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## Frequency Analysis of Injuries in Pregnant Women Depending on Season and Stage of Pregnancy Based on Forensic Medicine Expert Reports.

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### ABSTRACT

The actual prevalence of injuries in pregnant women is slightly higher than the prevalence recorded in hospitals mainly due to the fact that minor injuries fall into the scope of forensic medicine's competence. Given the above, analysis of the forensic medical examination reports provides the most complete picture of rate of injuries in pregnant women. In this article a retrospective analysis of forensic assessment reports based on surveys for the time period of 2011-2014 (155 reports) and forensic assessment based on medical records for the period of 2009-2014 (49 reports) examinations was conducted to analyze the relation between the frequency of injuries in pregnant women, season (time of year) and the stage of pregnancy (trimester). For this study statistical analysis of categorized data was performed. To assess the level of significance of differences in injuries among members of different groups, a chi-square test was used. Analysis of forensic medical reports showed that the highest number of injuries in pregnant women occurs in autumn, and the least traumatic stage of pregnancy is the 3<sup>rd</sup> trimester.

**Keywords:** forensic medicine, injury rate, pregnant women, Kazakhstan

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## ACTUALITY

Improvement of maternal health is one of the eight Millennium Development Goals (MDGs), adopted at the UN Millennium Summit in 2000 and approved by world leaders, including the President of the Republic of Kazakhstan (UN, 2000).

Violence and injury prevention, as well as management of health of mothers, infants, children and teenagers are prioritized activities of the World Health Organization (WHO, 2015). Therefore, all current programs, that are aimed at maternal and child welfare, are supported by WHO and Member States. Republic of Kazakhstan, together with the WHO, set out a list of priorities for co-operation, one of which is maternal and child health (WHO, 2015).

According to various sources, injuries cause complications in 1-8 % of all pregnancies. As a result of significant decrease in recent years in mortality rates due to obstetric pathology, traumas in pregnant women take the first place among the causes of maternal and fetal death (S. Einav, H.Y. Sela, C.F. Weiniger 2013; N.J. Murphy, J.D. Quinlan 2014). The most common causes of injuries in pregnancy are motor vehicle accidents, which account for almost half of all injuries. The second most common cause is falls (about a third of cases). In addition to that, violence by an intimate partner (domestic violence) also plays a significant role in the genesis of injuries (M. Zangene, B. Ebrahimi, F. Najafi 2015). Some authors have suggested that the true prevalence of trauma during pregnancy is higher as the frequency estimation is performed based on the number of women provided with emergency treatment in hospitals. However, minor injuries are left undetected and tend to get into the field of view of medical doctors only when expert evaluation of severity of injuries is requested (Harland Karisa, 2014).

Taking into account the fact that the legislative system of the Republic of Kazakhstan stipulates the mandatory appointment of forensic medical examination for assessment of the severity of injuries, analysis of forensic medical reports provides the most informative data for investigation of the true prevalence of minor injuries in pregnant women. Moreover, examination is carried out only in branches of the Center of Forensic Medicine depending on the place of residence, which can also be beneficial for analysis of forensic medical reports.

All the reasons described above justify the urgency of our investigation of injuries in pregnant women through the analysis of forensic medical reports.

**Aim.** To conduct analysis of the findings of forensic examinations based on surveys and medical records of pregnant women in order to investigate the dependence of frequency of injuries on time of the year (season) and the stage of pregnancy (trimester).

## MATERIALS AND METHODS

Retrospective analysis of forensic medical reports based on surveys of pregnant women for 2011-2014 and analysis of forensic medical examinations based on medical records for 2009-2014 was performed using materials of Astana branch of the State Enterprise "Centre of Forensic Medicine" of the Ministry of Justice of the Republic of Kazakhstan.

Continuous sampling was used as a method for retrospective analysis of the findings of forensic medical reports. During this period, 155 examinations and 49 medical expert committee examinations were performed. In this investigation, statistical analysis of categorized data was used for data analysis and interpretation. As a result of this analysis we: 1) identified the relative number of injury frequencies (relative frequency) in pregnant women depending on the time of year and trimester of pregnancy and evaluated their accuracy and reliability; 2) defined the levels of significance of differences in relative injury frequencies for different seasons of the year and the stage of pregnancy. Chi-square test was chosen to assess the level of significance of differences in relative injury frequencies of various groups (Yunkerov V. I., Grigoriyev S. G., 2002).

**RESULTS**

*I. Analysis of injury frequency in pregnant women depending on the time of year and the stage of pregnancy based on forensic medical examination.*

To investigate the dependence of injury frequency on time of the year, sampling of findings of forensic medical examinations of pregnant at the time of surveying women, was made for the time period from 2011 to 2014.

**Table 1 Distribution of forensic medical reports based on surveys according to seasons and trimesters of pregnancy**

Years	Seasons				Stage of pregnancy		
	Winter	Summer	Autumn	Spring	First trimester	Second trimester	Third trimester
2011	6	9	11	8	16	12	6
2012	6	14	15	13	28	11	9
2013	4	7	10	0	7	7	7
2014	9	7	17	19	15	28	9
Total	<b>155</b>				<b>155</b>		

Four distinctive groups according to the time of year were defined: I – winter – December, January, February (25 reports), II – summer – June, July, August (37 reports), III – autumn – September, October, November (53 reports), IV – spring – March, April, May (40 reports). In terms of stages of pregnancy, three categories were determined: I – first trimester (66 reports), II – second trimester (58 reports), III – third trimester (31 reports). The total number of forensic medical reports amounted 155.

Statistical analysis revealed the following data:

1. The relative values of injury frequencies and assessment of accuracy and reliability are represented in Table 2.

To determine the relative injury frequency values depending on the time of year in pregnant women, the calculation was performed as follows: for groups I and II, in which the identified relative frequency values were less than 25%, Fisher variable was introduced. For groups III and IV, in which the relative values of frequency were greater than 25% but less than 75%, mean square error of relative frequencies was used to assess the accuracy and reliability.

To define the relative value of injury frequency in pregnant women depending on the stage of pregnancy, in group III, where the relative value of frequency was less than 25%, Fisher variable was introduced. In groups I and II, in which the relative frequency values were greater than 25% but less than 75%, mean square error of relative frequency values was used to assess the accuracy and reliability.

**Table 2 Relative injury frequency values and accuracy and reliability assessment based on surveys**

Values/Groups	Seasons				Trimesters		
	I	II	III	IV	I	II	III
Relative value of injury frequency (RVF) %	16.1	23.9	34.2	25.8	42.6	37.4	20
Mean square error (RVF) %	-	-	3.8	3.5	0.04	0.039	-
Fisher variable (ratio between two $\chi^2$ variables)	0.825	1.02	-	-	-	-	0.927
Mean square deviation of Fisher variable $\phi$	0.08	0.08	-	-	-	-	0.080
95 % confidence interval for $\phi$	0.667-0.983	0.858-1.17					0.768 – 1.086
95 % confidence interval for P %	10.7-22.3	17.3-30.7	26.7-41.7	18.8-32.8	37.4-50.4	29.7-42.1	14-26.67

As a result of the calculations, it can be concluded that the likelihood of injuries in pregnant women, according to forensic medical examination reports, depends on the time of year. With a probability of 95 %, the likelihood for each of the groups is in the following ranges:

- Group I - from 10.7% to 22.3%;
- Group II - from 17.3% to 30.7%;
- Group III - from 26.7% to 41.7 %;
- Group IV – from 18.8% to 32.8%.

As evidenced by the forensic medical examination of pregnant women, the likelihood of injuries depending on the trimester of pregnancy for each of the groups with the reliability of 95% is in the following ranges:

- Group I - from 37.4% to 50.43%;
- Group II – from 29.73% to 42.17%;
- Group III - from 14% to 26.67 %.

2. The levels of significance of differences in injury frequencies depending on seasons and stages of pregnancy are represented in Table 3. Assessment of the significance of differences in relative frequency values was performed by Chi -square test criterion.

**Table 3 Levels of significance of difference with regards to the time of year and stages of pregnancy, according to the forensic medical reports based on surveys**

Compared groups	Seasons			Stages of pregnancy	
	II	III	IV	II	III
I	p> 0.05	p< 0.05	p< 0.01	p> 0.05	p< 0.01
II		p> 0.05	p> 0.05		p< 0,01
III			p> 0.05		

Comparative analysis of the data demonstrating the dependency of injury frequency on the season, revealed a significant difference between pregnant women from Group I and Groups III (p <0.05) and IV (p <0.01). Differences in the levels of injury frequencies in pregnant women of Groups II and III, II and IV, as well as III and IV, were insignificant (p> 0.05).

A statistically significant difference in the levels of injury frequencies in pregnant women appeared as a result of comparison of the first and the third trimesters (p <0.01), as well as the second and the third trimesters of pregnancy (p <0.01).

*II. Analysis of injury frequency values depending on the time of year and the stage of pregnancy using forensic medical examinations based on medical records.*

In this study, sampling of forensic medical records of pregnant women for the 5 – year period from 2009 to 2014, was performed. Table 4 represents the distribution of reports according to the time of year.

**Table 4 Distribution of forensic medical reports based on medical records according to seasons and trimesters of pregnancy**

Years	Seasons				Stage of pregnancy		
	Winter	Summer	Autumn	Spring	First trimester	Second trimester	Third trimester
2009	1	1	1	3	2	4	-
2010	5	1	1	4	3	6	2
2011	2	0	0	5	2	3	2
2012	4	1	3	1	1	6	2
2013	0	1	3	1	-	4	1
2014	3	3	2	3	2	7	2
Bcero	49				49		

The results obtained during this investigation, with regards to the seasons, can be divided into four separate groups: I – winter – December, January, February (15 reports), II – summer – June, July, August (10 reports), III – autumn – September, October, November (17 reports), IV – spring – March, April, May (7 reports). Three distinctive groups were determined according to the stage of pregnancy: I – first trimester (10 reports), II – second trimester (30 reports), III – third trimester (9 reports). The total number of reports for three groups was 49.

As a result of statistical analysis, the following results were obtained:

1. The relative values of injury frequency and accuracy and reliability assessment data is represented in Table 5.

For groups divided according to the time of year, the calculations were performed as follows: for Groups II and IV, in which the relative values of frequency were less than 25%, Fisher variable was introduced. In groups I and III, where the relative frequency values were greater than 25% but less than 75%, the mean square error of relative frequency values was used to assess the accuracy and reliability.

For groups divided according to the stage of pregnancy, the calculations were performed as follows: for Groups I and III, in which the relative values of frequency were less than 25%, Fisher variable was introduced. In group II, where the relative frequency values were greater than 25% but less than 75%, the mean square error of relative frequency values was used to assess the accuracy and reliability.

**Table 5 Relative injury frequency values and accuracy and reliability assessment based on medical records**

Values/Groups	Seasons				Trimesters		
	I	II	III	IV	I	II	III
Relative value of injury frequency (RVF) %	30.6	20.4	34.7	14.3	20.4	61.2	18.4
Mean square error (RVF) %	0.066		0.068			0.07	
Fisher variable (ratio between two x2 variables)		0.937		0.775	0.937		0.886
Mean square deviation of Fisher variable $\phi$		0.143		0.143	0.143		0.143
95 % confidence interval for $\phi$		0.65-1.224		0.488-1.062	0.65-1.224		0.599-1.173
95 % confidence interval for P %	17.4-43.8	10.2-33	21-48.4	5.8-25.7	10.2-33	47.2-75.2	8.7-30.6

Subsequently, conclusions regarding the association of likelihood of injuries in pregnant women with the time of year can be drawn. It can be seen from Table 5 that the likelihood for each of the groups falls in the following range with 95% confidence:

- Group I - from 17.4% to 43.8%;
- Group II – from 10.2% to 33%;
- Group III – from 21% to 48.4%;
- Group IV – from 5.8% to 25.7%.

The results of the calculations performed for analysis of dependency of injury frequency on the stage of pregnancy show that the likelihood of injury for each of the groups with 95% confidence is in the following range:

- Group I - from 10.2% to 33%;
- Group II - from 47.2% to 75.2%;
- Group III - from 8.7% to 30.6 %.

2. The levels of significance of injury frequencies with regards to the time of year and the stage of pregnancy are demonstrated in Table 6. Assessment of the significance of differences in relative frequency values was performed by Chi -square test criterion.

**Table 6 Levels of significance of difference with regards to the time of year and stages of pregnancy, according to the forensic medical reports based on medical records**

Compared groups	Seasons			Stages of pregnancy	
	II	III	IV	II	III
I	p> 0.05	p> 0.05	p> 0.05	p< 0,01	p> 0.05
II		p> 0.05	p> 0.05		p< 0,01
III			p<0.05		

**DISCUSSION**

According to the forensic medical assessment reports based on surveying, the lowest level of injuries in pregnant women is recorded in winter and amounts to 16.1 %, the highest – in autumn - 34.2 %. In summer, this value equals to 23.9 %, and in spring - 25.8 %. A statistically significant difference in the incidence of injuries in pregnant women occurs during the winter season compared with autumn and spring (p <0.05). In all other cases, the difference is not statistically significant.

Investigation of forensic medical reports based on medical records revealed that the highest level of injuries in pregnant women is observed autumn - 34.7 %, the lowest - in spring, 14.3 %. In summer, the rate amounts to 20.4 %, and in winter it is equal to 30.6 %. A statistically significant difference in the number of injuries in pregnant women is observed when autumn is compared to spring (p <0.05).

In relation to analysis of forensic medical reports based on surveying of pregnant women, 42.6 % of the women reported that they received injuries in the first trimester, 37.4 % - in the second, which is significantly higher than the number of women who reported an injury in the third trimester (20%). This variance is confirmed by the level of significance of the difference shown during comparative analysis of the first trimester with the third (p <0.01) , and the second trimester with the third (p <0.01).

However, examination of forensic medical reports based on the medical records demonstrated that the most traumatic period of pregnancy is second trimester (61.2 %) and the least traumatic is the third (18.4 %). In the second trimester the average injury frequency is 21.6%. The differences in significance between the groups suggest that the difference in the number of injuries in pregnant women is significant between the first and second (p <0.01), as well as the second and third trimesters (p <0.01).

**CONCLUSIONS**

Analysis of forensic medical reports showed that the highest number of injuries in pregnant women occurs in autumn, and the third trimester of pregnancy is the least traumatic.

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**Authors ' contribution**

ES and TZ jointly designed the study, analyzed the data and drafted and finalized the manuscript. TP, VO, MG participated in data collection and data management and critically revised the manuscript.

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