

FORECASTING TRENDS IN HOSPITALISATIONS DUE TO DRUG POISONING IN SEMNAN, IRAN UP TO 2021: TIME SERIES MODELLING

PROGNOZOWANIE TRENDÓW HOSPITALIZACJI Z POWODU ZATRUĆ NARKOTYKAMI W SEMNAN W IRANIE DO 2021 ROKU: MODELOWANIE SZEREGÓW CZASOWYCH

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Abstract

Introduction: Investigating and forecasting the changes in the frequency of referrals to the treatment centres of the patients with drug poisoning can aid the assessment of the burden of health problems and planning of appropriate intervention programmes. The aim of this study is to predict the trend of drug poisoning case referrals to the Iranian hospitals up to 2021.

Material and methods: The Box & Jenkins model was applied in a longitudinal study to forecast the frequency of drug and alcohol poisoning

Streszczenie

Wprowadzenie: Śledzenie i prognozowanie zmian w częstości hospitalizacji pacjentów z zatruciem substancjami psychoaktywnymi może pomóc decydom w ocenie obciążeń tymi problemami i zaplanowaniu odpowiednich programów interwencyjnych. Niniejsze badanie ma na celu określenie trendu dotyczącego hospitalizacji z powodu zatruc narkotykami w Iranie do 2021 r.

Materiał i metody: W badaniu podłużnym zastosowano model Boxa i Jenkinsa do prognozowania liczebności przyjęć z powodu zatrucia narkotykami

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case referrals. The number of cases referred to the hospitals in each month from March 2011 to February 2015 was provided. After data processing to gain stationary time series and investigation of the stability assumption with the Dickey-Fuller test, ARIMA model parameters were determined using ACF and PACF graphs. Using Akaike statistics, ARIMA (0, 1, 1) was selected as the best fit model.

Results: The number of referrals increased from 400 in 2011 to 735 in 2015. The highest referrals in 2011-2015 were 56 cases in January 2011, 43 in October 2012, 59 March 2013, 66 April 2014 and 80 in January 2015. The trend was linear without a regular seasonal pattern. The mean monthly poisoning referrals to the selected hospitals up to 2021 was predicted as 58.2.

Discussion: The estimated increased trend of referral cases due to poisoning showed in this study is parallel to the estimated increase of illegal drug use prevalence. Recent surveys, which showed that drug abuse prevalence in Iran is higher than the global mean, were also confirmed by our research. The limitation of our study is the lack of access to the full information on psychoactive substance consumption as well as classified information like police and national registry system databases.

Conclusions: Our study revealed a rising trend for drug poisoning patients referred to the studied hospitals. The forecasting also suggested that the trend will continue up to 2021 without suitable intervention.

Keywords: Trend, Forecasting, Poisoning, Drug abuse, Time series

i alkoholem. Analizowano liczbę osób skierowanych do szpitali od marca 2011 r. do lutego 2015 r. Po przekształceniach danych służących uzyskaniu stacjonarności badanych szeregów czasowych i zbadaniu założenia o ich stabilności za pomocą testu Dickeya–Fullera parametry modelu ARIMA określono na podstawie wykresów ACF i PACF. Posługując się kryterium Akaikego, wybrano ARIMA (0, 1, 1) jako model dający najlepsze dopasowanie.

Wyniki: Liczba hospitalizacji wzrosła z 400 w 2011 r. do 735 w 2015 r. Najwyższa liczba hospitalizacji w latach 2011–2015 przypadała na styczeń 2011 – 56 przypadków, październik 2012 – 43, marzec 2013 – 59, kwiecień 2014 – 66 i styczeń 2015 – 80. Trend był liniowy bez regularnego wzorca sezonowego. Przewiduje się, że średnia miesięczna liczba pacjentów z zatruciami kierowanych do wybranych szpitali do 2021 r. wyniesie 58,2.

Omówienie: Szacowany trend wzrostowy hospitalizacji z powodu zatruc wykazany w tym badaniu jest zgodny z przewidywanym wzrostem rozpowszechnienia używania narkotyków. Jak wynika z ostatnich badań rozpowszechnienie nadużywania narkotyków w Iranie jest wyższe niż średnia światowa. Zostało to również potwierdzone przez nasze badania. Ich ograniczeniem jest brak dostępu do pełnej informacji na temat konsumpcji substancji psychoaktywnych, a także dostępu do niejawnych danych z policji i rejestru krajowego.

Wnioski: Nasze badania pokazały trend wzrostowy hospitalizacji z powodu zatrucia substancjami psychoaktywnymi. Według naszych prognoz bez odpowiedniej interwencji taki trend może się utrzymać do 2021 r.

Słowa kluczowe: trend, prognozowanie, zatrucie, nadużywanie narkotyków, szeregi czasowe

■ INTRODUCTION

Epidemiologic studies have included illegal drug use as one of the four critical global crises [1]. Iran has been geographically located in the opium export belt. Illegal drug use is considered the main social and health concern in Iran with opium products the most commonly used substances that are also the main cause of poisoning [2, 3].

Frequent use of opium and stimulants can lead to adverse consequences and contribute to

approximately two-third of suicides [4, 5]. There is evidence of an increasing hospital referrals rate for patients with alcohol and opium poisoning in recent years. In some cases poisonings are result of consumption of more than one substance or of illegal additives like lead [2].

According to a national survey conducted in Iran with use of the Network Scale Up method, the prevalence of at least one-time alcohol consumption in the previous year among people 15-year-old or more and also men aged between 18 and 30 were

estimated as of 2.31% and 7% respectively. In addition, alcohol consumption among men was approximately eight times higher compared to females [6]. Another study carried out among Iranian high school students showed higher rates of illegal drug use among boys than girls. The lifetime rate of alcohol use as well as opium use were 9.9% and 1.2-8.6% respectively [7]. A study conducted in South-west of Iran showed that tramadol (69.3%), opium (27.3%) and heroin (2.7%) were major sources of opioid overdosing events [8]. Another national study showed increases in the hospitalisation rates due to alcohol overdose (25%), drug overdose (55%) and combined drug-alcohol overdose (76%) during 1999-2008 [9].

Considering the high burden and costs of dependence, suicide and other outcomes of drug abuse, reducing the prevalence of any hazardous consumption of alcohol and the use of opium and other illegal stimulants can contribute to control of mortality and morbidity within the communities [10].

Forecasting the increasing or decreasing trend of patients with drug poisoning referred to the hospitals can provide suitable information for policymaking and implementation of intervention strategies. Since there was not enough information regarding these trends, we aimed to investigate the trend of patients with opium, stimulants and alcohol poisoning referrals to Semnan (a province in north of Iran) hospitals during 2011-2015 and forecast this trend up to 2021.

■ MATERIAL AND METHODS

In this longitudinal study, Box & Jenkins model (ARIMA model) was applied for forecasting

the drug/alcohol poisoning incident cases. At first, the protocol of the study was approved in the ethical review board of Semnan University of Medical Sciences, Semnan Iran (Ethical code: IR.SEMUMS.REC.1396.71). Next, all information was collected from the patients' documents of hospitals of Semnan Province. This information was electronically available by diagnostic codes (ICD-10) during 2011-2015 in the medical records units of the hospitals.

Counts of following causes were included into the study: acute alcohol poisoning (ethanol, methanol), poisoning due to overdose of opium, of stimulants (cocaine, amphetamine), poisoning with mixture of opiates, tramadol overdose and methadone poisoning (see codes in Tables I and II) [11].

Time variable in this study was each of the months during the study period. Sampling was performed by census method. The number of poisoning cases in each month during formed monthly time series in period 2011-2015 was determined. As a result 60 time points were analysed. Graphing the data time series and describing the frequency of patients with poisoning, the structure of this time series were investigated. After data processing for designing the stationary time series and more detail investigation of this assumption using Dickey-Fuller test, the parameters of model were determined using ACF (auto-correlation function) and PACF (partial auto-correlation function) graphs. To investigate the details of the time series parameters like trend, seasonal effect and random component, the time series was decomposed using moving average method. Using Akaike information criterion (AIC) statistics for suggested models (model with the lowest amount of AIC), ARIMA (0, 1, 1) was

Table I. ICD-10 codes attributed to the nature of the poisoning

Sedatives	Amphetamines	Alcohol	Drugs	Methadone	Opium
T42.4	T43.6	T51.9	T50.9	T40.3	T40.0

Source: [11]

Table II. ICD-10 codes related to the cause of poisoning

Sedatives	Amphetamines	Alcohol	Methadone	Opium	Cause
X41	X41	X45	X42	X42	Accidentally
X61	X61	X65	X62	X62	Suicide
Y11	Y11	X15	Y12	Y12	Unknown
Y47.1	Y49.7	No	Y90.0	Y40.0	Adverse reactions

Source: [11]

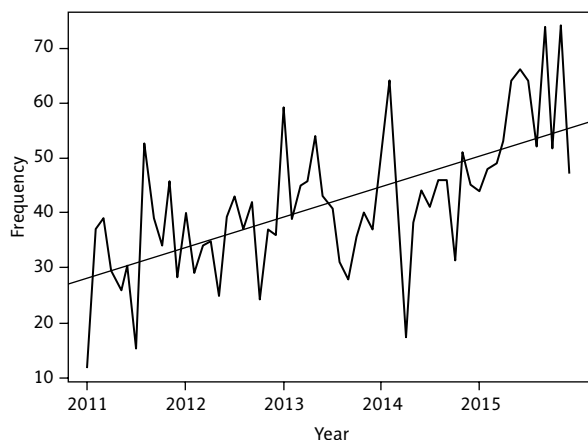


Figure 1. Time series of the frequency of referrals of patients with poisoning to the hospitals of Semnan showing a linear trend

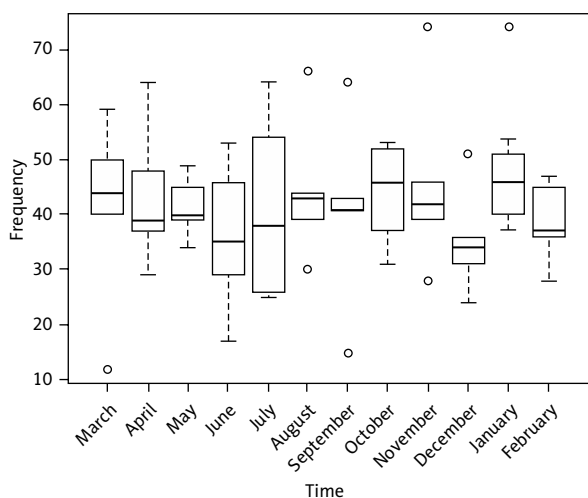


Figure 2. Box plot of the frequency of patients with poisoning referrals to the hospitals. X-axis is month, Y-axis is number of patients. The body of the box plot consists of a “box”, which goes from the first quartile (Q1) to the third quartile (Q3). The median or middle quartile (Q2) is shown by two horizontal lines that divides the box into two parts. Half the scores are greater than or equal to this value and half are less

selected as the choice with the best fit. Finally, the frequency of referrals of patients with poisoning up to 2021 was predicted using ARIMA (0, 1, 1). The results was analysed using R 3.4.3 (forecast and tseries package) software.

■ RESULTS

The frequency of patients referrals to the studied hospitals differed from 400 in 2011 to 735 in 2015. The maximum referral rates were in January 2011

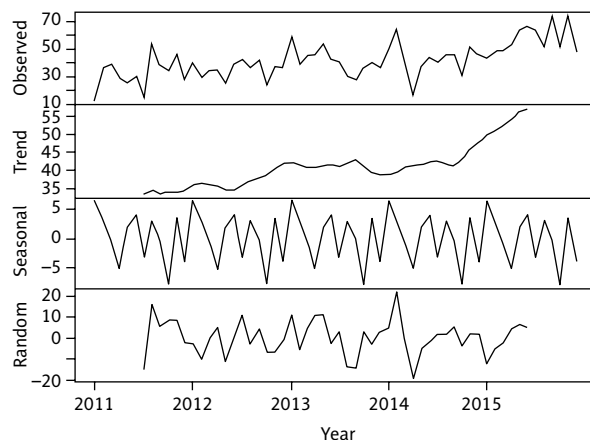


Figure 3. Decomposition of drug poisoning time series into additive component

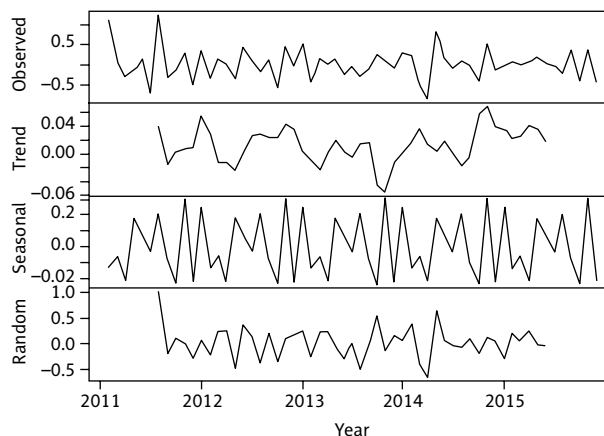


Figure 4. Decomposition of the structural time series of the converted data. From the top panel to the bottom panel, time series plots of the drug poisoning observed, trend, seasonal and random (irregular) are showed

(56 cases), October 2012 (43), March 2013 (59), April 2014 (66) and January 2015 (80). The minimum rates were in March 2011 (12 cases), July 2012 (25), October 2013 (34), July/December 2014 (41) and March 2015 (46). The time series investigations showed a linear trend without any regular seasonal effect, i.e. incidence of poisoning did not have any seasonal pattern. The time series graph of the frequency of referrals of patients with poisoning to the hospitals of Semnan province is illustrated in Figure 1.

The box plots (Figure 2) of the frequency of referrals of patients with poisoning to the hospitals show the highest and lowest dispersion of referral data for August and October respectively. Also, there was no visible trend or seasonality in con-

secutive months. In the first half of the year in the Persian calendar¹ March-September, all data have positive skewness indicating that the median number of patients was lower than the mean. This is the case for October, November and February in the second half of the year.

The details of the time series parameters like trend, seasonal effect and random component, were mentioned in Figure 3. This showed that the time series has an increasing trend which can affect its static assumption. Figure 4 shows the decomposition of the time series using logarithmic conversion and first degree differential operator. Following this process, the increasing trend was removed and changed to static time series. Based on Dickey-Fuller test, the null hypothesis was rejected and the static assumption of the transformed data was approved (Dickey-Fuller: -12.572 , p value: 0.01).

ACF and PACF graphs were used (Figures 5 and 6) to determine the degree of moving average and autoregression. ACF graph shows that the first and second observations were out of the mean range. Therefore MA (1) and MA (2) models have the best fit. Moreover, PACF graph shows that the deviation was just for the first observation, indicating that the AR (1) is the best model. Totally, ACF and PACF graphs revealed the usefulness of the ARIMA model regarding goodness of fit.

Figures 5, 6 and 7 demonstrate that ARIMA (0, 1, 1), ARIMA (1, 1, 1) and ARIMA (1, 1, 2) seem to have the best fit. The AIC for these three models was estimated as of 47.91, 49.35 and 51.3 respectively, indicating the best fit for ARIMA (0, 1, 1) model. Results of the Ljung-Box test showed that after ACF first lag, other residuals were not excluded from the mean area and also the Ljung-Box test statistic was within the confidence interval indicating that there is no concern about the correlation of the residuals.

ARIMA (0, 1, 1) model was applied for forecasting the time series until 2021. The predicted monthly mean (95% confidence interval) number of patients with poisoning referred to the hospitals during 2016-2021 was estimated as of 58.2.

DISCUSSION

In this study, the trend of referrals of patients with poisoning (opium, stimulants and alcohol) in the selected Iranian hospitals during 2011-2015

¹ The Persian calendar has 12 months starting with Fervardin (equivalent to March 20).

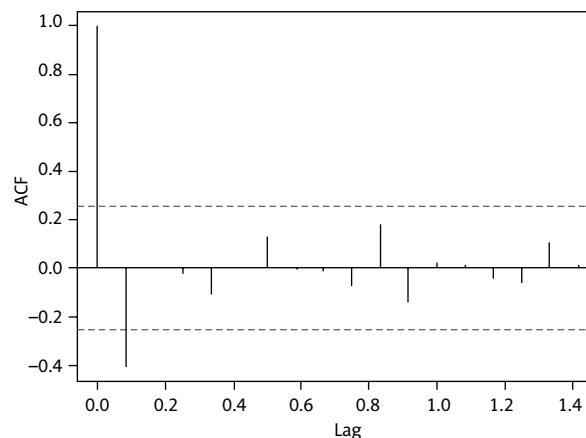


Figure 5. The ACF plot for the transformed data

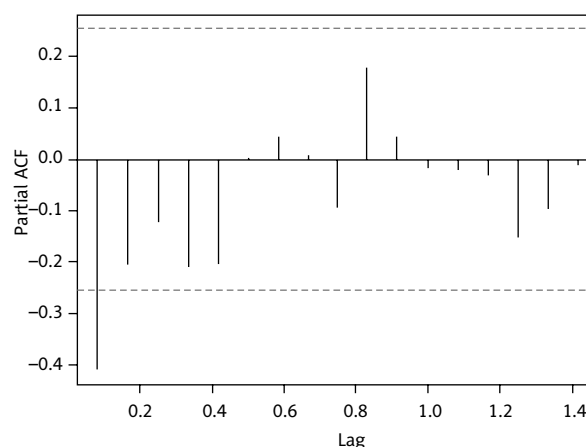


Figure 6. The PACF plot for the transformed data

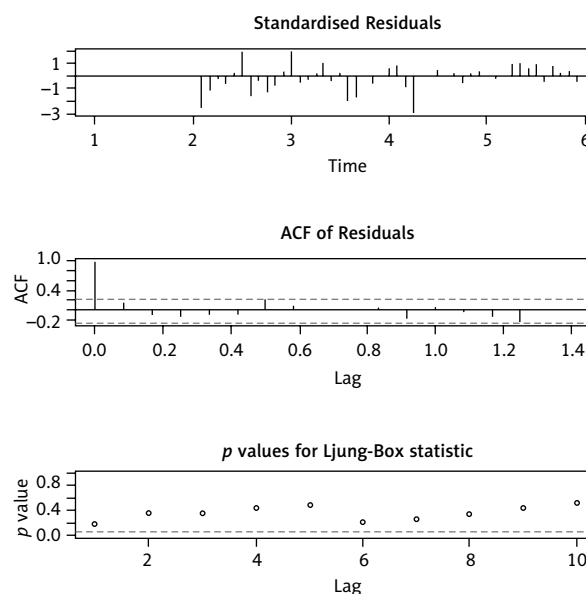


Figure 7. Residuals adequately checked (the horizontal lines indicate the confidence interval at 95% probability limits)

were investigated and also predicted up to 2021. The results showed an increasing trend which will continue if suitable interventions are not implemented. Control of diseases is one of the main goals of surveillance systems and reducing the prevalence of addiction can be suitable for limiting the burden of trauma [10].

The estimated increased trend of referral cases due to poisoning is parallel to the estimated increase of the prevalence of marijuana in the study carried out by Yuodelis-Flores and Ries, which showed that the prevalence of marijuana will increase from 1% in 2006 to 2.9% in 2020, and also number of illegal drug users will increase from 719,000 to 3.3 million persons [12].

Focusing on illegal drug use is one of the most important goals of the global burden of diseases (DALYs, Disability Adjusted Life Year) [13]. In a study carried out in 2003 in Iran, drug abuse attributed to the 510,000 deaths, which was the third cause of the main disease burden in men [14, 15]. The recent surveys showed that prevalence of drug abuse in Iran is more than the global mean [16]. In other words, drug associated mortalities was responsible for two-thirds of the suicides [10]. Similarly, our study showed an increasing trend for the patients with drug poisoning referred to the studied hospitals during 2011-2015.

Benzodiazepines, methadone, tramadol, morphine and codeine are among the chemical drugs used extensively for treatment of withdrawal symptoms, anxiety, insomnia, epilepsy and muscular spasm [17-19]. Use of these drugs without prescription can lead to adverse effects and hospitalisation and also increasing the health costs in the community [17]. Tramadol related mortality is increasing in Iran especially among opium users [20]. In addition, tramadol toxicity is a great concern particularly among children in Iran [21]. Moreover, because of high prevalence of oral and inhaled impure opium (lead impurity) consumption in Iran, many patients are being referred to the hospital with chronic lead poisoning [22].

Although alcohol consumption is legally and culturally banned in Iran [23] and limited information is available regarding the alcohol abuse, recent reports showed that the use of this substance is increasing. Iran is the most prevalent area in the Middle East for methanol poisoning [24]. Therefore it has been recommended that in the case of any alcohol poisoning all other users

were identified for any prophylactic interventions in order to reduce any probable poisoning and mortality. Methamphetamine use is a new health problem in this most populous Persian Gulf region country [25]. This kind of poisoning has many adverse consequences and there are many cases with cardiac arrest, convulsions, hallucinations, delusion, hypertension, unconsciousness, stroke and paraplegia that have been referred to the hospitals during the recent years [25].

Results of the current study may not be generalisable to the whole population affected by opium. Firstly because of the limited information about alcohol consumption in Iran [23, 24] and secondly the classified police and national registry database information has not been used in this study. Jansen investigated the official reported information of deaths due to smoking and alcohol consumption in France and found considerable underestimation. However, evaluating the hidden information revealed 30% increase in the overuse of these substances in the recent decade in that country [26]. Also we could not investigate the trend of referral rates based on some factors like age and gender due to lack of enough available information.

The present study responds to governmental concerns about mortality due to drug poisoning by suggesting the implementation of programmes like prevention of late intervention for referring and treatment of patients with poisoning. Naloxone is an FDA approved drug with appropriate effectiveness which can improve the symptoms of opium poisoning and reduce mortality [27-30]. Opium overdose preventive programme includes training activities about two main subjects: diagnosis of signs and symptoms of opium poisoning and type of response to poisoning such as naloxone therapy to prevent complications. This programme has been successfully implemented in several countries and training programmes have been carried out among families, emergency staff and police officers [31-34]. These programmes contribute to the reduction of referrals following poisoning events.

It should be noted that the frequency of drug poisoning referrals to the hospitals varied a lot with different months of each year. For example, it was zero in one month in a hospital while considerable cases were reported for that time in another hospital. In total, the lowest frequency was reported for December. No regular trend or sea-

sonal pattern was observed for drug poisoning. One of the limitations can be due to the low quality of registry of the information in different hospitals in different years. Variation of recorder staff, burden of the referrals, having appropriate protocols for registry can be factors contributing to the quality of information. In addition, the small size of the studied community is another limitation that can be resolved by national level studies.

■ CONCLUSIONS

Our study revealed an increasing trend of patients referrals to the hospitals due to drug poisoning and our modelling predicted its continuation in 2021 if no appropriate interventions are considered. Comprehensive policymaking in Iran is recommended to reduce the burden of drug poisoning in the near future.

Conflict of interest/Konflikt interesów

None declared./Nie występuje.

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None declared./Nie zadeklarowano.

Ethics/Etyka

The work described in this article has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki) on medical research involving human subjects, Uniform Requirements for manuscripts submitted to biomedical journals and the ethical principles defined in the Farmington Consensus of 1997.

Treści przedstawione w pracy są zgodne z zasadami Deklaracji Helsińskiej odnoszącymi się do badań z udziałem ludzi, ujednoliconymi wymaganiami dla czasopism biomedycznych oraz zasadami etycznymi określonymi w Porozumieniu z Farmington w 1997 r.

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