
**Artículo Original**
**Clinical and Epidemiological Characteristics of  
Suicides Committed in Medellín, Colombia**


**Paula Andrea Ortega<sup>a,\*</sup>, Ruben Darío Manrique<sup>b</sup>, Carlos Alfonso Tovilla Zarate<sup>c</sup>,  
Carlos López Jaramillo<sup>d</sup>, Jorge Mauricio Cuartas<sup>e</sup>**

<sup>a</sup> National Institute of Legal Medicine and Forensic Sciences, University of Antioquia, Medellín, Colombia

<sup>b</sup> Director of Research, CES University, Medellín, Colombia

<sup>c</sup> Laboratorio de Genómica, Medicine Faculty DAM, Comalcalco, Universidad Juárez Autónoma de Tabasco, México

<sup>d</sup> Psychiatry Department, Medicine Faculty, University of Antioquia, Medellín, Colombia

<sup>e</sup> Professor, Psychology Faculty, Universidad de San Buenaventura, Medellín, Colombia

**ARTICLE INFO**
**Article history:**

Received 19 September 2013

Accepted 13 February 2014

Available online 21 May 2014

**Keywords:**

Suicide

Sociodemographic characteristics

Multifactorial etiology

Medellín

**ABSTRACT**

**Background:** The purpose of this study was to identify the characteristics of individuals who committed suicide in Medellín between 2008 and 2010, and to identify variables related to the type of events.

**Methods:** A retrospective and descriptive analysis was conducted on data provided by the National Institute of Legal Medicine and Forensic Sciences. In addition, a univariate and bivariate analysis was used to identify the sociodemographic and medical-legal characteristics of the deceased. Multiple correspondence analysis was also used in order to establish typologies. The information was analyzed using STATA 11.0.

**Results:** Of the 389 cases occurring between 2008 and 2010, 84.6% (n = 329) were men. The male to female ratio was 5:1; 64% of the cases occurred in people aged 18-45 years; 6.7% occurred in children under 18, with hanging being the method most chosen by the victims (48.3%). Exploratory analysis was used to identify a possible association between the use of violent methods and events occurring in the housing and social strata 1, 2 and 3.

**Conclusions:** Some factors could be associated with suicide, providing data that could consolidate health intervention strategies in our population.

© 2013 Asociación Colombiana de Psiquiatría. Published by Elsevier España, S.L. All rights reserved.

**Características clínicas y epidemiológicas del suicidio consumado en  
Medellín, Colombia**
**R E S U M E N**

**Antecedentes:** El propósito del estudio es identificar las características de los individuos que cometieron suicidio en la ciudad de Medellín entre 2008 y 2010, además de identificar variables relacionadas con la tipología de los eventos.

**Palabras clave:**

Suicidio

Características sociodemográficas

\* Corresponding author.

E-mail addresses: portega@medicinalegal.gov.co, ortega.paulaandrea@gmail.com (P.A. Ortega).

<http://dx.doi.org/10.1016/j.rcp.2014.02.006>

0034-7450/© 2013 Asociación Colombiana de Psiquiatría. Published by Elsevier España, S.L. All rights reserved.

Etiología multifactorial  
Medellín

**Métodos:** Análisis descriptivo retrospectivo de los datos suministrados por el Instituto Nacional de Medicina Legal y Ciencias Forenses. Además, análisis univariable y bivariable para identificar las características sociodemográficas y médico-legales de los fallecidos. Para establecer posibles tipologías, se utilizó el análisis de correspondencias múltiples. La información se analizó utilizando el programa STATA 11.0.

**Resultados:** De los 389 casos ocurridos entre 2008 y 2010, el 84,6% (n = 329) correspondió a varones. La razón varones:mujeres es 5:1. El 64% de los casos ocurrió en personas de 18-45 años y el 6,7%, en menores de 18 años. El ahorcamiento fue el método más elegido por las víctimas (48,3%). El análisis exploratorio permitió identificar una posible asociación entre el uso de métodos violentos con los eventos que ocurren en la vivienda y los estratos sociales 1, 2 y 3.

**Conclusiones:** Se pudo delinear algunos factores asociados al suicidio consumado, aportando elementos que pueden consolidar estrategias de intervención en la salud de nuestra población.

© 2013 Asociación Colombiana de Psiquiatría. Publicado por Elsevier España, S.L. Todos los derechos reservados.

## Introduction

Suicide has been defined by the World Health Organization (WHO) as a “deliberate act by which a subject commits suicide, with knowledge or expectation of a fatal outcome...”.<sup>1</sup> According to O’Carroll et al (1996), there are three types of suicidal behavior: a) instrumental, in which the person has not tried to kill him/herself and wants to pretend otherwise for personal gain; b) attempted suicide, where the person tries to self-provoke death, without obtaining it, and c) suicide, in which there is evidence, express or implied, that the injury was self-inflicted.<sup>2</sup>

Suicide is considered a global public health problem in the world;<sup>3</sup> a report the Pan-American Health Organization (PAHO) on violence and health noted that in 2000 some 815 000 people died by this cause worldwide, representing a global annual mortality rate of 14.5 per 100 000 people, which amounts to 1 death every 40 s;<sup>4</sup> however, suicidal behavior varies across countries and even between regions with similar levels of development.<sup>5</sup>

Colombia has revealed a significant increase in cases since 1998, from 1.3 to 5.5 events per 100 000 persons in 2002.<sup>6</sup> Between 2008 and 2010, the average rate of suicide in men was 6.0 per 100 000 persons, while in women it ranged from 3,6 to 4,1 per 100 000 people. By 2011, according to preliminary data from the National Institute of Legal Medicine and Forensic Sciences (NILMFC) 1625 cases occurred<sup>7</sup>, representing a rate of 3.5 per 100 000 persons. Medellín is the municipality with the second highest number, 114 in 2011 is equivalent to a rate of 4.8 per 100 000, higher than the national average.<sup>7</sup>

Suicidal behavior is explained from the confluence of environmental and biological variables that contribute to susceptibility to commit suicide. Among the environmental variables are: the presence of unstable and insufficient socioeconomic factors, dysfunctional family dynamics, difficulties in social inclusion, expression of violence and abuse in early childhood,<sup>8,9</sup> abuse of drugs or alcohol and contexts of emotional vulnerability in the development of interpersonal relationships. For biological variables an inheritability ranging

from 40-50% has been reported, and for suicidal behavior there is converging evidence from different approaches including familial transmission, twin and adoption studies with candidate genes and genomic scans supporting a strong genetic contribution to suicidal behavior.<sup>10-12</sup>

These findings allow to infer how genetics contribute to the expression of bizarre behavior associated with suicide, however the complexity presented in the suicidal phenotype justifies hitherto controversial results of the research, which have failed to replicate consistently and discriminate specific molecular pathways for behavior and for the type of suicide.<sup>13</sup>

The purpose of this study was to identify the characteristics of individuals who committed suicide in the city of Medellín, in the periods between 2008 and 2010, and to identify variables related to the type of events to generate information to better understand this problem and contribute to building prevention strategies in public health and to outline approaches a posteriori that integrate aspects of clinical phenotypes of suicide.

## Materials and Methods

A retrospective analysis conducted with information provided by the Northwestern region of Medellín, Antioquia, Regional Reference Center on Violence (NILMFC). The source of the data was the platform SIRDEC—web system of missing people and cadavers—wherein cases handled by this institution are registered. A quality and consistency verification over the obtained data by the comparison of the information registered in some of the expert reports of necropsy. The subjects born in the department of Antioquia were studied, with those deceased by suicide in the city of Medellín, between 2008 and 2010; the analyzed variables were the sociodemographic characteristics, cause and place of death. For the calculation of the specific rates by age, proportional adjustments by age groups starting with the data of the population projection by years estimated by National Administrative Department of Statistics (DANE). We performed univariate and bivariate analysis to identify the sociodemographic and medical-legal deaths from suicide. The

**Table 1 – Suicide rates (per 100 000) in Medellín 2008 a 2010, by age and sex.**

Groups	MALE			FEMALE			TOTAL		
	Average of cases	Average population	Crude rate	Average of cases	Average population	Crude rate	Average of cases	Average population	Crude rate
10-14	3.33	87097	3.8	0.33	84116	0.4	3.67	171213	2.1
15-19	9.33	98851	9.4	4.33	94362	4.6	13.67	193213	7.1
20-24	20.33	100979	20.1	4.00	100020	4.0	24.33	200999	12.1
25-29	17.33	86116	20.1	2.00	93437	2.1	19.33	179553	10.8
30-34	11.67	71793	16.3	2.00	82660	2.4	13.67	154453	8.8
35-39	6.67	68182	9.8	1.00	81357	1.2	7.67	149539	5.1
40-44	6.33	85185	7.4	1.33	101154	1.3	7.67	186339	4.1
45-49	10.67	86388	12.3	1.67	106074	1.6	12.33	192462	6.4
50-54	8.00	72879	11.0	2.00	91363	2.2	10.00	164241	6.1
55-59	4.67	57109	8.2	0.67	71340	0.9	5.33	128449	4.2
60-64	3.67	42870	8.6	0.67	54909	1.2	4.33	97778	4.4
65-69	2.33	28461	8.2	0.00	38007	0.0	2.33	66468	3.5
70-74	2.67	22193	12.0	0.00	31976	0.0	2.67	54169	4.9
75-79	1.67	15769	10.6	0.00	23774	0.0	1.67	39543	4.2
>80	1.00	14415	6.9	0.00	103565	0.0	1.00	117980	0.8
Total	109.67	938285	11.7	20.00	1158114	1.7	129.67	2096400	6.2

Kolmogorov-Smirnov statistical test was applied to determine whether the age of the deaths from this cause was normally distributed or not, since this variable did not follow this distribution, nonparametric analysis was applied to describe or compare.

In order to establish possible typologies of the cases of complete suicides, an analysis of multiple correspondences was affected by a bivaried analysis with the variables that took place with greater frequency with the goal of completing the exploratory process of the data. The information was analysed using the STATA program version 11.0.

## Results

Of the 389 suicides that occurred between 2008 and 2010, 84.6% (n = 329) corresponded to male persons. The male to female ratio for this manner of death is approximately 5:1. By 2008, 107 of the 126 cases (84.9%) were males, a behavior similar to the year 2009, 112 of 131 cases (85.5%) and by 2010, 110 of the 132 cases (83.3%).

Among women, the average age was 31.9 (13.9) years, with a minimum of 13 years and a maximum of 63 years, the median was 27.5 years. Among men, the mean age was 36.2 (16.7) years, with a minimum of 10 years and a maximum of 98 years, the median was 31 years. 64% of events occurred in people between 18 and 45 years, 30% of all cases occurred between 18 and 25 years and 6.7% at age 18. There were 14 cases (3.6%) of people under 15.

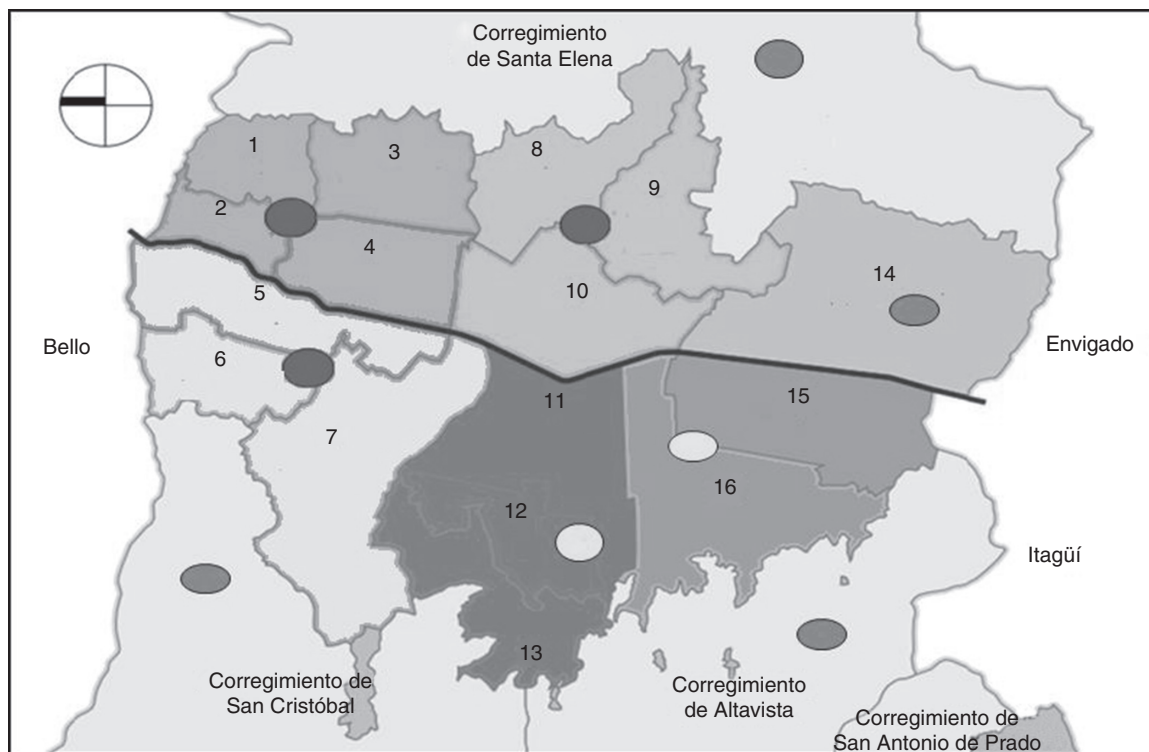
The suicide rate per 100 000 people during 2008-2010 was consistently higher among men, being observed by gender rate ratios up to 9.6 times higher. It is noteworthy that in this period there were no suicides in women over 65. Among men, the highest rates occurred in the group of 20-34 years, among women the highest rates were between 15 and 24 years; in general, the suicide rate in Medellín had its greatest figures in the group of 15-34 years. It should be noted that the suicide rate among 10- to 14- year-old males was 3.8 cases per 100 000 children of this age. For men, the suicide rate was almost

twice the citywide average rate (11.7 vs 6.2 per 100 000 people) (Table 1). Older adults had a rate of 3.6 per 100 000, among women it was 0.24, while men reached to 9.25, indicating a rate ratio 38 times higher among elderly males compared to the female gender. In Colombia, the suicide rates of this period were presented in 3.6 cases in 2010, 4.1 cases in 2009 and 3.8 cases for 2008 per 100 000 inhabitants.

According to some variables related individuals, both men and women have higher rates of events in the levels of primary and secondary schooling, reaching 52.5% and 28.9%, respectively. In terms of marital status, more than half of cases occurred among single individuals (53.1%), followed by married individuals (25.1%). Depending on the activity, the unemployed accounted for 20%, while those with any occupation, as employees or independent, accounted for 60% of all events. With regard to the occupancy classification according SENA (National Apprenticeship Service), a little more than a third were inactive people. The lowest proportion occurred in the health sciences and related occupations with mining and quarrying (livestock and agriculture), 0.6% in each of these groups.

The frequency of suicide in relation to the facts show similar behavior in men and women, with the home being the preferred scene in which to commit the act of suicide (70.7%), followed by public roads (11.4%). In the first and second socio-economic strata accounted for more than half of the cases (63.8%) and the least amount were present in the sixth stratum (3.6%). The central-eastern district zone that includes the 8th, 9th and 10th districts has the highest proportion of cases (24.2%) (Figure 1).

The monthly average was 32.3 (5.1) suicide cases, i.e. one case per day. The largest number of events was recorded in October (11.3%), however the behavior varied from year to year; in 2008, with 10.3% in November; in 2009, equal proportions were presented in April, June and October (12.2%); in 2010, 12.2% was in October. In men, the highest proportion occurs in October (11.3%) and women in equal proportion during the months of July, October and December (11.7%).



**Figure 1 – Frequency of suicide according districts and townships, Medellín 2008-2010.**

Regarding the mechanism used to commit suicide, hanging was found to be the most chosen method (48.3%), while the second option varies between men and women, the latter opts for poisoning and intoxication (38.3%) and males prefer firearms (22.2%). Table 2 shows the death mechanism used according to age group.

Bi-dimensional correlation analyses reveal three distribution patterns in the occurrence of suicide. Figure 2, left, shows the relationship between suicide and the variables of education, age and crime scene, denoting the group made up of people aged 18 to 45 years, with primary and secondary school educations, with the crime scene being in the home, places of business and at work. Figure 2, right, provides models according to socioeconomic status, mechanism used to cause death, and age range, observing that adults over the age of 41 years, from the strata 4, 5 and 6, chose jumping to their death and consumption of toxic substances as instruments of death, while people at levels 1, 2 and 3 prefer using firearms and hanging.

The data shown in Table 3 were found upon completing an exploratory analysis with logistic regression, using as response variables the use of violent methods (hanging and firearm projectile) versus nonviolent methods (poisoning, jumping to one's death and sharp weapon) and taking as risk variables the level of education, marital status, economic activity, the scene of the crime and the social strata.

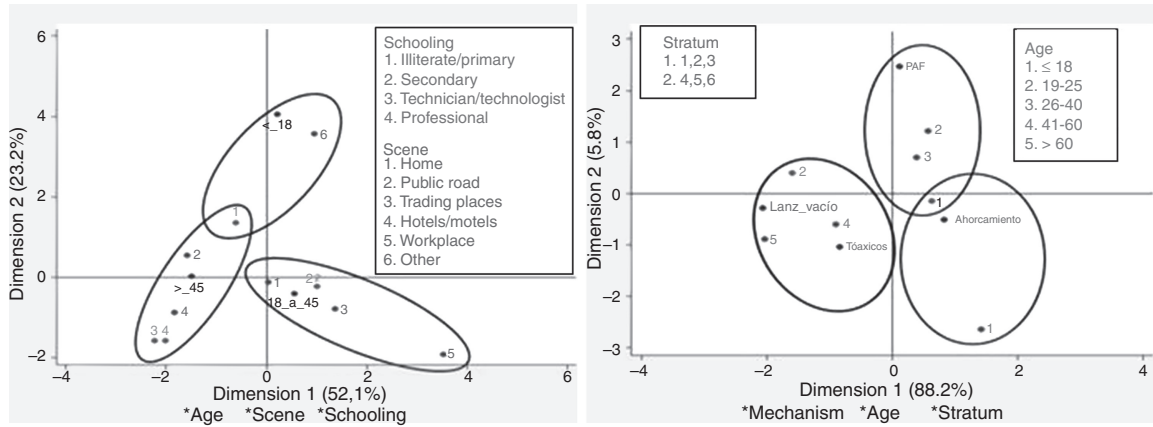
Exploratory analysis allows a possible association to be identified between the use of violent methods and acts of suicide occurring at home and among social strata 1, 2 and 3.

### Discussion

Suicide is a public health problem in the city of Medellín, whose rates exceed the national level, with men who are at increased risk, a situation that is maintained among all age groups and which conforms to what happens in most

**Table 2 – Suicide frequencies for different death methods in Medellín, 2008 a 2010, by age.**

Cause of death	Frequency, by age groups, n (%)					Total
	<18 years	>18-25 years	>25-40 years	>40-60 years	>60 years	
Firearms	4(10)	26 (25.2)	25 (23.6)	15 (14.2)	4 (11.8)	74 (19.06)
Hanging	28(70)	56 (54.4)	54 (50.9)	41 (38.7)	9 (26.5)	188 (48.3)
Poisoning	5 (12.5)	11 (10.7)	16 (15.1)	25 (23.6)	10 (29.4)	67 (17.2)
Jumping	3 (7.5)	9 (8.7)	11 (10.4)	20 (18.9)	11 (32.4)	54 (13.9)
Sharp weapon	0	1 (0.97)	0	5 (4.72)	0	6 (1.54)
Total	40	103	106	106	34	389



**Figure 2 – Left: correspondence analysis for variables of schooling, scene of the crime and age range. Right: correspondence analysis for variables of death mechanism, socioeconomic status and age range.**

countries. Some authors infer that this disparity is due in part to the fact that men tend to choose more effective methods.

In our study there was a higher proportion of cases in singles in both men and women, diverse studies of our country with adults and adolescents report that social isolation is recognized as a risk factor for suicide, as well as living alone has been associated with greater lethality of acts to decrease the likelihood of receiving timely medical help and assistance, which is consistent with the fact that the largest proportion of cases present in homes.<sup>14-16</sup>

With regard to the month in which a greater number of suicide cases took place and increment was observed in the month of October, coinciding with the resurgence of violence in the city; some studies indicate that violence is a process that increased psychosocial vulnerability, in particular, the increase in October may be related to the resurgence of violence in Medellín, according to the NILMFC reports, October was the most violent, between January 1 and October 31, 2009 increase in the number of cases of violent deaths in the city. On the other hand, several studies have reported a higher

incidence of suicide in the months of July and December, holiday seasons that coincide with changes in social dynamics, which could contribute in different ways to suicidal behavior in individuals with difficulties in bonding and social ties.

This research allows to discriminate the types of violent and nonviolent methods used to cause death, in which undoubtedly the choice of method is influenced by aspects of a socio-cultural type (Figure 2), and may indicate, for the context of the city, as the social fabric is permeated by the lack of opportunities for social inclusion and poverty. While from 1996 to 2008 policies have been effective in controlling the possession and carrying of firearms, and this has reduced the suicide rate for this method, in addition, the consummation of autolysis and its relation to the method not only depends on the intention of using it; parasuicidal actions that manage to materialize are closely related to highly conflictive social situations and dysfunctional family environments, just as, psychiatric illnesses can coexist that could spark the violent act. Therefore, the weakness of public policy failures have demonstrated failures the development of promotion and

**Table 3 – Logistic regression analysis for the determinants of the use of violent methods in suicide.**

Variable	n (%)	p	Crude OR	95%CI	Adjusted OR	95%CI
<b>Education level</b>						
Secondary	160 (52.5)	0.26	1.34	0.83-2.18	1.36	0.79-2.35
Others	145 (47.5)					
<b>Civil status</b>						
Single	190 (53.1)	0.12	1.81	1.16-2.83	1.57	0.91-2.70
Others	168 (46.9)					
<b>Activity</b>						
Employee	169 (48.6)	0.49	1.36	0.86-2.13	1.64	0.95-2.83
Others	179 (51.4)					
<b>Crime scene</b>						
Housing	261 (70.7)	0.0001	2.36	1.48-3.79	2.18	1.21-3.93
Others	108 (29.3)					
<b>Socioeconomic strata</b>						
1, 2 y 3	276 (71.1)	0.0001	3.29	2.07-5.21	2.97	1.68-5.25
Others	112 (28.9)					

prevention programs in mental health which helps to explain the increase in suicide by hanging among the population from lower socioeconomic strata.

The type or choice of method to achieve death relates directly with many of the biochemical signals that remodel physiopathological conditions limited to suicide,<sup>17-21</sup> that in addition to the psychosocial component outlines the pattern of vulnerability in the construct.<sup>19,22,23</sup>

On the other hand, this study shows how some risk factors that could explain suicide can be modified or relatively fixed, i.e. modifiable factors such as violence and aggression, the states or characteristics of anxiety and depression, can be operated and controlled with more inclusive and equitable social policies and with health systems and habits that promote healthy lifestyles. For relatively fixed risk factors, no treatment can modify previous attempts, factors such as age, ethnicity and genetic vulnerability; in this regard, gene-gene and gene-environment interactions contribute to the complexity of the system. Thus, genetic polymorphism, which has been previously associated with a population, may not be associated with another ethnic group, which may explain a great deal of misunderstandings in genetic discoveries regarding suicide.

This study presents a methodological type limitation for incomplete information, which is not accessible in the implementation of autopsies, since suicide cases are collected retrospectively and from indirect sources, and is a cross sectional study, making it impossible to generalize the results to the entire suicide population.

## Conclusions

One important difficulty in the advance of the etiopathogenesis of suicide lies in selecting an experimental model that incorporates clinical and phenomenological variables associated with suicide, i.e., to add and define variables related to the phenotype of interest and to allow refining subtypes within the phenotype being studied. However, underreporting of cases and some variables related to these decreases the reliability of the data and therefore the comparison of situations between different municipalities nationwide, which would facilitate the establishment of clear and rational allocation of resources according to different contexts. For now, the strength of epidemiological studies that address suicide lies in the review of epidemiological variables that relate to the expression of patterns that may be helpful in discriminating subtypes within the nuclear phenotype. Much of the research on suicide assessment that go beyond post-mortem observations of the victims do not include aspects related to previous diagnostic and therapeutic history of the suicide victim, and the methodological designs that further detail clinical elements through psychological autopsies do not determine ethnic aspects that could be very useful to delineate additional explanatory routes to dynamics and social contexts of vulnerability.

Finally, an appropriate model to address suicide requires consideration of the psychological, ecological, social, demographic and genetic factors. That allows restricting and better refining the phenotype in studies of suicide as a social

phenomenon,<sup>24-26</sup> and enabling new strategies for intervention in suicidal behavior.

## Conflict of interest

Authors have no conflict of interest to declare.

## Acknowledgements

The National Institute of Legal Medicine and Forensic Sciences, particularly the Regional Reference Center on Violence, Northwest Regional for providing the data analyzed in this study.

## REFERENCES

1. Health topics, suicide. Geneva: World Health Organization; 2012 [cited 2012 March 8]. Available from: <http://www.who.int/topics/suicide/>
2. O'Carroll PW, Berman AL, Maris RW, Moscicki EK, Tanney BL, Silverman MM. Beyond the Tower of Babel: a nomenclature for suicidology. *Suicide & life-threatening behavior*. 1996;26:237-52.
3. Suicide preventing. Geneva: World Health Organization; 2012 [cited 2012 March 8]. Available from: <http://www.who.int/mental.health/prevention/suicide/suicideprevent/en/index.html>
4. Informe mundial sobre la violencia y la salud. Washington: Organización Panamericana de la Salud; 2003.
5. Liu KY. Suicide rates in the world: 1950-2004. *Suicide & life-threatening behavior*. 2009;39:204-13.
6. Cendales RVC, Fierro M, Córdoba R, Olarte A. Tendencias del suicidio en Colombia, 1985-2002. *Rev Panam Salud Pública*. 2007;22:231-8.
7. Instituto Nacional de Medicina Legal y Ciencias Forenses—INMLCF/Grupo Centro de Referencia Nacional sobre Violencia—GCRNV. Boletín estadístico mensual, diciembre de 2011. Bogotá. Disponible en <http://www.medicinalegal.gov.co/index.php/estadisticas/gcrnv/100-boletines-estadisticos-mensuales-2011>
8. Bradley RG, Binder EB, Epstein MP, Tang Y, Nair HP, et al. Influence of child abuse on adult depression: moderation by the corticotrophin-releasing hormone receptor gene. *Arch Gen Psychiatry*. 2008;65:190-200.
9. Brodsky BS, Stanley B. Adverse childhood experiences and suicidal behavior. *Psych Clin North Am*. 2008;31:223-35.
10. Brodsky BS, Mann JJ, Stanley B, Tin A, Oquendo M, Birmaher B, et al. Familial transmission of suicidal behavior: factors mediating the relationship between childhood abuse and offspring suicide attempts. *J Clin Psychiatry*. 2008;69:584-96.
11. Smith AR, Ribeiro JD, Mikolajewski A, Taylor J, Joiner TE, Iacono WG. An examination of environmental and genetic contributions to the determinants of suicidal behavior among male twins. *Psych Res*. 2012;197:60-5.
12. Voracek M, Loibl LM. Genetics of suicide: a systematic review of twin studies. *Wiener klinische Wochenschrift*. 2007;119:463-75.
13. Mann JJ, Currier DM. Stress, genetics and epigenetic effects on the neurobiology of suicidal behavior and depression. *Eur Psychiatry*. 2010;25:268-71.
14. González A, Rodríguez A, Aristizábal A, García J, Palacio C, López C. Suicide and gender in Antioquia (Colombia): a psychological autopsy study. *Rev Colomb Psiquiatr*. 2010;39:251-67.

15. Castro V, Martínez A, Camacho P, Rueda G. Risk and protective factors in Colombian suicidal adults. *Rev Colomb Psiquiatr.* 2010;39:705-15.
16. Rueda G, Martínez A, Castro V, Camacho P. Suicide potential in adolescents: a comparison with adult population. *Rev Colomb Psiquiatr.* 2010;2010.
17. Roy A, Hodgkinson CA, Deluca V, Goldman D, Two Enoch MA. HPA axis genes, CRHBP and FKBP5, interact with childhood trauma to increase the risk for suicidal behavior. *J Psych Res.* 2012;46:72-9.
18. Jaeschke R, Siwek M, Dudek D. [Neurobiology of suicidal behavior]. *Psychiatria Polska.* 2011;45:573-88.
19. Judy JT, Seifuddin F, Mahon PB, Huo Y, Goes FS, Jancic D, et al. Association study of serotonin pathway genes in attempted suicide. *Am J Med Genet B.* 2008;159B:112-9.
20. Althoff RR, Hudziak JJ, Willemsen G, Hudziak V, Bartels M, Boomsma DI. Genetic and environmental contributions to self-reported thoughts of self-harm and suicide. *Am J Med Genet B.* 2012;159B:120-7.
21. Mann JJ, Arango VA, Avenevoli S, Brent DA, Champagne FA, Clayton P, et al. Candidate endophenotypes for genetic studies of suicidal behavior. *Biol Psychiatry.* 2009;65:556-63.
22. Stoltenberg SF, Christ CC, Highland KB. Serotonin system gene polymorphisms are associated with impulsivity in a context dependent manner. *Prog Neuropsychopharmacol Biol Psychiatry.* 2012;39:182-91.
23. Fernandez-Navarro P, Vaquero-Lorenzo C, Blasco-Fontecilla H, Diaz-Hernandez M, Gratacos M, Estivill X, et al. Genetic epistasis in female suicide attempters. *Prog Neuropsychopharmacol Biol Psychiatry.* 2012;38:294-301.
24. Bilder RM, Howe A, Novak N, Sabb FW, Parker DS. The genetics of cognitive impairment in schizophrenia: a phenomic perspective. *Trends Cogn Sci.* 2011;15:428-35.
25. Lanktree MB, Hegele RA. Gene-gene and gene-environment interactions: new insights into the prevention, detection and management of coronary artery disease. *Genome Med.* 2009;1:28.
26. Medland SE, Neale MC. An integrated phenomic approach to multivariate allelic association. *Eur J Hum Genet.* 2010;18:233-9.