suicide group with and without a history of psychiatric disorder) as the factor between the subject group and the scores of the components of the CPT (commission error, omission response, correct response, and response time) as dependent variables were entered in the model. The results of this analysis in table 3 illustrate that there is a significant difference between the study subjects of the three groups in the new variable derived from the linear combination of the components of the four types of CPTs as dependent variables (Pillai's trace = 0.238, Wilks' lambda = 0.775, P = 0.005, F = 2.85) (Table 3).

Discussion

This study was planned to evaluate EFs based on having a history of psychiatric disorder or recurrent suicide attempts in patients with poisoning. The results of the current study showed that there was a significant difference between the three groups of patients regarding EFs. Individuals who had suicide with a history of psychiatric disorder obtained the highest score in two components of omission response and response time, and patients without a history of psychiatric disorder obtained the highest mean of the correct response.

The present study showed that EF defects affected suicidal patients. In this regard, there is a connection between deficits in the PFC of the brain and suicide behavior, and deficits in the PFC will weaken EFs.[13] Moreover, the findings demonstrated that a history of psychiatric disorders could highlight the effect of executive dysfunction on suicide attempts because individuals with a history of psychiatric disorders have higher scores on the components of omission response and response time. In this regard, the findings of Zhang et al.[20] and Haidarpor et al.[21] also show that there are similarities between the deficits of EFs of individuals attempting suicide and people suffering from depression, bipolar disorder, schizophrenia, and borderline personality disorder. Therefore, it can be concluded that the existence of a history of psychiatric disorder can exacerbate deficits in EFs.

Table 3. Results of Pillai's trace and Wilks' lambda test for evaluation of the significance of multivariate effects

	Estimate	df (hypothesis)	df (error)	F	P
Pillai's trace	0.238	8	170	2.86	0.005
Wilks' lambda	0.775	8	168	2.85	0.005

df: Degree of freedom

EF refers to a diverse group of cognitive processes that connect a person's external and internal worlds. Therefore, suicidal thoughts are related to the cognitive process, and the actions are considered to be related to executive processes that strongly affect the person's behavior. In other words, deficits in EFs result in deficits in cognitive processing behavioral organization, avoidance of impulsive behaviors, and problem-solving. All cognitive functions can be effective in committing suicide.

On the other hand, it can be said that the relationship between EF deficits and the suicide attempt is a two-way relationship. This means that having frequent suicidal thoughts can impair a person's EFs. As a result of weakening EFs in a person, the probability of suicidal behavior increases. Suicidal ideation is a kind of cognitive processing and is an action related to executive, cognitive, and even abstract processes that can negatively affect EFs.

The findings of Harfmann et al.[22] study also show that the presence of cognitive impairment is common among all people who are more likely to commit suicide. The reason for this can be seen as suicidal thoughts with the bias of processing and inhibiting negative and emotional information.

On the other hand, our study showed that education level acted as a predictor of suicide. Therefore, in the groups with a high school diploma and lower than that, there was a significant increase in suicidal behavior compared to those having higher education. There is no linear relationship between education and suicide risk.

Individuals with a high school diploma consistently show higher suicide rates than persons without a high school diploma.[23] In 1999, suicide rates for individuals aged 45-54 with a high school degree or lower were 1.7 times greater than those with a college degree; however, this difference increased to 2.4 by 2013.[23] A meta-analysis by Li et al.[24] showed that the highest relative and demographic risk of suicide could be attributed to men in low-occupational classes as well as low-income classes. Among women, relative risk ratios were highest for unemployed individuals and individuals with low education. Regarding relations between education and suicide, in a study combining census and mortality register data, suicide was 2.12 times more often observed in the lowest educational group compared to those with the highest level of education in 12 countries.[25]

In contrast to these results, several studies yielded less conclusive findings. Among Malaysian patients, unemployment and low levels of education did not confer any significant increases in suicide attempts.[26] It should be mentioned that individuals with higher educational achievement may be more prone to suicide risk when facing failures, public shame, and illness.[27]

The present study has limitations such as available sampling and geographical constraints; therefore, caution should be exercised when generalizing the findings.

Moreover, the results of such studies can be presented to specialists and practitioners of rehabilitation, empowerment, and treatment of these people. By accurately recognizing functional deficits in these individuals, we can help them better adapt by providing them with better treatment strategies and strengthening their healthy functions. On the other hand, such studies can also have clinical and therapeutic applications. It can also be noted that recognizing the inability of such people in EFs, especially impulse control and sustained attention, can be very beneficial in designing cognitive empowerment and rehabilitation programs for these patients. As a result, the current study can have both practical and fundamental results.

However, our limitation is the small sample size. To draw a more definitive conclusion, further research is needed.

Conclusion

There were significant differences among patients with recurrent suicide and those with suicide for the first time with and without previous psychiatric disorder concerning different components of CPT. This study provides important information regarding how the education level predicted recurrent suicide attempts in our patients. Therefore, interventions involving education can help prevent suicide. Since committing suicide is associated with individuals' poor attention control and inhibition and these people rely on cognitive biases in problem-solving, attention control training can be used to enhance the inhibition of impulsive responses and social skills of people exposed to suicidal behaviors, and education plays an important role in inhibition. Finally, it can be used as an appropriate intervention method.

Conflict of Interests

Authors have no conflict of interests.

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