



# Pregnancy Outcomes in Kerman Cities: Using Clustering Methods

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## Abstract

**Background:** Managing pregnancy complications is a major health concern worldwide. This study aimed at investigating the pregnancy outcomes in mothers and infants in Kerman province and ranking important indicators in different cities of Kerman using cluster analysis method.

**Methods:** In this cross-sectional study, demographic information and pregnancy outcomes were extracted from the mother and infant national system of Kerman province in 2014 and imported into Excel file. Data analysis was performed using SPSS software through clustering.

**Results:** More than 98% of deliveries were performed in hospitals. The prevalence of cesarean section was 44%. Three maternal deaths occurred in hospitals and the prevalence of neonatal death was 0.9%. Approximately, 10.1% of infants born in Kerman had low birth weight. Clustering different cities of Kerman province showed 4 different clusters in Kerman province. Kerman was in a single cluster. Cities with no specialists or those very close to Kerman were in one cluster. Three large cities in the south of Kerman province and Rafsanjan were clustered. Two cities located in the southwest of Kerman were clustered in a group.

**Conclusions:** The rate of cesarean section is high and low birth weight is a health issue in this area. Thus, policymakers should pay more attention to mother and neonate deaths that occur in hospitals. Bad pregnancy outcomes are more frequent in referral cities, as high risk pregnancies are more frequent in such cities. Governments should focus on equipping hospitals in referral cities and build and upgrade hospitals in disadvantaged cities.

**Keywords:** Pregnancy Outcomes, Cluster Analysis, Justice

## 1. Background

Annually, about 515 000 women lose their lives due to prenatal complications worldwide, the majority of which occur in developing countries. Improving the quality of prenatal care, promoting the socioeconomic status, and improving family planning are the most important strategies to reduce these complications (1, 2).

One meta-analysis revealed that the prevalence of preeclampsia has increased and the prevalence of eclampsia has decreased in recent years in Iran (3). Another study showed that the risk of neonatal mortality has decreased, especially in rural areas in Iran (4). The prevalence of low birth weight in Iran was reported to be 7% in a systematic review (5).

Statistics in Iran have also revealed that the rate of cesarean section is much higher in Iran compared to inter-

national standards. The Ministry of Health report in 2005 revealed that 40.7% of childbirths in Iran are performed through cesarean deliveries (6).

The World Health Organization (WHO) estimated the maternal mortality rate in Iran (2012) as 20.3 per 100000. The ratio of hospital births has increased in Iran during 1997 and 2009 from 78.7% to 97%. Concurrently, the ratio of hospital deaths has increased from 43% to 82% during this period. Low quality of care and lack of availability of services were the most causes of maternal deaths in hospitals (7, 8).

The Eight Millennium Development Goals focus on maternal and child mortality because these indicators are signs of health inequity (9). Although primary care systems are highly important in the health sector, hospitals have an important role in health outcomes (10). Geograph-

ical accessibility to the hospitals has an important role in equitable distribution of services (11).

Obstetrics and gynecology ward is one of the most important parts of the hospital. There are some performance indicators including maternal mortality rate, the percentage of cesarean section, and percentage of neonatal mortality to the total deliveries that are used to evaluate the performance of the hospital (12, 13).

## 2. Objectives

According to the importance of pregnancy and delivery outcomes and the need for accurate information to evaluate the existing status of hospitals in obstetrics and gynecology wards, this study aimed at investigating the pregnancy outcomes in women in Kerman province and ranking important indicators in different cities of Kerman using cluster analysis method.

## 3. Methods

This cross-sectional study was conducted in Kerman province in 2014. Kerman is located in southeastern Iran. It is the most populated province of this area, with approximately 2 938 988 population. The urbanization ratio is 1.36 in Kerman province (14).

The data on the mother and infant national system in 2014 in Kerman province, which were accessed in coordination with the Ministry of Health and Medical Education, was used. Permission was obtained from the Ethics Committee of Kerman University (ethical code: K/93/596). Data included demographic data associated with pregnancy complications and outcomes including maternal age, number of pregnancies, abortions, familial relationship between the parents, mother's education, having an insurance, the nationality of the mother, the delivery manager (specialist or midwife), delivery complications, maternal death during delivery, and neonatal information, such as the sex of the baby, type of delivery, place of delivery, neonatal death after birth, and low birth weight, which were collected in a form and imported into an Excel file. Data were exported from the Excel file and analyzed using SPSS software Version 20. Descriptive data are presented as mean and standard deviation (SD), and frequency and percentage.

Among different existing data on the mother and infant national system, 4 pregnancy outcome data (delivery complications, mother death, neonate death, and low birth weight) were selected for clustering of different cities of Kerman province.

The prevalence of pregnancy outcomes was calculated for each city. The prevalence of mother death during 2

hours after delivery was calculated by dividing the total number of mother deaths to total deliveries for each city. The prevalence of neonatal death (total number of neonatal deaths in a hospital/total deliveries) and low birth weight (total number of low birth weight/total deliveries) were calculated. Then, 13 cities of Kerman province were clustered according to these 4 pregnancy outcome indicators to determine the homogenous cities. The hierarchical cluster analysis was used to cluster the cities. Using pregnancy outcome indicators, the square euclidean distance matrix was calculated. According to the furthest neighbor method, most similar cities were clustered together. The Kruskal-Wallis H test was used to compare the clusters in pregnancy outcomes.

## 4. Results

In the present study, data of 60 838 deliveries in Kerman province in 2014 was analyzed. Mean  $\pm$  SD of women's age was  $27.72 \pm 5.9$  years and mean  $\pm$  SD of the neonates' weight was  $3047.29 \pm 539.1$  g.

Generally, 95.4% of mothers were Iranian, 28.6% of the couples had a familial relationship with each other, 8.1% of mothers were illiterate, 30.1% did not have high school education, 38% had high school education, and only 23.8% of mothers had a college education. Moreover, 7.8% of the patients had no insurance coverage, 51.7% of the infants born were boys. Of the total number of births registered in 2014 in Kerman province, 34.3% were the first pregnancy, 33% were the second, 18.7% the third, and 14% the fourth or more. Of the total pregnancies, 15.8% resulted in abortion, among which 78.5% was the first abortion, 16.5% the second, and 5% the third or more.

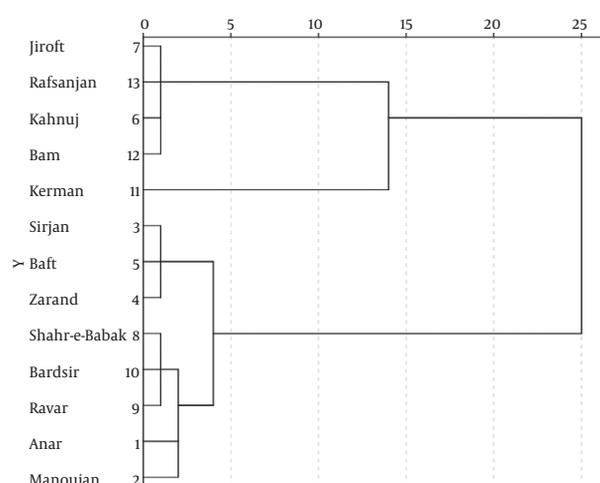
In Table 1, the characteristics of deliveries are presented in general and based on different cities. Of the total deliveries in Kerman, 58% were performed by specialists. More than 98% of deliveries were done at the hospital in all the cities of Kerman province and 44% of mothers underwent cesarean section. Kerman (56.6%) had the highest percentage of cesarean section among cities with obstetricians and Kahnooj had the lowest rate (21.5%).

Overall, 3.2% of mothers have experienced complications during labor, and Kerman with 7.7% had the highest rate. There were 3 maternal deaths in Kerman province hospitals in 2014, and 2 of them occurred in Kerman, while one occurred in Baft. The perinatal infant death rate in Kerman province was 0.9%, among which Kahnooj and Baft with 1.3 and 2.1%, respectively, had the highest infant death rate than the general childbirths, and no neonatal death occurred in Anar. Approximately, 10.1% of infants born in Kerman had low birth weight (LBW), and Bam and Kahnooj had the highest rate of LBW with 11.6 and 11.2%, respectively.

Manoujan with 4.4% had the least cases of low birth weight (Table 2).

To identify the homogenous cities in pregnancy outcomes, hierarchical cluster analysis method by furthest neighbor method was used. The range of solutions was selected as 2 - 4 (15). The dendrogram diagram is shown in Figure 1. The results of dendrogram are described in Table 3. Kerman cities were clustered in 4 groups.

Comparing different pregnancy outcomes among the 4 clusters revealed significant differences between clusters in newborn death (P-value: 0.034), and low birth weight (P-value: 0.014). There were no significant differences in maternal death (P-value: 0.087) and delivery complications (P-value: 0.303).



**Figure 1.** Dendrogram Diagram for Clustering Different Cities of Kerman According to Pregnancy Outcomes

## 5. Discussion

One of the mainstays of the health system in each country is the hospitals and to improve the services provided by the health system, improving the performance of these centers seem to be necessary (13). To evaluate the effectiveness and efficiency of hospitals, various indices have been designed, the most common of which is the classification of criteria in indices of input, process, output, and outcome. The percentage of infant mortality to total births, maternal mortality to total births, and caesarean section to total births include output indices of the obstetric ward (16).

The total rate of caesarean section in Kerman province was 44% in 2014. The results of a meta-analysis study conducted in Iran represent a rate of 48% for caesarean section in Iran (17). Caesarean sections in the entire Kerman

province are lower than Iran's average, but higher in 3 cities, including Kerman, Rafsanjan, and Shahr-e-Babak. The World Health Organization states that the incidence of caesarean section should not exceed 15% of their total child-births (18). Educating obstetricians, gynecologists, and patients to prevent unnecessary demand of caesarean section and following-up on the relevant legal issues and laws and regulations in this regard can be highly important.

Three maternal deaths occurred in Kerman hospitals in 2014. Approximately, 0.9% of newborns died after delivery. According to current standards, maternal death rate should be zero and by no means should it exceed 0.2%. Also, the expected rate of neonatal death in Iran is 2% (16). Indices for infants' death were all less than expected in different cities despite some differences. The percentage of low birth weight to total births in Bam, Kerman, and Kahnuj was worse compared to other cities. From the perspective of public health, mean birth weight in a society reflects the quality of health services, prenatal care, and quality of intrauterine growth (19-21). Many maternal deaths were attributed to poorly-managed childbirth, especially in women with complicated pregnancies or childbirth. On-time treatment of adverse pregnancy outcomes and emergency care measures during childbirth can be effective in prevention of maternal mortality (22).

Clustering different cities of Kerman province showed 4 different clusters in Kerman province. Kerman, the center of Kerman province, was in a single cluster because it has large subspecialty referral hospitals that manage high-risk pregnancies. Cities that have no specialists or are very close to Kerman were in a single cluster because many high-risk pregnancies in these cities were referred to the central hospitals in their nearest cities. Three large cities in the south of Kerman province and Rafsanjan were clustered together because they had independent academic centers. Two cities located in the southwest of Kerman was clustered in a group.

The present study is important given the large sample size and use of all hospital data in the health system and the use of advanced statistical methods. However, this study had some limitations due to the use of secondary data. Thus, it is recommended that a national survey using factor analysis and clustering be conducted on the entire country's data to assess the situation of these indices in different cities.

### 5.1. Conclusions

Most pregnant women refer to hospitals for delivery in Kerman province. The rate of caesarean section is high and low birth weight is a health issue in this area. Thus, policy-makers should pay more attention to maternal and neonatal deaths that occur in hospitals. Pregnancy outcomes are

**Table 1.** Characteristics of Deliveries in General and Based on Different Cities

| City                     | Specialist as Delivery Manager | Hospital as Place of Birth<br>N (%) | Cesarean Section Surgery |
|--------------------------|--------------------------------|-------------------------------------|--------------------------|
| Anar (n = 80)            | 0 (0)                          | 80 (100)                            | 0 (0)                    |
| Kahnuj (n = 6405)        | 1542 (24.1)                    | 6376 (99.6)                         | 1378 (21.5)              |
| Baft (n = 1328)          | 546 (41.1)                     | 6456 (100)                          | 443 (33.4)               |
| Sirjan (n = 5299)        | 2173 (41)                      | 5294 (99.9)                         | 2128 (40.2)              |
| Jiroft (n = 8750)        | 3674 (41.4)                    | 8734 (99.8)                         | 3111 (35.6)              |
| Zarand (n = 3535)        | 1912 (54.1)                    | 3530 (99.9)                         | 1672 (47.3)              |
| Bam (n = 5847)           | 3306 (56.8)                    | 5822 (99.6)                         | 1963 (33.6)              |
| Bardsir (n = 683)        | 260 (38.1)                     | 682 (99.9)                          | 258 (37.8)               |
| Ravar (n = 480)          | 450 (93.8)                     | 480 (100)                           | 184 (38.3)               |
| Shahr-e-Babak (n = 1096) | 537 (49)                       | 1096 (100)                          | 534 (48.7)               |
| Kerman (n = 20604)       | 16851 (82.3)                   | 20584 (99.9)                        | 11670 (56.6)             |
| Manoujan (n = 274)       | 0 (0)                          | 269 (98.2)                          | 0 (0)                    |
| Rafsanjan (n = 6457)     | 3947 (61.1)                    | 6456 (100)                          | 3407 (52.8)              |
| <b>Total (n = 60838)</b> | <b>35199 (58)</b>              | <b>60728 (99.8)</b>                 | <b>26748 (44)</b>        |

**Table 2.** The Frequency of Pregnancy Outcomes in General and Based on Different Cities

| City                     | Delivery Complications | Maternal Death   | Newborn Death    | Low Birth Weight   |
|--------------------------|------------------------|------------------|------------------|--------------------|
| N (%)                    |                        |                  |                  |                    |
| Anar (n = 80)            | 0 (0)                  | 0 (0)            | 0 (0)            | 5 (6.2)            |
| Kahnuj (n = 6405)        | 88 (1.4)               | 0 (0)            | 76 (1.2)         | 744 (11.6)         |
| Baft (n = 1328)          | 8 (0.6)                | 1 (0.07)         | 17 (1.3)         | 90 (6.8)           |
| Sirjan (n = 5299)        | 42 (0.8)               | 0 (0)            | 53 (1)           | 371 (7)            |
| Jiroft (n = 8750)        | 100 (1.1)              | 0 (0)            | 75 (0.9)         | 875 (10)           |
| Zarand (n = 3535)        | 18 (0.5)               | 0 (0)            | 26 (0.7)         | 286 (8.1)          |
| Bam (n = 5847)           | 24 (0.4)               | 0 (0)            | 59 (1)           | 656 (11.2)         |
| Bardsir (n = 683)        | 9 (1.3)                | 0 (0)            | 4 (0.6)          | 45 (6.6)           |
| Ravar (n = 480)          | 10 (2.1)               | 0 (0)            | 3 (0.6)          | 30 (6.2)           |
| Shahr-e-Babak (n = 1096) | 11 (1)                 | 0 (0)            | 5 (0.5)          | 64 (5.8)           |
| Kerman (n = 20604)       | 1581 (7.7)             | 2 (0.01)         | 192 (0.9)        | 2295 (11.1)        |
| Manoujan (n = 274)       | 2 (0.7)                | 0 (0)            | 1 (0.4)          | 12 (4.4)           |
| Rafsanjan (n = 6457)     | 51 (0.8)               | 0 (0)            | 54 (0.8)         | 642 (9.9)          |
| <b>Total (n = 60838)</b> | <b>1944 (3.2)</b>      | <b>3 (0.005)</b> | <b>565 (0.9)</b> | <b>6115 (10.1)</b> |

more frequent in referral cities because high-risk pregnancies are more frequent. Therefore, governments should focus on equipping hospitals in referral cities and build and upgrade hospitals in disadvantaged cities.

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### Footnote

**Conflict of Interest:** There was no conflict of interest.

**Table 3.** Homogenous Cities According to Pregnancy Outcomes

| Cluster 1     | Cluster 2 | Cluster 3     | Cluster 4 |
|---------------|-----------|---------------|-----------|
| <b>Kerman</b> | Sirjan    | Shahr-e-Babak | Kahnuj    |
|               | Baft      | Bardsir       | Jiroft    |
|               | Zarand    | Ravar         | Bam       |
|               |           | Anar          | Rafsanjan |
|               |           | Manoujan      |           |

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