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STUDY OF PECULIARITIES FOR CASES OF MECHANICAL ASPHYXIA DISTRIBUTION IN KHARKOV AGGLOMERATION

ABSTRACT

The number of suicides in the world according to official statistics decreased slightly and amounts to 18 cases per 100 thousand population. According to the World Health Organization the suicide rate in 2016 year among men is 3-4 times higher than among women. On the basis of the data of the US Center for Disease Control and Prevention Health (CDC) in 2016, low-skilled workers who work and live in isolation from society most often commit suicide. About 20 million people each year commit unsuccessful suicide attempts, which has psychological consequences for both suicide itself and at least 6 people in his environment.

According to the State Statistics Service of Ukraine in 2016, almost 7.5 thousand Ukrainians committed suicide, of which about 6 thousand were men. Over the years of the radical transformation of Ukrainian society, many trials have fallen on the population. Economic instability, loss of jobs, riots, hostilities have significantly affected public sentiment. The maximum number of suicides for the years of independence was recorded from 1996 to 2000.

The aim of this study is to conduct mathematical and statistical analysis to substantiate the peculiarities of the empirical distribution of cases of mechanical asphyxiation in the Kharkov agglomeration.

The main stages of this study were the assessment of statistical sampling error and the use of statistical criteria to test hypotheses regarding sex and age characteristics of mechanical asphyxia cases.

KEYWORDS

suicide, empirical distribution, mechanical asphyxiation, statistical analysis

In the XXI century the number of suicides in the world according to official statistics decreased slightly and amounts to 18 cases per 100 thousand population, however, information about suicides in military operations and on territories beyond the control of state authorities may not be completely reliable [4, 5].

According to the World Health Organization the suicide rate in 2016 year among men is 3-4 times higher than among women.

According to the US Center for Disease Control and Prevention Health (CDC) in 2016, low-skilled workers who work and live in isolation from society most often commit suicide.

About 20 million people each year commit unsuccessful suicide attempts, which has psychological consequences for both suicide itself and at least 6 people in his environment.

World Health Organization divides countries by suicide indicator into 3 groups.
High and very high suicide rate (over 20 persons per 100,000 population): Gayana – 44.2, Republic of Korea – 28.9, Sri Lanka – 28.8, Lithuania – 28.2, Mozambique – 27.4., Nepal – 24.9, Tanzania – 24.9, Kazakhstan – 23.8, Latvia – 22.9, China – 22.2, Slovenia – 21.9, India – 21.1.

Average suicide rate (10 to 20 people per 100 thousand population): Turkmenistan – 19.6, Russia – 19.5, Hungary – 19.1, Japan – 18.5, Belarus – 18.3, Ukraine – 16.8, Poland – 16.6, Latvia – 16.2, Finland – 14.8, Moldova – 13.7, Estonia – 13.6, France – 12.3, USA – 12.1, Canada – 11.3, Cuba – 11.4, Sweden – 11.1.

Low suicide rate (up to 10 people per year per 100 thousand population): Germany – 9.2, Kyrgyzstan – 9.2, Switzerland – 9.2, Uzbekistan – 8.5, Great Britain – 6.2, Israel – 5.9, Italy – 4.7, Greece – 3.8, Georgia – 3.2, Armenia – 2.9, Azerbaijan – 1.7.

The lowest suicides indicator level is recorded in Egypt, Haiti and Jamaica, where the suicide rate is almost zero.

According to the State Statistics Service of Ukraine in 2016, almost 7.5 thousand Ukrainians committed suicide, of which about 6 thousand were men [1,4,5,6].

Over the years of the radical transformation of Ukrainian society, many trials have fallen on the population. Economic instability, loss of jobs, riots, hostilities have significantly affected public sentiment. The maximum number of suicides for the years of independence was recorded from 1996 to 2000.[6]

One of the forensic doctors who thoroughly investigated cases of suicide by hanging is Molin Yu. A., in whoeh monograph there is presented a detailed analysis of a particular region (Leningrad Region, Russia) for 10 years (1983 – 1992). He points out that the number of hangings annually ranged from 328 to 560 (from 78.3% to 85.9% among all suicides). By the gender indicator, men accounted for 86%, women – 14%. By age, the distribution was as follows: under 15 years old – 3%, 16-25 years old – 10%, 26-35 years old – 15%, 36-45 years old – 34%, 46-55 years old – 18%, 56-65 years old – 15%, over 65 years old – 5%. An analysis was also carried out regarding the psychological portrait of the dead and their somatic status at the time of suicide.

According to this study, two "peaks" were found that occurred in 1983-1984 and 1991-1992, which the then Soviet scientists and doctors explained and associated with the war in Afghanistan, with the transformation of the social system and the collapse of the Soviet Union [10].

Interesting information is presented in the works of foreign scientists dealing with the problems of forensic medical and forensic psychiatric research of cases of hanging and their separation from other cases of suicide or murder, imitated as suicide.

Many foreign scholars have researched gender, age, social, regional and cultural factors in relation to hanging suicides [3, 7, 9, 11].

The study of hanging as a completed act of suicide remains an urgent scientific and applied problem for forensic doctors. The special literature devoted to the study of mechanical asphyxia, in particular hanging, is quite numerical, but at the same time does not cover all aspects of forensic diagnostics of strangulation asphyxia. So, in the domestic and foreign literature, scientific works are given on the statistical analysis of hangings using absolute and relative values, but information on the distribution of cases of mechanical asphyxiation in the modern large agglomeration of our country is practically absent [3, 7, 9-12].

The study of the suicide causes and the motives of their perpetrators is more of the interest of psychiatrists and psychotherapists. At the same time, forensic experts investigate the morphological manifestations of pathological conditions in the human body in various types of suicide, including hanging.

From the very beginning of our work, we`ve faced a number of problems and shortcomings in the statistical recording of suicides that ended in death. At the first stage of the collection of statistics, it was established that the existing system for determining the death type is imperfect. Information about the death type should be entered by the doctor in the corresponding column of the medical certificate of death. However, a single methodological approach to determining the death type using the codes of the International Statistical Classification of Diseases 10th revision (ICD-10) has not been worked out, and this fact leads to confusion. Forensic doctors do not always fill in the relevant columns correctly than they do at the stage of drawing up a medical death certificate curving statistical data. Therefore, for a specific solution of the issue of the death type, it is necessary to analyze each of these cases separately, with a thorough study of the circumstances of the incident and the experimental part of the „Expert Opinion".

It should be noted that each country has its own suicide registration methodology. It depends on the procedure of distinguishing suicides from other death types, as well as on the profession and position of the authorized person registering them.

In Ukraine, if a forensic medical examination is carried out in determining the death type, there are certain legislative restrictions according to which the forensic expert is not authorized to establish the death type, which is connected with the concept of intent, which refers to issues of law. Therefore, in such cases, the death type is determined by the investigating authorities during or after the investigation.

The aim of this study is to conduct mathematical and statistical analysis to substantiate the peculiarities of the empirical distribution of cases of mechanical asphyxiation in the Kharkov agglomeration.

The main stages of this study were the assessment of statistical sampling error and the use of statistical criteria to test hypotheses regarding sex and age characteristics of mechanical asphyxia cases.

1. Estimate of statistical sampling error for the study.

For the period from 2013 to 2017, according to the Kharkiv Regional Bureau of Forensic Medical Examination (KhRBFME) data, 31149 corpses were examined among the residents of the Kharkiv agglomeration, covering the territory of the Kharkiv city and the adjacent Kharkiv region, among them there were 1486 cases of mechanical asphyxiation, which is 4.76% of the total number of corpses, which were studied in KhRBFME.

Among the total number of deaths from mechanical asphyxia, there were 960 cases of strangulation asphyxia, which is 64.6%. The identified data allowed us to establish indicators of the total population in the Kharkiv agglomeration population. It was found that out of 960 deaths as a result of strangulation asphyxia, there were 768 men, 192 women – 80% and 20%, respectively (ratio: 4 to 1).

Baseline data on gender distribution about the number of cases of strangulation asphyxiation for the „male" and „female" groups are presented in table 1.

Table 1. Gender distribution of deaths from strangulation asphyxia for the period 2013-2017 in Kharkiv agglomeration

General indicators	In total	
male	768	80%
female	192	20%
Generally	960	100%

We substitute into formula (1) the data from table 1 and get for male group

$$\Delta = 1,96\sqrt{\frac{80(100-80)}{960}} = 2,53\%$$

The interval in which the percentage of cases of strangulation asphyxia for „male" groups is P±Δ or 80%±2,53%.
Thus, the limits of the confidence interval are [77,47%;82,53%].
Similarly, formula (1) calculates the statistical error for the female group.

For the female group

$$\Delta = 1,96\sqrt{\frac{20(100-20)}{960}} = 2,53\%$$

The interval in which the percentage of cases of strangulation asphyxia for „female" groups of is found is P±Δ or 20%±2,53%.

Thus, the limits of the confidence interval are [17,47%;22,53%].
Since histological objects are stored in the KhRBFME archive for 3 years, only drugs that were the subject of examination in the Department of Forensic Medical Histology in 2016-2017 are available for our study. In this regard, a sample of 48 cases of strangulation asphyxia was used in our study, with the compilation of the group „male" and „female" with shares of 80% and 20% (Table 2).

Table 2. Total sample with gender distribution by group of the study

General indicators	In total	
male	38	80%
female	10	20%
Generally	48	100%

For the male group

$$\Delta = 2,02\sqrt{\frac{80(100-80)}{48}} = 11,66\%$$

The interval in which the percentage of cases of strangulation asphyxia for the „male" groups is found is P±Δ or 80%±11,66%.
Thus, the limits of the confidence interval are [68,34%;91,66%].
For the female group

$$\Delta = 2,02\sqrt{\frac{20(100-20)}{48}} = 11,66\%$$

The interval in which the percentage of cases of strangulation asphyxia for the „female" groups is found is P±Δ or 20%±11,66%.
Thus, the limits of the confidence interval are [8,34%;31,66%].
Despite the same proportions between the percentage of cases of strangulation asphyxia in the „male" and „female" groups that were observed in the small sample (table 2), the calculated error is 11.66%, while for the original sample (960 observations) the error was only 2.53%, that is, 4.6 times less. However, given the objective restrictions on access to archival data only over the past two years, a statistical error of 11.66% can be considered permissible in the case of small samples.

In the general population (n = 960 cases) and in the sample that was used for the study (n = 48 cases), there are significant differences between the percentage of cases of strangulation asphyxia in male, compared with female.
To confirm this hypothesis, we use the Student's t-test for proportions in samples [2].
The z value for this criterion is calculated by the following formula:

$$z = \frac{|p_1 - p_2|}{\sqrt{p(1-p)\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}},$$

where p_1- percentage (fate) in the first sample, p_2- percentage (fate) in the second sample, n_1 – amount of observations in the first sample, n_2 – amount of observations in the second sample, p value is calculated as follows:

$$p = \frac{p_1 n_1 + p_2 n_2}{n_1 + n_2}$$

Calculated value z – statistics is compared to critical value $z_{кр}$ for a given level of significance and number of degrees of freedom.
For a sample of n = 960 cases, the calculated value of z – statistics is 15.941, that is, at the significance level p<0,00001 the percentage of cases of strangulation asphyxia in the „male" group differs from the percentage of strangulation asphyxia in the „female" group.
For a sample of n = 48 cases, the calculated value of z – statistics is 3.604, that is, at the significance level p<0,0003 the percentage of cases of strangulation asphyxia in the „almn" group differs from the percentage of strangulation asphyxia in the „female" group.
Thus, for the general population and for the sample that was used for the study, there is a significant statistical difference between the percentage of cases of strangulation asphyxia in the „male" group and the percentage of cases of strangulation asphyxia in the „female" group. For the „male" group, the percentage of strangulation asphyxia is significantly higher than the percentage of strangulation asphyxia in the „female" group.
That is, the obtained sample in 48 cases contains the properties of the general population according to proportional properties and it is a permissible statistical error, and it is also representative.

2. Study of age distribution of percentage of strangulation asphyxia .
Let`s calculate the average age of the cases of strangulation asphyxia for the „male" group (number of observations = 768) and other statistical characteristics of the sample. The average age of cases of strangulation asphyxia is 50.1 years. Taking into account the confidence 95% intervals for the average sample values, the average age of cases of regulational asphyxiation falls on 50.1 to 1.26 and is contained in the interval [48,9;51,4]. The median, that is, the value that defines the boundary of 50% of the volume of observations, is 50 years. The upper bound of lower quartile (the lower quartile – an interval to which 25% of observations of the minimum value to the upper bound of the lower quartile get), is 35 years. The lower limit of the upper quartile (the upper quartile is the interval in which 25% of observations fall from the lower limit of the upper quartile to the maximum value) is 63 years. The average square deviation for this sample is 17.8. The results of the calculations are shown in table 3.

Table 3. Sample processing results for the „male" group in the Statistica package (n = 768 observations)

Module Descriptive Statistics (Descriptive Statistics) file (newforensic.sta)											
Group	Number	Average	Confidential intervals averages		Median	Min	Max	Lower quar-tile	Upper quar-tile	Dis -per-sion	Middle Qu-adratic
Male	Valid N	Selec-tive Average	Confid.	Confid.		Value	Value	Lower	Upper		
			-95%	+95%	Median	Min	Max	Quar -tile	Quar -tile	Vari -ance	Std. Dev.
MALE	768	50,1	48,9	51,4	50	13	91	35	63	315,9	17,8

Let`s calculate the average age of the cases of strangulation asphyxia for the female group (number of observations = 192) and other statistical characteristics of the sample. The average age of cases of strangulation asphyxia is 55,7 years. Taking into account the confidence 95% intervals for the average sample values, the average age of cases of strangulation asphyxiation falls on 55.7 3.08 and it is contained in the interval [52,6;58,7]. The median, that is, the value that defines the boundary of 50% of the volume of observations, is 52.5 years. The upper bound lower quarts (the lower quartile – an interval to which 25% of observations of the minimum value to the upper bound of the lower quartile get), is 38 years. The lower limit of the upper quarter (the upper quartile is the interval in which 25% of observations fall from the lower limit of the upper quartile to the maximum value) is 76 years. The average square deviation for this sample is 21.7. Calculation results are presented in table 4.

Table 4. Sample processing results for the group „female" in the Statistica package (n = 192 observations)

Module Descriptive Statistics (Descriptive Statistics) file (newforensic.sta)											
Group	Number	Average	Confidential intervals averages		Median	Min	Max	Lower quar-tile	Upper quar-tile	Dis -per-sion	Middle Qu-adratic
Male	Valid N	Selec-tive Average	Confid.	Confid.		Value	Value	Lower	Upper		
			-95%	+95%	Median	Min	Max	Quar -tile	Quar -tile	Vari -ance	Std. Dev.
MALE	192	55,7	52,6	58,7	52,5	1	92	38	76	469,2	21,7

Next, we will test the hypothesis that there is a significant statistical difference in average age for observations of strangulation asphyxia in the group „female" and in the group „male". For original ungrouped data for these samples, you can apply the Student`s and Fisher`s parametric criteria for independent samples [2,7].

Table 5 shows the results of the calculations, which show that the null hypothesis about the absence of a statistically significant difference between the average age in the group „female" and the average age in the group „male" can be discarded at the level of significance p<0,01.

Table 5. Results of calculation of Student`s and Fisher`s parametric tests for the sample „female" (observational number = 192) and „male" (observational number = 768)

Module T-test for Independent Samples (newforensic.sta)											
Note: Variables were treated as independent samples											
	Average for the group 1	Average for the group 1	Value according to Stu-dent's criterion	Quantity degrees freedoms	p-level	Scope of obser -vation.	Scope of obser -vation..	Middle Quadratic Deviation	Middle Quadratic Deviation	Value according to Fisher's criterion	p-level
	Average	Average				Valid N	Valid N	Std. Dev	Std. Dev	F-ratio	p
Group «female» compared to a group «male»	Group 1	Group 2	t-value	df	p	Gro-up 1	Gro-up 2	Group 1	Group 2	Vari ancs	Vari ancs
FEMALE vs. MALE	55,651	50,136	3,672	958	0,0002	192	768	21,662	17,772	1,486	0,0003

That is, the average age in the full samples of the „female" group (number of observations = 192) is statistically significantly different from the average age in the „male" group (number of observations = 768), the average age of cases of strangulation asphyxia in the „female" group exceeded the same indicator in the „male" group by 5,5 years.

Next, we will conduct statistical analysis for small sub-samples, the materials of which will be used in a further study.

Here are the results of the calculations of the distribution of the presence of strangulation asphyxia by the aggregate sample (number of observations = 48), which were carried out using the statistical package Statistica (version 10) (table 6) [2].

Table 6. Results of sample characteristics calculations for 48 observations for 2016-2017

Average value	Lower bound for average value	Upper bound for average value	Median	Minimum value	Maximum value	Lower quartile	Upper quartile	Percentile, 10%	Percentile, 90%	Standard deviation	Standard mistake
46,54	41,68	51,41	41,5	20	92	35	60	27	66	16,76	2,42

As can be seen from the results of the calculations of the initial data, the average age of cases of strangulation asphyxia was 46,5 years. The calculated lower and upper limits for averages including 95% confidence intervals were 41,68 years and 51,41 years. The median, that is, a variant that divides ordered data into two equal parts, was defined as 41,5 years. The minimum age for this sample was 20 years and the maximum age was 92 years. The lower quartile, that is, the limit to which 25% of ordered data fell, was 35 years, that is, 25% of extreme observations were in the age interval from 20 to 35 years. The upper quartile, that is, the limit to which 25% of the ordered data fell, was 60 years, that is, 25% of the extreme observations were in the age interval from 60 to 92 years. 10% – persentile of this sample was in 27 years old meaning, and 90% – was percentile for the age of 66 years. The standard deviation for this sample was 16, 76 years, and the standard error for averages was 2,42 years.

It should be noted that the calculations for the original sample data are more accurate than the calculations for the interval grouped series, where the age intervals according to the POPs methodology differed for the „male" group and the „female" group, in addition, the size of the age groups for these intervals differed.

To test the hypothesis that the samples of the general population and the sample that was used for the study do not differ significantly in frequencies, parametric (Student's test) and non-parametric tests (sign criterion, Wilcoxon's test) were used [2,7]. Both age-grouped and non-grouped (baseline) data were used.

Calculation of the Student`s criterion for the „male" group (table 7) showed that there is no significant difference between the average frequencies in the two groups, $p > 0,05$ and the null hypothesis is not disproved.

Table 7. Calculation results with Student's criterion for grouped data („male" group)

	Average frequency	Average square deviation	Number of intervals	Difference		Value according to Student's criterion	Number of degrees of freedom	p- level
	Average	Std.Dv.	N	Diff.	Std.Dv. Diff.	t	df	p
MALE_S (observations number 38)	14,28	16,63566						
MALE_D (observations number 762)	14,28	16,05184	7	-1,4E-16	3,247799	-1,2E-16	6	1

The result that there is no significant statistical difference in the data in terms of the characteristics of the age distribution of cases of strangulation asphyxia in the „male" group between the full sample (observational volume = 768) and the small sample (observational volume = 38) was confirmed also in the case of the use of ungrouped (initial) data.

Calculation of the Student`s criterion for the „female" group (table 8) showed that no significant difference between the average frequencies in the two groups was observed for the grouped data, $p > 0,05$ and the null hypothesis was not disproved.

Table 8. Calculation results with Student's criterion for grouped data („female" group)

	Average frequency	Average square deviation	Number of intervals	Difference		Value	Number of degrees of freedom	p- level
according to Student's criterion	Number of degrees of freedom	p- level	N	Diff.	Std.Dv. Diff.	t	df	p
	Average	Std.Dv.	N	Diff.	Std.Dv.			
Diff.	t	df	p	-1,4E-16	3,247799	-1,2E-16	6	1
FEMALE_S (observations number 10)	14,285	21,491						
FEMALE_D (observations number 192)	14,284	13,233	7	0,0014	15,8244	0,000239	6	0,999817

We will test the hypothesis whether there is a statistical difference relative to the average age of strangulation asphyxia observed in individual samples for the „male" and „female" groups.

To test this hypothesis, we will use the Student`s criterion for independent samples. The results of the calculations are shown in table 9.

Table 9. Results of Student's criterion calculations for data from the „male" and „female" groups.

	Average frequency	Average square deviation	Number	Differen-ce		Value		
accor-ding to Student's criterion	Number of de-grees of freedom	p- level						
	Average	Std.Dv.	N	Diff.	Std.Dv.	t	df	p
"female" group	48,9	19,47334						
"male" group	43,1	14,98481	10	5,800000	25,78458	0,711325	9	0,494905

As p>0,05, then the null hypothesis that there is no significant difference on average age of cases of strangulation asphyxia for „female" group (number of observations 10) and „male" groups (number of observations 38) can be left behind. It should be noted that this conclusion may result from the use of a relatively small amount of observations. However, it can be seen that the result for the average value in the „female" group is higher than the result in the „male" group, but as a result of small volumes of observations and a sufficiently large dispersion of values, this difference is not statistically significant. However, in the full samples for the „female" group (the number of observations is 192) and the „male" group (the number of observations is 768), the statistical difference between the average age for cases of strangulation asphyxiation in the „female" group is statistically significantly different from the same indicator in the „male" group.

Thus, using the methods of mathematical statistics, it is shown that a sample of 48 observations is representative, according to the age distribution in the groups „male" and „female" does not differ significantly from the data of the general population, there are no significant statistical differences between the average age of cases of strangulation asphyxia for the group „female" and the group „male".

That is, sample data can be used for further investigation, given the fact that several immunohistochemical marker indicators will be analyzed for each observation. In this regard, the volume of observations will increase several times and it will be possible to use parametric methods and criteria to test certain hypotheses.

Own calculations were carried out, as well as a review of the research results of scientists from several countries and regions of the world who have significant economic, social, cultural, religious differences, indicates that along with pathological signs factors as a result of suicide by hanging, pathopsychological disorders that were common causes, it should be scrutinized the impact of gender, regional, socio-economic and cultural factors, which effected on suicide rates by hanging in Ukraine and other countries. On the basis of improved informatization of the data of forensic medical bureaus, medical institutions, police data, etc. in Ukraine it should be established regional databases for research with formalized description of suicide cases by hanging, which would take into account the set of characteristics, important in investigating these suicides. Careful mathematical, statistical and expert analysis of these representative data would identify risk factors and crisis social and age groups, which are associated with suicides by hanging, and to develop a set of effective economic, social, psychological and medical measures to prevent suicide among the population.

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BADANIE SZCZEGÓW PRZYPADKÓW ROZKŁADU ASFIKSJI MECHANICZNEJ W AGLOMERACJI CHARKOWSKIEJ

STRESZCZENIE

Liczba samobójstw na świecie według oficjalnych statystyk nieznacznie spadła i wynosi 18 przypadków na 100 tys. mieszkańców. Według Światowej Organizacji Zdrowia wskaźnik samobójstw w 2016 roku wśród mężczyzn jest 3-4 razy wyższy niż wśród kobiet. Na podstawie danych US Center for Disease Control and Prevention Health (CDC) z 2016 r. Samobójstwa popełniają nisko wykwalifikowani pracownicy, którzy pracują i żyją w izolacji od społeczeństwa. Około 20 milionów ludzi każdego roku popełnia nieudane próby samobójcze, co ma konsekwencje psychologiczne zarówno dla samego samobójstwa, jak i dla co najmniej 6 osób w jego otoczeniu.

Według Państwowej Służby Statystyki Ukrainy w 2016 r. Samobójstwo popełniło prawie 7,5 tys. Ukraińców, w tym ok. 6 tys. mężczyzn. Przez lata radykalnej transformacji ukraińskiego społeczeństwa na ludność spadło wiele prób. Niestabilność gospodarcza, utrata pracy, zamieszki, działania wojenne znacząco wpłynęły na nastroje społeczne. Maksymalną liczbę samobójstw za lata niepodległości odnotowano od 1996 do 2000 roku.

Celem pracy jest przeprowadzenie analizy matematycznej i statystycznej w celu wykazania specyfiki empirycznego rozkładu przypadków uduszenia mechanicznego w aglomeracji charkowskiej.
Głównymi etapami tego badania była ocena statystycznego błędu próby oraz zastosowanie kryteriów statystycznych do testowania hipotez dotyczących płci i wieku przypadków asfiksji mechanicznej.

SŁOWA KLUCZOWE

samobójstwo, rozkład empiryczny, uduszenie mechaniczne, analiza statystyczna