

Estimation of Rate and Number of Under-reporting DSP

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Estimation of Rate and Number of Under-reported ~~ing~~ Deliberate Self-poisoning Attempts in Western Iran 2015

Abstract

OBJECTIVES: Rates of ~~d~~Deliberate ~~S~~Self-~~P~~poisoning (DSP) attempts are subjected to under-counting, under-reporting, and denying suicide attempts. In this study, therefore, we seek to ~~make some estimation of estimate the~~ rates of under-reported ~~ing of~~ DSPs, which is the most ~~method-common way~~ of attempting suicide ~~attempts~~ in Iran.

Methods: Using truncated count models, we estimated rates and numbers of under-counted ~~ing the~~ DSP attempts ~~ing individuals~~ in western part of Iran in 2015. ~~By this method, n₀, namely the number of people attempted~~ DSP, but not referring to any health care centers, was calculated through data connection. Then, crude and adjusted age rates of DSP attempts were estimated directly ~~by~~ using average population of ~~the respective city~~ and standard world population with and without taking under-reporting into account. Monte Carlo method was used to determine confidence level.

Results: Completeness of data recorded to estimate the number of people attempting DSP was obtained in the range of 46.6%_53.2% by using different methods. Rates of under-reported ~~cases ing~~ were higher among women than ~~those among~~ men and decreased as age increased. Rates of under-reported ~~ing~~ decreased with an increase in potency and intensity of toxic factors. Maximum under-reported ~~ing~~ rates of 69.9%, 51.2% and 21.5% were observed with oil and detergents (x66), medications (x60_64) and agricultural toxins (x68, 69), respectively. Crude rates, with and without considering under-reporting, were obtained by mixture method at 167.5 and 331.7 per 100,000 in order, which decreased to 129.8 and 251.3 per 100,000, respectively, after adjusting age on the basis of standard population given by WHO.

Conclusions: nearly half of individuals attempted ~~ing~~ DSP ~~do did~~ not referred to the hospital for treatment or deni~~es~~y SA for political and social-cultural ~~considerationsreseans~~. Individuals without any consultation services are at higher risks of repeated suicide attempts and fatal suicides.

Keywords: Deliberate ~~s~~Self-~~P~~poisoning, Truncated count models, Under-reporting, Completeness

Introduction

Suicide is one of ~~the~~ important social ~~and~~, health problems in many countries ~~, taking a great part of~~ primary and secondary health care ^[1]. Accounting for 80% of total rate of suicide attempts worldwide, ~~D~~deliberate ~~S~~self-~~P~~poisoning (DSP) is the most common way of suicide around the world ^[2]. Although proportion of DSP-based ~~S~~suicide ~~A~~attempts (SA) leading to death is very small compared to that of other ways ~~of SA~~ ^[3, 4], rates ~~s~~ and ~~likelihood-risk~~ of repetition of the former are very high ^[4, 5].

The most important solution to reduce the rate ~~of of~~ and mortality caused by SA is to identify and provide those attempted ~~ing~~ suicide with consulting services and to solve their problems, if

possible^[6]. Studies performed on SA, especially poisoning, unfortunately show that the number of SAs is subject~~ed~~ to under-counting, under-reporting and denying because of political, cultural and social issues as well as ~~of~~-taboo imposed by doing so on individuals and societ~~iesy~~ at large. The more powerful the issues mentioned, the more prevalent the SA under-reporting and under-counting^[4].

Levels of SA under-counting, under-reporting and denying are higher for virulent, fatal modes than ~~for~~-violent, aggressive ones. Majority of individuals attempting suicide may repeat that again and again simply because of not being identified and not receiving health care and consultation. In addition, to identify frequency of SA can help health care providers plan better programs and provide proper services^[2].

With advancements of statistics, different methods have been developed to estimate ~~r~~Rate of under-counting and sizes of hidden population, including the number of people attempting suicide^[7]. One of these methods is the truncated count models which have a lot ~~of~~ advantages such as more precise estimation, simplicity, and making use of available data^[8]. Such advantages caused this method to be used extensively in areas of public health and epidemiologic studies like estimation of the numbers of criminals^[9, 10], ~~of~~-drug abusers^[11-14], and ~~of~~-homosexuals^[15].

Given the explanations presented above and the lack of knowledge ~~of~~-regarding accurate number of SAs and of under-reporting ~~r~~Rate, we seek to ~~make some~~ estimates ~~on~~ the rate of DSP attempts in the west of Iran (Kermanshah city).

Methods

Data sources

Study population consists of all individuals attempting suicide by DSP (x60-69), who did so in Kermanshah city and were taken to Imam Khomeini Hospital, the principal poisoning treatment center in the west of country, in 2015. Having a nearly 1 million population, Kermanshah is the westernmost city in Iran and shares common borders with Iraq. Imam Khomeini poisoning center is the largest and only center for poisoning, most principal and most equipped poisoning center in western Iran, to which more than 90% of non-deliberate and deliberate poisoning cases refer, regardless of severity. Given that all people attempting suicide are not discharged until 8 hours after recovery of physical and mental conditions, information on the reasons for attempting DSP are collected by psychologists routinely through interviewing ~~these people in a quiet, peaceful and secure environment these people when~~, ~~after~~ their conditions have become stable, ~~within a quiet, peaceful and secure environment~~. Gathered information includes demographic variables, causes of SA, history of SA among family members and friends, time of incidents, poisoning agents, ~~and~~-psychological conditions, and drug abuse (abuse substances such as drugs, alcohol, heroin, opium, and morphine) which is gathered on paper first and recorded electronically next.

In order to determine the number of SAs, in addition to the hospital data, forensic data being gathered daily and reported monthly by forensics employees through interviewing family and relatives of individuals attempting suicide was used along with treatment documents and records.

By connecting data based on national codes (IDs), then, all records of individuals ~~with suicide~~ attempt~~ing suicide~~-were extracted, based on which the number of SAs was ~~determined for any person~~.

Truncated count estimators

Data on DSP makes the number of SAs (1 or >1 time) known for us, but we are unaware of the zero number (n_0) of SAs, that is, the number of individuals attempting DSP, but not referring to the poisoning treatment center is unknown. We will be able to estimate the number of individuals attempting DSP more accurately by estimating and adding n_0 to the number of observed ($N_{\text{total}} = n_{\text{Observed}} + n_0$). Several estimators for estimating population sizes via the Truncated count data Among the most important of these are Chao, Zelterman and Mixture. The population size estimator according Chao's method is $N = n_1^2 / (2n_2) + n$, that $n_1; n_2; \dots; n_m$ number of SAs (n_{Observed}). And in Zelterman estimator $N = n / (1 - \exp(-2n_2/n_1))$.

In Mixture method heterogeneity problems by grouping homogeneous observations into several stratum disappears. In this method, we consider a mixture of k components where each of the components follows a certain parametric distribution. Mixture method includes the negative binomial (NB), Zero Inflated Poisson (ZIP), and Zero Inflated Negative Binomial (ZINB) models cater for different dispersion parameters and heterogeneity aspects. Therefore, mixture method often deal with extra dispersion problems. Among truncated count models, Mixture of truncated count data method gives less square error (MSE) and more precision with high volume of samples and under conditions of homogeneity and heterogeneity^[8]. Therefore, rates of under-reporting in sub-groups were calculated according to mixtures.

In order to decrease bias and increase precision, number of individuals attempting DSP was estimated based on different strata, in addition to general population. Two indices of Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC) were used to evaluate the model. Confidence level was calculated by using Monte Carlo method via a probability-based sensitivity analysis for crude and adjusted age rates and mixtures of truncated count data. Suicide crude rates were calculated from using average population of the city, with help of 2011 census data and cooperation of registry office information^[16]; and directly standardized rates were calculated from using standard world population^[17]. Also, level of completeness was calculated by using mixtures of method by and dividing observed level (direct method) by estimated level.

STATA version 13.1 (Tata Corp, College Station, TX, USA) software and CAMCR (Computer-Assisted Mixture model analysis for Capture-Recapture count data) software were used to analyze data and to estimate under-reporting rates, respectively^[18].

Ethical considerations

The Present study was conducted on the basis of Helsinki Declaration. DSP attempters were interviewed personally by aided by a group of Imam Khomeini Hospital psychologists. Also; the study and related methods were approved by Ethical Committee of Kerman Medical Science University (IR. KMU. REC. 2015. 440).

Results

From a total of 1790 individuals who attempting DSP suicide (x60-69) 1023 were female (57.2%) and 767 (42.8%) were male, respectively. Sixty-four among these, 64 people subjects (20 women, 44 men) died from of severe poisoning, which indicates

severity of poisoning among males ($P < 0.001$). Age means were 25.2 ± 11 for females and 24.4 ± 8 for males, with no statistically significant difference ($P = 0.1$).

~~Based on significance, the most important~~ poisoning substances were, ~~in order of importance~~, medications (x60-64), agricultural toxins (x68, 69), and drugs and alcohol (x65, 62) used by 1315 (76.2%), 304 (17.6%), and 44 (2.5%) individuals, respectively. The most commonly used medications were tramadol ($n = 235$; 17.8%), psychotropic drugs ($n = 129$; 9.8%) and methadone ($n = 54$; 4.09%). Among ~~the failed those attempting failed suicide~~ SAs, 657 (43.8%) ~~people cases~~ had history of SA ~~and, with~~ the highest rate ~~being was~~ 15 times (table 1).

Table 1. Observed frequencies of SA by self-poisoning in west of Iran, 2014

Number of suicide attempts by self-poisoning in a case (i)	0	1	2	3	4	5	6	+7
Number of cases (Frequency n_i)	---	1069	334	156	78	32	15	30

Regardless of heterogeneity (strata), number of SAs in west of Iran was estimated at 3689, 3425 and 3238 by Zelterman, Chao and Mixtures methods, respectively, the last of which showed the least value of ~~r~~Root ~~M~~mean ~~S~~square ~~E~~rror (RMSE) (table 2).

Table 2. Estimation of number of SAs by DSP ~~by~~ using truncated count models

Estimator	Unobserved (N_0)	Total		RMSE*
		N	(95 % CI)	
mixture	1524	3238	(3127-3352)	429.4
Chao	1711	3425	(3315-3535)	466.2
Zelterman	1975	3689	(3573-3805)	520.4

* Root mean square error

For mixture estimation, no significant differences were observed among sub-groups after considering heterogeneity. ~~C~~and ~~calculation of n~~g strata-based population ~~by~~ using mixture method ~~giving gave~~ better estimates compared to other truncated count models (table 3).

Table 3. Number of unobserved SAs by DSP

Variable stratified	Discrete mixture		Observed known population	Mixture Estimator (N)	Total (95 % CI)
	λ^*	K^{**}			
Sex	Male	2.9	3	723	1432
	Female	5.0	3	1003	2004
Age group	≤ 18 year	2.2	2	361	1031
	19-25 year	3.8	2	797	1377
	26-30 year	3.3	2	276	501
	31-40 year	3.6	2	157	311
	≥ 41 year	0.9	1	116	194
Education duration	0 year	0.6	1	88	187
	1-6 year	2.5	2	192	676
	7-9 year	3.1	2	386	805

	10-13year	4.1	2	812	1363	
	≥14 year	1.0	1	124	305	
Drug abuse	Yes	5.0	3	304	478	3324
	No	3.2	2	1398	2846	(3211-3427)

* Poisson parameter

** The number of mixture components

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Crude rates of the number of SAs by DSP estimated by direct and mixture methods were 167.5 and 331.7 per 100,000 people, ~~respectively,~~ which reached 129.8 and 253.1, respectively, after adjusting on the basis of WHO standard population.

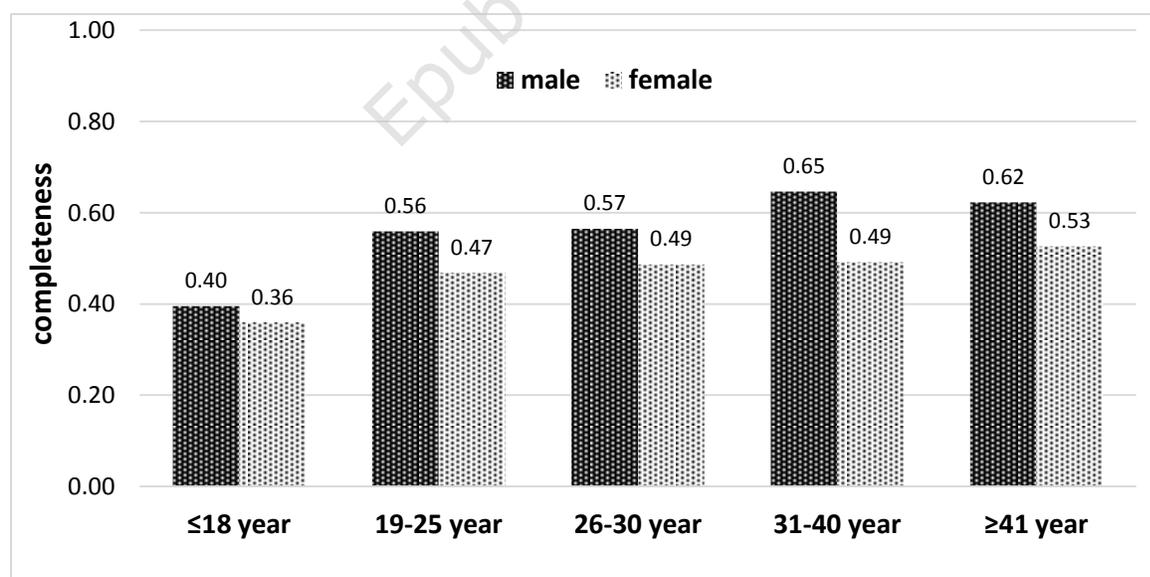
Table 4: Estimates of crude and adjusted age rates of SA by DSP in 2015

variable	Direct estimation		mixture estimation		
	Crude rate	age-specific rates	Crude rate	age-specific rates	
gender	Male	146.2	104.1	298.2	205.8
	female	187.2	156.0	363.6	302.8
Age	≤18 year	105.9	42.3	294.7	117.9
	19-25 year	562.9	45.0	1064.8	85.1
	26-30 year	324.1	25.9	528.9	42.3
	31-40 year	132.7	15.9	213.8	25.6
	≥41 year	41.1	13.1	63.9	20.4
Total	167.5	129.8	331.7	253.1	

Rate per 100,000

Levels of data completeness in identifying the number of individuals attempting suicide were obtained by various estimators in range of 46.6% and 53.2%. Under-reporting rates decreased as potency and intensity of poisoning agents increased. Maximum under-reporting rates related to oil and detergents (x66), medications (x60-64) and agricultural toxins (x68, 69) were 69.9%. 51.2% and 21.5%, ~~respectively in order~~. As shown in diagram 1, completeness rate is higher for men than for women and under-reporting rate decreased with an increasing age (diagram 1).

Figure1. Levels of data completeness by sex and age group



Discussion

One major problem with studying hidden populations is the lack of reporting and the faults of registering systems. In most countries of the world, SA ~~reported~~ statistics are ~~reported~~ less than real number, ~~where-when~~ a case of death is recorded as suicide only when homicide, and accidental death can be rejected or when a note of SA written by deceased is obtained. So, it is possible that some cases of SA ~~be-recorded-from~~ are based on undetermined deaths due to impossibility of rejecting other causes of death ^[19].

After adjusting age based on WHO population, annual rates of DSP decreased due to the fact that Iranian population was young and that this age group attempts suicide more frequently. In ~~sum~~ general, compared to studies performed in other parts of Iran, the present study showed higher annual rates of SA by DSP ^[20, 21]. But compared to similar studies, this study was not much different even after considering under-reportings; for example, rates of SA by DSP was 315 per 100,000 (330 men, 299 women) ^[22] and 133.75 ^[23] for Sri Lanka and UK, respectively. In a European multicenter study, rates of SA by medication poisoning were 135(men)-188 (women) in Oxford, 211 (men)-188 (women) in Helsinki and, on the average, 172 per 100,000 for both sexes in Stockholm ^[24]; and rates of DSP was 76 per 100,000 (66 men, 101 women) for those who ~~referring~~ ing to the U.S. hospitals ^[25].

In general, in Asia, rates of SA are higher among men than women while the opposite is true in Europe ^[26]. Rate of DSP in Asian countries is nearly 20%-30% more than ~~that in~~ European and Western countries ^[25, 27]. This difference ~~is due to different~~ results from reasons such as availability ^[28], urbanization ^[29], and cultural-economic differences ^[30]. While, in rural areas and Asian countries, chemicals and agricultural toxins are the most importantly used substances for DSP, in urban areas and most of European countries, more than 70% of poisoning substances are accounted for by medications, especially psychotropic drugs ^[24].

In this study, the highest rate of SA was observed with in age group from age 19 to 25 years group, which is in agreement with ~~those of similar~~ other studies performed in this field. In ages between 19 and 25, in general, rates of SA are 2-4 times higher than other age groups ^[22, 25]. Given high rate of SA in this age of group, on one hand, and ~~given~~ that more than 20% of Iranian population fall in this group, on the other hand, it is necessary for authorities and attendants to endeavor more vigorously to solve problems and meet needs of this group.

Although more than 90% of non-deliberate or deliberate poisoning cases attempted in Kermanshah refer to Imam Khomeini Treatment Center in order to receive health care, rate of completeness of identifying by this center all individuals attempting suicide was 50%, even ~~by~~ using different estimates. This, ~~which~~ is in agreement with views of professionals and psychologists in the poisoning word, who believe that half of these individuals do not receive treatment or consulting and psychological services because they deny SA or do not refer to treatment centers ^[30].

-Rate of under-reporting is higher among women than men, which is most likely due to stronger taboo of this act on women compared to men. As severity of virulence and fatality of poisoning agents increases, rate of under-reporting decreases so that rates of denial and under-reporting are less for agricultural toxins than ~~for~~ oil and detergents because of being more toxic. Similar studies have shown that more potently toxic substances increase likelihood of being taken to the hospital and decrease denying and not registering SAs ^[29, 30].

Rates of SA under-reporting decreased with an increase in age, maximum of which was observed with people under 18. Generally, rates of SA denial and under-reporting are higher among individuals attempting suicide for the first time than those having history of more SAs.

One reason ~~why-for decreasing~~ under-reporting rates ~~decreases~~ with an increasing ~~e-in~~ age is ~~making-that they use of~~ poisoning substances with more potency and higher amount.

Chao and Zelterman estimators ~~-~~ derived under homogeneity and when number of component are low ($k < 3$) ~~-~~ show ~~the~~ good performance which is consistent with similar studies^[8]. The proposed estimator, ~~Mi (mixture estimator)~~, is an excellent estimator with smallest ~~bias values of bias~~. This article has shown ~~that~~ the ~~M~~mixture estimator ~~is-has~~ small bias ~~value~~ when ~~the~~ data have heterogeneity. For data sets under homogeneity and heterogeneity, mixture of the truncated Poisson models provides the best estimated population. Chao's and Zelterman's estimator provides a lower and upper bound value, respectively, and the mixture of truncated count models provided ~~d~~ value between Chao's and Zelterman's estimators.

Strengths and weaknesses of study

This study has a lot of strengths such as using several information sources with respect to data completeness, employing clinical psychologists to perform interviews, and precise systems for recording information about individuals attempted ~~ing~~ DSP. But like any other similar studies in this field, ~~present study~~ it has some weaknesses and limitations such as lack of cooperation from some individuals attempted ~~ing~~ suicide, limited and difficult access to information from different centers, Lack of precise identification of the type of drugs and substances used for suicide and limited statistical methods for estimating rates of under-reporting. Main limitations on methods of truncated count models are small values of λ and heterogeneity of data. **Small values of λ cause different methods o give different estimates**; therefore, it is difficult to determine which method gives accurate estimates. **In addition, with small values of λ , large confidence intervals result and reduce precision of calculations.** So, ~~to avoid overestimating n_0 frequencies,~~ it is required to interpret estimates more carefully when λ values are small ~~to avoid overestimating n_0 frequencies.~~

Solutions for reducing ~~rates of under-reporting rates~~

There exist some SA under-reporting and under-counting around the world, but ~~with~~ different rates ~~, which have s~~ two reasons: first, due to cases not being reported and ~~to the~~ faults of registering systems, which is not a big problem in developed countries; second, due to political, cultural and social issues as well as ~~to the~~ taboo imposed by SA on individuals and society at large. Rates of under-reporting and under-counting are higher in small societies and in societies where stronger stigma is placed on SA.

Rate of under-reporting and under-counting the number of SAs are extremely higher than that of suicides leading to death. Rates of SA denial and under-reporting are sharply higher among people attempting suicide for the first time compared to those having history of SA. Such people conceal their attempts to suicide due to the fear of social treatment. Levels of individuals' trust/SA denial rates can increase/decrease by giving assurance to and interviewing them ~~is-in~~ isolated room. In many countries, including Iran, individuals attempting suicide are not under coverage of health insurance to receive treatment services. So, individuals and their families try to conceal acts of SA in the hope of using insurance coverage. Unfortunately, sometimes health care staff pays less attention to and spend less time on treating individuals attempted ~~ing~~ suicide. ~~To eliminate~~ **Elimination of the** distinction between such individuals and those being poisoned non-deliberately can be positively effective in reducing the rates of SA denial and under-reporting.

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Conflicting interests

Authors have no conflicting interests to disclose.

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Table1. Observed frequencies of SA by self-poisoning in west of Iran, 2014

Number of suicide attempts by self-poisoning in a case (<i>i</i>)	0	1	2	3	4	5	6	+7
Number of cases (Frequency n_i)	---	1069	334	156	78	32	15	30

Table2. Estimation of number of SAs by DSP by using truncated count models

Estimator	Unobserved (N_0)	Total		RMSE*
		N	(95 % CI)	
mixture	1524	3238	(3127-3352)	429.4
Chao	1711	3425	(3315-3535)	466.2
Zeltermann	1975	3689	(3573-3805)	520.4

* Root mean square error

Table3. Number of unobserved SAs by DSP

Variable stratified		Discrete mixture		Observed known population	Mixture Estimator (N)	Total* (95 % CI)
		λ	k			
Sex	Male	2.9	3	723	1432	3436 (3323-3539)
	Female	5.0	3	1003	2004	
Age group	≤18 year	2.2	2	361	1031	3414 (3300-3531)
	19-25 year	3.8	2	797	1377	
	26-30 year	3.3	2	276	501	
	31-40 year	3.6	2	157	311	
	≥41 year	0.9	1	116	194	
Education duration	0year	0.6	1	88	187	3336 (3216-3452)
	1-6year	2.5	2	192	676	
	7-9year	3.1	2	386	805	
	10-13year	4.1	2	812	1363	
	≥14 year	1.0	1	124	305	
Addiction	Yes	5.0	3	304	478	3324 (3211-3427)
	No	3.2	2	1398	2846	

Table 4: Estimates of crude and adjusted age rates of SA by DSP in 2015

variable		Direct estimation		mixture estimation	
		Crude rate	Age-standardized rates	Crude rate	Age-standardized rates
gender	Male	146.2	104.1	298.2	205.8
	female	187.2	156.0	363.6	302.8
Age	≤18 year	105.9	42.3	294.7	117.9
	19-25 year	562.9	45.0	1064.8	85.1
	26-30 year	324.1	25.9	528.9	42.3
	31-40 year	132.7	15.9	213.8	25.6
	≥41 year	41.1	13.1	63.9	20.4
Total		167.5	129.8	331.7	253.1

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