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Review

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Cesarean or Cesarean Epidemic?

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Abstract

Due to advances in surgical procedure, anesthesia techniques, blood transfusion and antibiotic therapy, the technique of cesarean section has been progressing over the time. However, cesarean section is still a risk-specific operation, with long-term and short-term consequences for the mother and neonate. The rate of cesarean surgery is constantly growing due to both justifiable and non-justifiable medical and non-medical reasons. There is evidence indicating that efforts are made in many countries to reduce the rate of cesarean delivery. In this review article, we try to assess the frequency of cesarean section in different countries, especially Iran. We searched several keywords, including cesarean section prevalence, cesarean section rate, world, delivery, Iran and health policies within the newest articles published in Google Scholar, PubMed, and ISI/Web of Sciences, as well as Iranian databases (Magiran, SID), from January 2017 to April 2019. The results show that there is still a high prevalence of C-section. In Iran, the highest rate of cesarean was in Tehran province (62.1%-72.1%) and the lowest was in Sistan and Baluchestan province (12%). It appears necessary to plan for effective interventions in terms of painless vaginal delivery, improving the quality of vaginal delivery services, proper culture and education.

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Introduction

The cesarean section is well described as the oldest abdominal surgery as well as one of the most common types of surgeries that are performed in pregnant women. This surgery is conducted for withdrawal of the neonate and placenta through cutting the abdominal wall (laparotomy) and the uterus incision (hysterotomy), and then suturing the uterus and the layers of the abdominal wall.[1] Cesarean is a surgical procedure to save the mother and/or neonate's life through terminating a complicated pregnancy in which vaginal delivery jeopardizes their health. It has also been reported that cesarean section prevents approximately 187 000 maternal and 2.9 million neonatal deaths annually.[2] However, unreasonable cesarean section raises the delivery-related risks for mothers and neonates.[3] Thus, although cesarean was initially introduced as a method for saving mother and neonate's life, we are facing today what is described as an "epidemic of cesarean section".

The cesarean was a fatal operation for mothers, which was performed only for saving either the neonate's life or mothers who were dying during delivery up to 18th century. For a long time, it was believed that "cesarean" was related to the birth of the Roman Emperor Julius Caesar (44-100 BCE). Currently, this theory is unacceptable, because the Caesar's mother lived for many years after the delivery. Given the deadlines of this surgical operation at that time, it does not appear possible. On the other hand, based on the mythical story Rostam's birth to his mother "Roudabeh", which is well described in Ferdowsi's *Shahnameh* (the famous Iranian epic), it appears that the operation defined as "*Rostamineh*/*Rostamin*" (equal to the method we know as cesarean) has a very long history of several thousand years in Iran (before the birth of Julius Caesar).

During the first half of the 19th century, maternal mortality rate due to cesarean section was 60%-100%. However, at the beginning of the 20th century, cesarean section was responsible for 25% and 24% of maternal and neonatal mortality, respectively. Mortality was often due to sepsis and severe bleeding.[4] Although during the first half

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of the 20th century, maternal mortality was significantly reduced, the rate of mortality in cesarean delivery was 10 times higher than that of vaginal delivery.[5]

Considering the professional achievements over the time and given the advances that have been accomplished in disinfection, abdominal surgery, anesthesia, and blood transfusion, the C-section technique has developed over a period of 1000 years. It is noteworthy that cesarean is still a serious operation, and is associated with special risks and complications, potentially resulting in both short- and long-term consequences for the mother and neonate. The incidence of cesarean's side effects is estimated to be 12%-15%. These complications resulting from elective cesarean (2.6%-6.8%) are less frequent than those caused by emergency cesarean (5.2%-14.8%).[4]

Possible Complications of Cesarean section

The possible complications during C-section include: entrapment of the fetus's head within the pelvis (withdrawing the fetus's head is impossible), rupture of the cervix accompanied by bleeding, damage to the uterus vessels in the low uterus segment incision, bleeding from the placental bed, uterine atony, damage to the bladder, damage to the ureter and bowel, and thromboembolism.[6] Tachypnea, infantile respiratory distress syndrome, hospitalization of the neonate in the intensive care unit (ICU),[7] complications associated with anesthesia,[4] longer hospitalization compared to vaginal delivery, delay in restarting routine activities, later onset of breastfeeding, increased need for re-hospitalization, and increased costs have also been mentioned as other complications of C-section.[8] Worldwide, the approximate cost caused by unnecessary cesareans is estimated to be 2.32 billion dollars.[9]

Additionally, a cesarean may affect subsequent pregnancies and lead to complications such as placenta previa, placental abruption, placenta accreta, and uterine rupture.[10] It is clear that cesarean interacts with short-term immune responses (reduced expression of inflammatory markers in the neonate), and is associated with increased risk of developing asthma, allergy, diabetes type 1, celiac disease, and cancer.[11]

Reasons for Increased Rate of Cesarean Section

The underlying reasons for the rise in the rate of cesarean section have yet to be fully understood. However, some causative reasons for cesarean are mentioned in reference books and articles, as listed below:

1. The average age of mothers has increased; as women get older, especially in case of those without any children, they are at higher risk of cesarean.[12]
2. Women with fewer children (including a large percentage of women without children) are more at risk of increased C-section requirement.
3. The use of electronic monitoring of the fetus is expanding. This technique, compared with the fetal heart rate periodic controlling technique, is associated with an increased cesarean rate. In the first place, cesarean is performed due to "fetal distress", accounting for minimal cases of all cesareans conducted. In many cases, concern over abnormal heart rate or irrecoverable heartbeats of the fetus results in increased cesarean cases.
4. Currently, most fetuses in the breech position are delivered through C-section. Concerning over a neonate in the breech position almost causes the delivery to be performed mostly by C-section. At delivery, in 90% of cases, the fetal position is cephalic where the fetal head lies in the mother's pelvis. However, in the breech position, the fetal hip lies inside the mother's pelvis, while the infant's head is upwards.
5. The number of deliveries through forceps and vacuum has decreased.
6. The number of labor induction cases has grown, in which the rate of C-section increases, especially among women without children.
7. The prevalence of obesity has increased considerably, and with obesity, the risk of C-section increases.
8. The rate of C-section in women with preeclampsia is increasing, while induction of vaginal delivery among these women is decreasing.
9. The number of vaginal births after cesarean is decreasing.
10. Elective C-section is increasingly performed for different indications such as concern over damage to the pelvic floor due to a vaginal delivery, reduction of the risk of damage to the fetus, and the mothers' desire.
11. The criminal procedure related to fetal damage during vaginal delivery is considerably involved in increasing the rate of C-section.[1,13]
12. The physician incentive to receive more profit.
13. Some mothers choose C-section since they want the birth of their child to happen on a special day that can bring them fortune.[14]
14. Many people believe that this method is a low risk for mothers.[14]
15. It is believed that in the 40th week of pregnancy, C-section decreases fetal mortality. On the other hand, vaginal delivery may occur up to the 42nd week of pregnancy.[14]

Worldwide Epidemiology of Cesarean Section

The frequency of cesarean is growing due to both justifiable and non-justifiable medical and non-medical reasons, and this trend should be preferably terminated. The growing interest in cesarean is observed in both primary and repeated C-sections.[15] The recommended rate of cesarean is approximately around 15% in major

centers, well-equipped midwifery clinical centers, and maternity hospitals to which a large percentage of high-risk pregnancies are referred, while the recommended rate is even lower for smaller delivery centers.[4]

The international committee for health care has considered the ideal rate for C-section around 10%-15% from the 1980s (year 1985).[16] However, this surgical operation is progressively increasing in both developed and developing countries and even in low-income countries, due to different (mostly nonessential) reasons.[17-19] Moreover, governments and physicians have particular concerns regarding the increasing number of C-section and its potentially negative consequences for both mother and neonate's health.[20-22] According to the World Health Organization (WHO) report in 2010, the frequency of C-section was estimated at more than 15% in 69 out of 137 countries.[23] In Latin America and the Caribbean, the rate of C-section increased 19.4% (from 22.8% to 42.2%) between 1990 and 2014.[24]

Mittal and colleagues reported that over the past decade in western India, the cesarean has increased from 17.15% in 2001 to 23.47% in 2006 and 28.93% in 2011.[25] Barber and colleagues reported that the frequency of C-section has risen from 26% in 2003 to 36.5% in 2009 at Yale-New Haven Hospital in the United States.[15] Another investigation showed that the frequency of C-section has increased from 10.6% in 1996 to 19.1% in 2006 in Saudi Arabia.[26] Stavrou et al in New South Wales in Australia indicated a general increase in C-section from 19.1 to 29.5 per every 100 births during 1998 to 2008.[27] In a study in Singapore by Chong et al the frequency of C-section was shown to have increased from 19.9 to 29.6 per every 100 births from 2001 to 2010.[28] The rising frequency of C-section in Tanzania was also evidenced by Litrop et al as they reported that C-section has increased from 19% in 2000 to 49% in 2011.[29] In Brazil, the rates of C-section have been reported to be 55.6%, 80% and 99% in first, second and third deliveries, respectively.[11]

According to the latest information presented by the Organization of Economic Cooperation and Development (OECD), Italy, Poland, and Hungary have the highest frequency of C-section (around 35.7%) among the European countries, while Scandinavian countries show the lowest rates of C-section (15.8% in Finland, 16.6% in Norway, and 17.0% in Sweden).[30]

Among Italian regions, the maximum rate of cesarean was reported in Campania (58.4%). In this region, in a private hospital with fewer than 500 deliveries per year, this rate was even higher (84.4%).[31]

In Japan, Ono et al reported that the total rate of C-section was as high as 37.3% in 125 institutes in 2013.[32] Einarsdottir and colleagues have also shown a growing rate of C-sections in Australia from 19.22% in 1995 to 33.6% in 2010. It was also reported that C-section was performed more frequently in private hospitals compared to state hospitals.[33]

The frequency of C-section in Egypt was 27.6% in 2010.[9] However, in a study by Dawood et al it was reported that in hospitals of Tanta University in Egypt, the frequency of C-section was 41%, 45%, and 46% in 2013, 2014, and 2015, respectively,[34] showing a considerable increase in C-section in this country. The ministry of health and population of Egypt has estimated the total rate of C-section in 2014 to be more than 50.8% of all deliveries, which may reach 60% in some urban regions. In this report, the possible leading causes of increased C-section were defined as fear of labor pain, misconceptions about damage to the genital system after the vaginal delivery, and misconceptions about greater safety of the child with the C-section method.[35] Frequencies reported in other studies are also considerable. In Peru, the rate of C-section in years after health reforms in private hospitals has reached 52.9%, indicating a growing percentage (86.3%).[36] This rate among Brazilian women referring to private hospitals was almost similar to Peru (86.2%).[37]

The Epidemiology of Cesarean Section in the Middle East Regional Countries

The C-section is performed with a frequency of 22.2-24.4% in Iraq,[38,39] which is higher than the recommended limit.[40] Shabila and colleagues reported that the rate of C-section has considerably increased in recent years in Iraq, particularly in the Kurdistan region of Iraq.[39]

These authors have proposed the effect of private healthcare on increasing the rate of C-section, which is usually attributed to the demand of the service provider.[41] Such an effect from the private sector is evident, especially in Iraq, particularly due to the fact that in provinces with more private hospitals, a higher rate of C-section has been reported.[39] The remarkably high rate of C-section in the Kurdistan region of Iraq might then be due to the rapid development of the private sector.[42] The results of another study, which was conducted by Hassain in five hospitals of the Babel province of Iraq, also show a C-section frequency of 34.5% in this province.[14]

In 2000, Haider et al reported that only 33% of deliveries were conducted through C-section which has increased to 63% in 2014.[43]

Zakai Ghadeer et al reported the rate of C-section at 13.7% in Jeddah, Saudi Arabia, which is lower than the rate of C-section in many countries. Various factors are involved in the increasing rate of C-section. One of these factors is constant monitoring of the fetus. Zakai Ghadeer et al have proposed that lack of this monitoring in Jeddah might be considered as one of the possible causes of the low frequency of C-section in comparison with other countries.[44]

The rate of C-section in Turkey has also grown from 21% in 2002 to 51% in 2014, showing almost a 2.5-fold increase.[45] This elevated frequency has been found (69.5%)

in private hospitals and in state hospitals (35.5%) of Turkey.[46] Okumus and Sahin stated that 87% of women in Istanbul who had undergone C-section preferred to choose a C-section again for their next delivery.[46] It is confirmed that women request repeated C-section for their next delivery because of their physicians' recommendation.[47]

In a study conducted on 29 270 Lebanese women, 49% of deliveries were performed through C-section, while 51% were done through vaginal delivery. The frequency of C-section was reported to be 23%, while the frequency of vaginal delivery after cesarean was only 0.2%. In this study, the factors with associated increased rate of C-section were analyzed and proposed as follows: older age of mothers, elective cesarean, improper position of the fetus in the uterus, multiple births, long-term pregnancy, prolonged labor, and fetal distress.[48]

Amjad et al studied the factors associated with cesarean deliveries among childbearing women in Pakistan. They reported that among women who had given birth to at least one child in the past five years, the rate of C-section was 13.6%. The probability of labor through C-section was higher in mothers older than 25 years, women residing in Panjab province, women belonging to the wealthy class of the society with higher income and well-educated women, those employed at professional/management levels, and finally, urban dwelling women. In addition, the rate of C-section was higher in women with pregnancy complications, users of pre-labor care, and women who had referred to private hospitals.[49] Although the rate of C-section has been lower in Pakistan compared to many other countries, it shows an increase compared to the rate of C-section in 2008, which was reported at 7.3%.[50] Amjad and colleagues also stated that in developing countries such as Pakistan, C-section is not performed at the mother's request and it is the physician who generally determines the method of labor, which has been mentioned as one of the possible causes of the increased rate of C-section.[49]

Epidemiology of Cesarean Section in Iran

An increased frequency of C-section has been well evidenced in most parts of the world, and Iran is no exception to this ascending trend. Based on reports, the rate of C-section is 47.9% in Iran.[24] According to the WHO report, Iran held the second global rank of C-section in 2008. However, now, Iran is the first country of the world in terms of cesarean section rate.[51] The findings of a meta-analysis indicated that the total prevalence of C-section in Iran is 48%, and some private institutes have reported this rate as high as 87%.[52] The studies that have been undertaken on investigating the rate of C-section across different cities of Iran suggest that the frequency of C-section is almost higher than the rate considered by the international healthcare committee (except in the Sistan and Baluchestan province) (Figure 1).

In a study by Khooshideh and colleagues on low-risk mothers hospitalized in the Arash hospital in Tehran, the rate of C-section was reported at 62.1%, and the reason for C-section in 6% to 8% of cases was reported to be repeated C-section.[7] Maroufizadeh et al investigated nulliparous women referring to 46 province hospitals and 30 private hospitals in the Tehran province. The rate of C-section in this study was 72.1%. In their study, 713 (81.85%) of 871 pregnant women with an academic level of education, and 816 (65.33%) of 1249 pregnant women with non-academic levels underwent C-section. They mentioned that older age of the mother and high BMI were among the factors affecting the increased rate of C-section.[53]

Zandian et al investigated the effect of the health care system transformation plan on the prevalence of vaginal and C-section delivery and studied all women referring to Buali healthcare educational center in Ardabil.[54] The Ministry of Health developed the health care system transformation plan in the early 2014, having as one of its principal axes the promotion of natural labor in order to improve the health status of mothers and neonates in Iran.[55] In the study by Zandian et al the frequency of C-section was reported at 60.5% before implementing the healthcare transformation plan, while afterwards, it was reported to be 43%.[54] Despite the considerably decreased rate of C-section, this percentage is still far from the rate recommended by the international healthcare committee. In this regard, Rezaie et al also reported that before and after implementing the healthcare transformation plan, the C-section rate decreased from 47.57% to 38.70% in Jahrom.[56] Although the establishment of this program has resulted in 8.87% reduction in the rate of C-section, it still seems highly deserving to adopt plans for appropriate establishment of the health care transformation and develop supplementary programs to attain the ultimate goal of this program. Rezaie et al stated that the most frequent reason for undergoing elective C-section was repeated C-section with a frequency of 82% prior to establishing the healthcare transformation plan and 85.7% after it.[56] Fouladi et al also investigated the rate of C-section in two

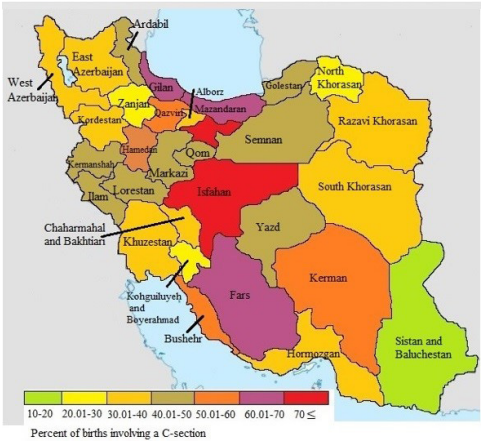

Figure 1. Percent of Births Involving a Cesarean Section in Iran.

hospitals affiliated with the Qom University of Medical Sciences and reported that the rate of C-section decreased from 48.1% in 2012-2013 to 42.18% in 2014-2015.[57] This reduction is still far from the ideal rate of C-section.

Dadipour et al stated that the rate of C-section in nulliparous women referring to healthcare centers of Bandar Abbas was 36.2% in 2016.[58] It was also indicated that the healthcare transformation plan has been considerably effective in Kohguiluyeh and Boyerahmad in reducing the rate of C-section, with the rate of C-section falling from 37.44% this plan to 28.75% after its implementation.[59] The results of some studies on the rate of cesarean delivery in different cities of Iran are summarized in Table 1.

Health Policies of Countries Regarding Cesarean Section and their Success Rate

According to the results obtained from several studies, the absence of health care insurance to supervise service providers and limit abusing the services have been reported as reasons for increased rate of C-section especially in private centers. In such cases, paying the costs of services or pocket payment is performed for private services, which increases the demand of service providers. Creating the conditions to allow public use of health care insurance services can be effective in reducing the rate of C-section.

In a study undertaken among Turkish pregnant women, the frequency of C-section was compared between Istanbul and Siirt, and a higher rate of C-section was observed in Istanbul (57%) compared to Siirt (22%). This may be attributed to the socioeconomic situation; while Istanbul samples were chosen from private hospitals, the study subjects in Siirt were selected from a state hospital.[46] Okumus et al believed that midwifery support and consultation might have a positive effect on reducing the rate of C-section. The authors suggested further complementary studies to explore factors such as fear from normal labor and selection of C-section, as well as the presentation of a governmental midwifery care model in healthcare systems to reduce negative perceptions about labor and support all Turkish women experiencing labor.[46]

In a study conducted in Bangladesh, ages younger than 19 and older than 35 years, living in urban regions, relatively higher socioeconomic status, higher educational levels, low number of children (fewer than or equal to two), pre-labor healthcare, and overweight or obesity were all reported as key factors correlated with an increased frequency of C-section.[43]

Although studies suggest that some steps have been taken for reducing the rate of C-section in Iran, there still exists a long way to reach the desirable conditions. Several factors, including continuation of the adopted plans and greater supervision of the appropriate implementation of these plans might increase the vaginal delivery rate and are able to promote and improve the health status of mothers and neonates. Applying the upcoming strategies in these cases might then result in an attenuated rate of C-section: 1) raising the level of training courses before labor, improving the pregnant women's awareness regarding the risks and disadvantages of C-section compared to vaginal labor, thereby encouraging them for vaginal delivery instead; 2) The knowledge and professional skills of midwives, physicians, and gynecologists need to be improved regarding normal labor in women who have a history of C-section; 3) Providing the facilities for different methods of pain-free labor as well as educating and notifying pregnant women and their spouses to enhance the level of knowledge and develop a spirit of sympathy; 4) Determining C-section indications and announcing them to hospitals, especially private hospitals, and consideration of sufficient salary and perquisites for the staff in order to be financially fulfilled and refrain from promoting or recommending C-section delivery; 5) In cases where fear

Table 1. Summary of the Results of Some Studies on the Cesarean Rate in Different Cities of Iran

Authors	Published Date	Special Point	Cesarean Rate	Location of Study
Khooshideh et al[9]	2017	The main reason for cesarean section: Previous cesarean	62.1%	Arash hospital Tehran
Maroufizadeh et al[53]	2014	The main reason for cesarean section: high maternal age, economic status, body mass index	72.1%	76 hospitals, Tehran
Zandian et al[54]	2017	Before Health Sector Evolution After Health Sector Evolution	60.5% 43%	Buali hospital, Ardabil
Rezaie et al[56]	2018	The main reason for cesarean section: Previous cesarean	37%	Jahrom
Fouladi et al[57]	2015	The rate of C-section has decreased from 2012-2013 to 2014-2015	42.18%	Qom
Dadipour et al[58]	2016	The mean score of maternal awareness regarding the advantages and disadvantages of delivery methods was relatively low	36.2%	Bandar Abbas
Shokoohi Asl et al[59]	2016	The percentage of cesarean section decreased after the implementation of the health system reform plan	28.75%	Kohgiluyeh and Boyer Ahmad
Safari-Faramani et al[60]	2016	The main reason for cesarean section: previous cesarean	51.2%	Kerman
Seyedi-Andi et al[61]	2017	After education, the women were significantly more inclined to have vaginal delivery	50.42%	Minoodasht
Shams-Ghahfarokhi et al[62]	2016	37.2% of women with primary and secondary education, 69.9% with diploma and 87.6% with a university education reported cesarean section.	75%	Isfahan
Omani-Samani et al[63]	2017	Economic status was associated with an increased rate of CS	72%	76 hospitals, Tehran

of labor-associated pain, misconceptions about damage to the genital system after vaginal labor and misconceptions about greater safety of the babies are the reasons for requesting C-section, holding educational classes before labor, and designing brochures and educational pamphlets for mothers are recommended.

In addition to what has been mentioned above, one of the reasons for the increased rate of C-section (especially in women with a history of C-section) is the powerful influence of physicians and suggestion of C-section by them to the patient. Therefore, the healthcare systems should adopt plans for financing physicians, presenting the necessary training to physicians and midwives, and implementing the necessary regulations to prevent non-essential C-sections.

In conclusion, the present study has collected important information, which might be useful for other researchers and planners in order to make the best and the right decisions to reduce the frequency of C-section and understand the factors affecting this process. The results of previous studies suggest that some steps have been taken to reduce the rate of C-section; however, there is still a high prevalence of C-section. It seems necessary to plan for effective interventions in terms of painless vaginal delivery, improving the quality of vaginal delivery services, and proper culture and education.

Authors' Contribution

AJ, GHH and MH introduced the project and wrote the main body of the article. MR, RV, FA and AS helped in data collection. MH managed the project.

Conflict of Interest Disclosures

The authors have declared that they have no conflict of interest.

Ethical Statement

Not applicable.

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