Addiction & Health

https://ahj.kmu.ac.ir
10.34172/ahj.2024.1439
Vol. 16, No. 1, 2024, 6-10

Original Article

Assessment of Blood Lead Levels in Mothers Addicted to Opium and Their Neonates in Kerman: A Cross-sectional Study

Fatemeh Sabzevari[1], Maryam Ahmadipour[1*], Najmeh Nezamabadipour[2], Abbas Jahanara[2]

[1]Department of Pediatrics, Afzalipoor Hospital, Kerman University of Medical Sciences, Kerman, Iran
[2]Department of Pediatrics, Bam University of Medical Sciences, Bam, Iran

***Corresponding Author:** Maryam Ahmadipour, Email: maryam.ahmadipour5@gmail.com, m.ahmadipour@kmu.ac.ir

Abstract

Background: High blood lead levels (BLLs) in pregnant women are associated with poor outcome in neonates. One of the newest non-occupational sources of lead contamination is opium consumption. Accordingly, this study aimed to assess BLLs in mothers addicted to opium and their neonates in Kerman.

Methods: This cross-sectional was conducted in Afzalipour hospital in Kerman, from February 2019 to February 2020. The BLLs were measured in 100 opium-addicted and non-addicted mothers and their newborns, and the lead levels higher than 5 μg/dL were considered contamination. Then, the demographic and anthropometric data were compared.

Findings: Based on the results of the present study, the BLLs of opium-addicted mothers (33.40 ± 9.22 μg/dL vs 3.2 ± 1.5 μg/dL) and their neonates (13.46 ± 4.86 vs 1.1 ± 0.9) were significantly higher (P = 0.001) than those of non-addicts. Moreover, the average birth weight of the newborns in the addicted group was significantly lower than in the non-addicted group (2572.8 ± 77.49 vs 2946 ± 46.87) (P = 0.001). Besides, there was a significant relationship between the average birth weight and the BLL of the mother and baby, and the average weight of the babies was significantly lower at higher levels of lead. However, no correlation was observed regarding the average height and head circumference of the neonates (P > 0.05).

Conclusion: It seems that the serum level of lead in neonates of opium-addicted mothers contaminated with lead is significantly higher than that of non-addicts, but their anthropometric characteristics at birth were not different from those of the non-addicted group.

Keywords: Environmental exposure, Maternal exposure, Neonatal screening, Maternal behavior

Citation: Sabzevari F, Ahmadipour M, Nezamabadipour N, Jahanara A. Assessment of blood lead levels in mothers addicted to opium and their neonates in Kerman: a cross-sectional study. *Addict Health*. 2024;16(1):6-10. doi:10.34172/ahj.2024.1439

Received: January 15, 2023, **Accepted:** March 11, 2023, **ePublished:** February 29, 2024

Introduction

Lead is a heavy metal and as it is widely used in several chemical products, lead poisoning has become a common problem mainly in developing countries.[1,2] Lead is simply absorbed through the skin, respiratory system, and intestinal tract. It freely crosses the blood-brain barrier and placenta after crossing the plasma and is spread in all soft and hard tissues. Abdominal pain, fatigue, anemia, memory impairment, joint pain, headache, ataxia, peripheral neuropathy, weakened immunity, reduced birth weight, abortion, and premature birth are some of the most significant signs of lead poisoning.[1,3-5] Lead poisoning is diagnosed based on the elevation of blood lead level (BLL) higher than 10 μg/dL.[6] Recently, there have been reports about lead poisoning in opium-addicted people in Iran[7]. For instance, a study in Iran reported the mean concentration of lead in opium was 1.88 ± 0.35 ppm which is harmful in chronic consumption.[8]

Although lead poisoning frequently occurs only when the individual has a history of contact with old-style sources of lead, new kinds of non-occupational poisoning have led to certain problems. One of the newest non-occupational sources of lead poisoning is drug addiction, which has recently been reported as a major source of lead poisoning in some countries, including Iran.[9-13]

Lead freely crosses the placenta. An increased rate of abortion and preterm deliveries seems to be associated with high lead exposures in pregnant women. Low birth weight, cognitive and behavioral impairments, and increased blood pressure have been observed in children born to mothers with elevated lead in venous blood or cord blood.[14-16]

Lead contact during fetal growth may result from the mobilization of bone lead stored from the previous contact into the maternal bloodstream and/or from the direct elevation of maternal BLL caused by acute or chronic environmental lead contact through pregnancy. In utero, lead exposure relates to postnatal neurodevelopmental delay and behavioral abnormalities.[4,17-19]

Substance abuse is a complex public health problem with social and economic health implications [20,21]. Although maternal substance abuse during pregnancy occurs in all socioeconomic classes, ages, and races, there is an increased prevalence in younger women.[22-25] Nearly 90% of drug-using women are of childbearing age.[26] In the United States, the reported prevalence of substance abuse among non-pregnant and pregnant women aged 15 to 44 was 10% and 4% respectively, but this level increased to 15.5% among pregnant women aged 15 to 17 years.[27,28] The results of a study in Iran showed out of 100,620 deliveries, substance abuse was recorded for 519 women with a prevalence of 0.5%, with opium being the most common substance abused followed by crack (a combination of heroin and amphetamine).[27]

Therefore, exposure to lead during pregnancy can affect the developmental process of the fetus as opium- or other drug-addicted women may have a high BLL. Accordingly, this study aimed to evaluate the BLLs in mothers addicted to opium and their neonates.

Methods

Study population and design

This cross-sectional study was conducted in gynecology, obstetrics, and neonatology tertiary referral center of Afzalipour hospital in Kerman, from February 2019 to February 2020. A total of 50 full-term pregnant women addicted to opium and its derivatives and 50 non-addicted mothers and their newborns, were randomly selected for the study through convenience sampling after giving written consent. Sampling continued until the completion of the sample size. None of the participants had a history of working in plastic, crystal, and toy factories, or living outside Kerman.

Immediately after birth, blood samples from the mother and the baby were sent simultaneously to determine the serum lead level. The blood samples were analyzed by Atomic Absorption Spectrophotometry (Dong, Anyang, 431-836, Korea). In addition, anthropometric variables, including gestational age, weight, and head circumference of neonates as well as maternal age, education level, and socioeconomic status were recorded. The BLL values higher than 5 μg/dL were considered positive and the p-value less than 0.05 was considered significant.

According to a study by Li et al, mothers with serum lead levels < 1.18 μg/dL were considered low-Pb (lead), from 1.18 to 1.70 μg/dL were medium-Pb, ≥ 1. 71 μg/dL were high-Pb, and above 5 μg/dL were considered toxic.[19]

To compare the average serum level between addicted and non-addicted mothers, due to the high cost of measuring lead, the ratio of patient to control was determined 3 to 1.

According to previous study[29] and given a test power of 98% and a significance level of less than 0.05, the minimum sample size for each group was calculated as 45.

Statistical analysis

Frequency, relative frequency, and central average index were used for descriptive statistics, the chi-square or Fisher test was utilized for comparison of qualitative data between the two groups, and the t-test was used for comparison of quantitative data between the two groups. All analyses were conducted using SPSS (Version 20). A two-sided *P* value less than 0.05 was considered statistically significant.

Results

The BLLs of 100 mothers who enrolled in the study and their neonates were measured. Table 1 shows data on mean (± SD) age, weight, height, blood pressure (systolic and diastolic), hemoglobin, and lead levels of mothers at the time of delivery.

A total of 50 participants in the addicted group and 50 in the non-addicted group met the inclusion criteria and were analyzed. In terms of education level, the majority of the mothers had higher education (addicted: 66% and non-addicted: 56%). Table 1 shows the other demographic characteristics of the study groups.

Table 1. Comparison of demographic variables in the two study groups

		Addicted group		Non-addicted group		*P*
		No.	%	No.	%	
Level of Education	Illiterate	3	6	1	2	0.245
	Under diploma	14	28	21	42	
	Diploma and higher	33	66	28	56	
Job	Housewife	41	82	36	72	0.235
	Employed	9	18	14	28	
Type of delivery	Normal delivery	24	48	20	40	0.420
	Cesarean section	26	52	30	60	
Neonate's gender	Male	27	54	29	58	0.771
	Female	23	46	21	42	
		Mean	SD	Mean	SD	
Age (y)		29.32	4.96	29.64	4.94	0.747
Gravida		2.92	0.26	2.48	0.14	0.153
Parity		2.46	0.20	2.28	0.13	0.442
Live birth		2.22	0.16	2.29	0.16	0.792
Abortion		1	0.24	1.07	0.07	0.822
Death		0.29	0.23	1	0.22	0.496
Weight (g)		2572.8	77.49	2946	46.87	0.001
Height (cm)		48.17	0.60	48.60	0.29	0.525
Head circumference (cm)		33.78	0.37	34.40	0.13	0.122

The mean age of women in the two groups was approximately equal (addicted: 29.33 years and non-addicted: 29.64 years). There was no significant difference between the two groups in terms of demographic variables (Table 1).

Although the mean gravida, parity, and live birth in the addicted group were higher than those of the non-addicted group, this difference was not statistically significant (Table 1). The mean live birth, abortion, and death were not significantly different between the two groups. Table 1 shows the results of comparing demographic variables between the two groups.

The mean BLL of infants and mothers in the addicted group were 13.46 ± 4.86 µg/dL and 33.40 ± 9.22 µg/dL, respectively. In addition, in the non-addicted group, the mean BLL in infants and mothers were 1.1 ± 0.9 and 3.2 ± 1.5 µg/dL, respectively. Besides, there was a significant relationship between the BLL of mothers and neonates in both groups ($P < 0.01$).

The average weight, height, and head circumference of the neonates in the two groups were compared, and only the average weight of the neonates in the addicted group was significantly lower than that of the non-addicted group ($P = 0.001$).

Furthermore, there was no significant difference between the average height and head circumference of the infants in the two groups ($P > 0.05$; Table 1).

The average weight, height, and head circumference of the newborns in the two groups were determined in relation to the serum lead level of the mother and the newborn, and only the average weight of the newborns showed a significant relationship with their serum lead level. Height and head circumference of neonates in the two groups were not related to serum lead level of the mother or the infant (Table 2).

The results showed that BLLs were significantly higher in opium-addicted mothers and infants than in non-addicted ones ($P = 0.001$) (Table 3).

The mean neonatal and maternal BLLs were 2.36 ± 1.03 µg/dL and 2.74 ± 0.46 µg/dL in the addicted group, 2.22 ± 0.63 µg/dL in oral opium users, and 2.53 ± 0.64 µg/dL in inhalers, but there was no significant difference between the two groups ($P1 = 0.942$ and $P2 = 0.917$) (Table 4).

Univariate linear regression analysis of BLL with weight, height, and head circumference in neonates is shown in Table 5. Weight was negatively correlated with maternal BLL (β = -0.04), but this correlation was not statistically significant ($P = 0.7$). Moreover, there was an inverse relationship between the level of neonatal BLL and weight (β = -0.07), which was not statistically significant. Although there was a positive correlation between the BLL of mothers and neonates and height, this relationship was not statistically significant ($P = 0.6$ and $P = 0.7$). The correlation between maternal and neonatal BLL and head circumference was not statistically significant ($P = 0.9$).

Table 6 shows the relationship between maternal and neonatal BLL and weight, height, and head circumference after controlling the confounding factors. There was an inverse relationship between maternal and neonatal BLL, which was not statistically significant ($P = 0.7$ and $P = 0.5$). Furthermore, there was an association between maternal and neonatal BLL and height, but this relation was not statistically significant (β = 0.04 and β = 0.01) ($P = 0.7$ and $P = 0.9$). In addition, there was no statistically significant relationship between maternal and neonatal BLL and head circumference ($P = 0.9$ and $P = 0.7$)

Discussion

In terms of demographic variables, including age, gravidity, parity, and live birth, there was no difference between the two groups. In addition, there was no significant difference in terms of education, occupation, type of delivery, and gender ($P > 0.05$).

In the opium-addicted group, the total mean neonatal and maternal BLLs were 13.46 ± 4.86 and 33.40 ± 9.22, respectively and in the non-opium addicted group, the corresponding values were 1.1 ± 0.9 and 3.2 ± 1.5, respectively, which were significantly different ($P < 0.05$).

In line with the results of a number of previous studies, the present study showed maternal and neonatal BLLs in the opium-addicted group were significantly higher than in the non-addicted group.[10,13,30,31]

Salesmen may add lead to opium during the process of opium preparation to escalate the weight of opium for more income.[10,30,31]

Salehi et al,[30] showed the BLL in the opium-addicted group was higher than in the non-addicted group. The mean difference was statistically significant ($P < 0.0001$).

In the study by Li et al,[19] maternal serum lead level was only associated with an increased risk of late preterm birth. This study provided evidence that maternal serum lead level during pregnancy was positively associated with the risk of preterm birth in a Chinese population.

In the present study, there was no relationship between maternal and neonatal lead levels and weight, height, and

Table 2. The relationship of weight, height, and head circumference with maternal and neonatal lead in the study groups

		Weight		Height		Head circumference	
		Spearman correlation	P	Spearman correlation	P	Spearman correlation	P
Case group	Maternal BLL	-0.07	0.58	0.1	0.48	0.3	0.8
	Neonatal BLL	-0.07	0.6	0.06	0.6	0.005	0.9

BLL, blood lead level.

Table 3. Prevalence of lead level in mothers and infants in the study groups

Variable		Blood lead level		P value
		Addicted group No. (%)	Non-addicted group No. (%)	
Mother	<5 µg/dL	2 (4)	43(86)	0.001
	≥5 µg/dL	48(96)	7(14)	
Neonate	<5 µg/dL	16 (32)	49(98)	0.001

Table 4. Comparison of mean maternal and neonatal BLLs in the study groups

	Total	Addicted group	Non-addicted group	P
Maternal BLL	18.3 ± 7.31	33.40 ± 9.22	3.2 ± 1.5	0.001
Neonatal BLL	7.28 ± 2.9	13.46 ± 4.86	1.1 ± 0.9	0.001

Table 5. Univariate linear regression analysis of BLL with weight, height, and head circumference in neonates

	Weight		Height		Head circumference	
	β	P	β	P	β	P
Maternal BLL	-0.04	0.7	0.06	0.6	0.004	0.9
Neonatal BLL	-0.07	0.6	0.04	0.7	-0.01	0.9

BLL, blood lead level.

Table 6. Multivariate linear regression analysis of BLL with weight, height, and head circumference in neonates

	Weight		Height		Head circumference	
	β	P	β	P	β	P
Maternal BLL	-0.04	0.7	0.04	0.7	-0.01	0.9
Neonatal BLL	-0.08	0.5	0.01	0.9	-0.07	0.7

BLL, blood lead level.

head circumference ($P > 0.05$). However, the neonates of addicted mothers had significantly lower weight than the non-addicted group. This finding is consistent with those of several previous studies showing that infants of mothers using opium, have a higher risk of low birth weight. Rahi et al[32] showed that the low birth weight of the infants of addicted mothers was 5 times more than those of non-addicted mothers. Maghsoudlou et al,[33] in a cohort study, showed that the increased risk of small for gestational age was higher in mothers who used opium during their pregnancy. In their study, there was also an increased risk of a short birth length and a small head circumference in infants of the addicted mothers.However, the sample size of this study was larger than that of the present study. Another study by Derakhshan et al[34] indicated that low birth weight was more frequent in the opium-exposed neonates compared with the control group. Nevertheless, none of these studies measured BLLs. However, although maternal and neonatal BLLs do not affect infant size at birth, their adverse effects may be evident in later years of life.

In patients addicted to opium, whether asymptomatic or with clinical symptoms, we should think about lead poisoning and increased lead levels. It seems reasonable that addicted patients should be monitored for BLLs. In addition, if the patient has certain symptoms such as abdominal pain, nausea and vomiting, jaundice, weight loss, and increased liver enzymes, we should consider lead poisoning. Based on the results, it can be concluded that addicted women who are pregnant need to check their BLLs to prevent pregnancy complications and fetal problems. However, more studies should be conducted to determine the exact relationship of BLL in neonates and their opium-addicted mothers.

Conclusion

According to the results, it can be concluded that in pregnant women who are addicted to drugs, checking the BLLs of addicted mothers is essential to prevent pregnancy complications and fetal problems.

Acknowledgements

The authors are thankful to the Departments of Gynecology and Neonatology for providing details of patients for collecting data.

Authors' Contribution

Conceptualization: Fatemeh Sabzevari and Abbas Jahanara.
Data curation: Fatemeh Sabzevari, Abbas Jahanara and Najmeh Nezamabadipour.
Investigation: Maryam Ahmadipour and Najmeh Nezamabadipour.
Methodology: Fatemeh Sabzevari and Abbas Jahanara.
Software: Fatemeh Sabzevari and Abbas Jahanara.
Supervision: Maryam Ahmadipour.
Visualization: Maryam Ahmadipour and Najmeh Nezamabadipour.
Writing–original draft: Fatemeh Sabzevari, Abbas Jahanara and Najmeh Nezamabadipour.
Writing–review & editing: Maryam Ahmadipour.

Competing Interests

The authors declare that there is no conflict of interest.

Ethical Approval

This research project was approved by the Ethics Committee of the Vice-Chancellor for Research of Kerman University of Medical Sciences with the Code of Ethics IR.KMU.AH.REC.1397.098.

Funding

None.

References

1. Alarcon WA. Summary of notifiable noninfectious conditions and disease outbreaks: elevated blood lead levels among employed adults - United States, 1994-2012. MMWR Morb Mortal Wkly Rep. 2015;62(54):52-75. doi: 10.15585/mmwr.mm6254a4.
2. Martins E, Varea A, Apezteguía M, González HF, Girardelli A, Caro LS, et al. Prenatal lead exposure and relationship with maternal exposure determinants in a public maternity hospital of La Plata, Argentina. Sci Total Environ. 2014;473-474:43-7. doi: 10.1016/j.scitotenv.2013.11.128.
3. Golmohammadi T, Ansari M, Nikzamir A, Safary R, Elahi S.

Association of lead concentration in colostrum, maternal and cord blood with newborn weight in polluted vs. non-polluted areas of Iran. Tehran Univ Med J. 2007;65(8):74-8. [Persian].
4. Hu H, Téllez-Rojo MM, Bellinger D, Smith D, Ettinger AS, Lamadrid-Figueroa H, et al. Fetal lead exposure at each stage of pregnancy as a predictor of infant mental development. Environ Health Perspect. 2006;114(11):1730-5. doi: 10.1289/ehp.9067.
5. Masoodi M, Zali MR, Ehsani-Ardakani MJ, Mohammad-Alizadeh AH, Aiassofi K, Aghazadeh R, et al. Abdominal pain due to lead-contaminated opium: a new source of inorganic lead poisoning in Iran. Arch Iran Med. 2006;9(1):72-5.
6. Hayatbakhsh Abbasi MM, Ansari M, Shahesmaeili A, Qaraie A. Lead serum levels in opium-dependent individuals. Addict Health. 2009;1(2):106-9.
7. Fatemi R, Jafarzadeh F, Moosavi S, Afshar Amin F. Acute lead poisoning in an opium user: a case report. Gastroenterol Hepatol Bed Bench. 2008;1(3):139-42. doi: 10.22037/ghfbb.v1i3.36.
8. Aghaee-Afshar M, Khazaeli P, Behnam B, Rezazadeh Kermani M, Ashraf-Ganjooei N. Presence of lead in opium. Arch Iran Med. 2008;11(5):553-4.
9. Soltaninejad K, Flückiger A, Shadnia S. Opium addiction and lead poisoning. J Subst Use. 2011;16(3):208-12. doi: 10.3109/14659891.2010.545860.
10. Khatibi-Moghadam H, Khadem-Rezaiyan M, Afshari R. Comparison of serum and urine lead levels in opium addicts with healthy control group. Hum Exp Toxicol. 2016;35(8):861-5. doi: 10.1177/0960327115607947.
11. Soltaninejad K, Shadnia S. Lead poisoning in opium abuser in Iran: a systematic review. Int J Prev Med. 2018;9:3. doi: 10.4103/ijpvm.IJPVM_22_17.
12. Hayatbakhsh MM, Oghabian Z, Conlon E, Nakhaee S, Amirabadizadeh AR, Zahedi MJ, et al. Lead poisoning among opium users in Iran: an emerging health hazard. Subst Abuse Treat Prev Policy. 2017;12(1):43. doi: 10.1186/s13011-017-0127-0.
13. Nemati A, Jafari S, Afshari M, Dahmardeh S, Tabrizian K. Comparing blood lead level among oral/inhaled opium addicts with a non-addict control group in the southeast of Iran. Addict Health. 2016;8(4):235-41.
14. Taylor CM, Golding J, Emond AM. Adverse effects of maternal lead levels on birth outcomes in the ALSPAC study: a prospective birth cohort study. BJOG. 2015;122(3):322-8. doi: 10.1111/1471-0528.12756.
15. González-Cossío T, Peterson KE, Sanín LH, Fishbein E, Palazuelos E, Aro A, et al. Decrease in birth weight in relation to maternal bone-lead burden. Pediatrics. 1997;100(5):856-62. doi: 10.1542/peds.100.5.856.
16. Huang S, Hu H, Sánchez BN, Peterson KE, Ettinger AS, Lamadrid-Figueroa H, et al. Childhood blood lead levels and symptoms of attention deficit hyperactivity disorder (ADHD): a cross-sectional study of Mexican children. Environ Health Perspect. 2016;124(6):868-74. doi: 10.1289/ehp.1510067.
17. Committee on Obstetric Practice. Committee opinion No. 533: lead screening during pregnancy and lactation. Obstet Gynecol. 2012;120(2 Pt 1):416-20. doi: 10.1097/AOG.0b013e31826804e8.
18. Gulson BL, Mizon KJ, Korsch MJ, Palmer JM, Donnelly JB. Mobilization of lead from human bone tissue during pregnancy and lactation--a summary of long-term research. Sci Total Environ. 2003;303(1-2):79-104. doi: 10.1016/s0048-9697(02)00355-8.
19. Li J, Wang H, Hao JH, Chen YH, Liu L, Yu Z, et al. Maternal serum lead level during pregnancy is positively correlated with risk of preterm birth in a Chinese population. Environ Pollut. 2017;227:484-9. doi: 10.1016/j.envpol.2017.05.009.
20. Amaro H, Fried LE, Cabral H, Zuckerman B. Violence during pregnancy and substance use. Am J Public Health. 1990;80(5):575-9. doi: 10.2105/ajph.80.5.575.
21. Hutchins E, DiPietro J. Psychosocial risk factors associated with cocaine use during pregnancy: a case-control study. Obstet Gynecol. 1997;90(1):142-7. doi: 10.1016/s0029-7844(97)00181-6.
22. Ebrahim SH, Gfroerer J. Pregnancy-related substance use in the United States during 1996-1998. Obstet Gynecol. 2003;101(2):374-9. doi: 10.1016/s0029-7844(02)02588-7.
23. Vega WA, Kolody B, Hwang J, Noble A. Prevalence and magnitude of perinatal substance exposures in California. N Engl J Med. 1993;329(12):850-4. doi: 10.1056/nejm199309163291207.
24. Chasnoff IJ, Landress HJ, Barrett ME. The prevalence of illicit-drug or alcohol use during pregnancy and discrepancies in mandatory reporting in Pinellas county, Florida. N Engl J Med. 1990;322(17):1202-6. doi: 10.1056/nejm199004263221706.
25. Chasnoff IJ, McGourty RF, Bailey GW, Hutchins E, Lightfoot SO, Pawson LL, et al. The 4P's Plus screen for substance use in pregnancy: clinical application and outcomes. J Perinatol. 2005;25(6):368-74. doi: 10.1038/sj.jp.7211266.
26. Kuczkowski KM. Anesthetic implications of drug abuse in pregnancy. J Clin Anesth. 2003;15(5):382-94. doi: 10.1016/s0952-8180(03)00056-4.
27. Saleh Gargari S, Fallahian M, Haghighi L, Hosseinnezhad-Yazdi M, Dashti E, Dolan K. Maternal and neonatal complications of substance abuse in Iranian pregnant women. Acta Med Iran. 2012;50(6):411-6.
28. Sheehan TJ. Stress and low birth weight: a structural modeling approach using real life stressors. Soc Sci Med. 1998;47(10):1503-12. doi: 10.1016/s0277-9536(98)00236-6.
29. Reihani Kermani H, Niktab AR. The relationship between blood lead concentration and electroneurographic findings in lead-exposed subjects. J Qazvin Univ Med Sci. 2005;8(4):27-31. [Persian].
30. Salehi H, Sayadi AR, Tashakori M, Yazdandoost R, Soltanpoor N, Sadeghi H, et al. Comparison of serum lead level in oral opium addicts with healthy control group. Arch Iran Med. 2009;12(6):555-8.
31. Amiri M, Amini R. A comparison of blood-lead level (BLL) in opium-dependant addicts with healthy control group using the graphite furnace/atomic absorption spectroscopy (GF-AAS) followed by chemometric analysis. Iran Red Crescent Med J. 2012;14(8):488-91.
32. Rahi E, Baneshi MR, Mirkamandar E, Haji Maghsoudi S, Rastegari A. A comparison between Apgar scores and birth weight in infants of addicted and non-addicted mothers. Addict Health. 2011;3(1-2):61-7.
33. Maghsoudlou S, Cnattingius S, Montgomery S, Aarabi M, Semnani S, Wikström AK, et al. Opium use during pregnancy and infant size at birth: a cohort study. BMC Pregnancy Childbirth. 2018;18(1):358. doi: 10.1186/s12884-018-1994-8.
34. Derakhshan R, Roodpeyma S, Balaee P, Bakhshi H. A case-control study on perinatal outcomes of opium-addicted pregnant women and their offsprings in Rafsanjan, Iran. J Compr Ped. 2014;5(1):e14779. doi: 10.17795/compreped-14779.