Abstract

**Background:** In recent decades, the rate of caesarian section (C-section) has increased in the Islamic Republic of Iran. A reform in the Iranian health system – the Health Transformation Plan (HTP) – was launched in 2014 in which one of the objectives of HTP is decreasing the rate of C-section.

**Aims:** This study aimed to assess the effects of the Health Transformation Plan (HTP) on the C-section rate in the Islamic Republic of Iran.

**Methods:** This study was an interrupted time series analysis that used segmented regression analysis to assess the immediate and long-term effects of the HTP on C-section rate in two groups of hospitals affiliated and not affiliated to the Ministry of Health and Medical Education (MoHME) in Kurdistan province. Study samples were selected using the data on monthly C-section rate collected over a period of four years.
Results: We observed significant decreases in C-section rate immediately after the HTP in both groups of hospitals by 0.0629 and 0.0013, respectively (P

Conclusions: The implementation of HTP decreased the C-section rate. However, the reduction does not meet expectations.

Keywords: Health system reform, caesarean section, financial incentive, Iran

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Introduction

In recent years, the Islamic Republic of Iran, like many countries of the world, has observed an increase in the rate of caesarian section (C-section) (1–3). Between 2000 and 2013 the C-section rate increased from 35% to 56.1% (1,4,5), while the acceptable rate of C-section recommended by the World Health Organization (WHO) is between 10% and 15% (4,6). The rapid increase in the rate of C-section can be attributed to both clinical and non-clinical factors. Among the non-clinical factors that can affect a physician’s decision for C-section are training and fear of malpractice claims (6–9), as well as opportunity for higher income (10). On the other hand, the mother’s level of education, ethnicity, income, and insurance status are also contributing factors (11,12).
The growing number of unnecessary C-sections can result in many problems; for example, it not only increases healthcare costs but also augments the risk of mortality and morbidity in mothers and neonates, which in turn affects public health (13). In recent years, in order to reduce the rate of C-sections in the Islamic Republic of Iran, the Ministry of Health and Medical Education (MoHME) has suggested a number of reforms. For instance, it is recommended to change the educational curriculum of midwives and the content of obstetric residency programmes as well as revise their postgraduate training courses. It is also suggested to develop guidelines for outpatient and inpatient obstetrical emergencies and even make changes to medical legislation. However, the C-section rate has still not declined (5).

Previous studies have shown that cost variation is another factor that affects the decision regarding the mode of delivery. As C-section is financially more rewarding and requires less time per birth than a vaginal delivery, physicians are motivated to over-utilize C-section (14–17). Thus, changes in the reimbursement system with respect to the cost of delivery may change the decision of physicians and mothers regarding the mode of delivery. In recent years in the Islamic Republic of Iran, the mean cost of C-section delivery has been almost twice as much as that of vaginal delivery. According to health experts, it is one of the reasons that motivates obstetricians and gynaecologists to perform C-section without any indication (18).

**An overview of the Iranian healthcare system**

In the Islamic Republic of Iran, public, private, quasi-public and charity sectors provide healthcare services. Primary healthcare services are provided by the government through an extensive healthcare network and are offered free of charge. Over 93% of second and third level healthcare services are provided by clinics, centres and hospitals affiliated to MoHME, with other centres affiliated to the Social Security Organization (SSO) and the private sector. Centres affiliated to MoHME and SSO, respectively, are classified as public sector and quasi-public sector. SSO not only provides health services, but is also one of the largest insurance agencies in the country. Social security insurance holders who attended the centres affiliated to SSO receive the majority of services free of charge, but other insurance holders have to pay a portion of the costs (19,20).

The Islamic Republic of Iran has three main insurance organizations including the Iranian Health Insurance Organization (IHIO), SSO, and Armed Forces Insurance Organization (AFIO). IHIO and SSO have multiple insurance schemes, which cover both compulsory and optional insurances, while the AFIO schemes are compulsory. The universities of medical sciences in every province are responsible for monitoring all healthcare centres (public or not) in the province; in addition, the hospitals affiliated to MoHME in each province are under the direct supervision of the university (19). In the Islamic Republic of Iran, about 95% of deliveries occur in hospitals (20), with 557 hospitals affiliated to MoHME, 337 hospitals to the private sector, and 70 hospitals to SSO (19).
Iranian Health Transformation Plan

In the Islamic Republic of Iran a series of health reforms (under the title of Health Transformation Plan) were implemented over three phases that started in 2014. The first phase consisted of eight packages and came into force 5 May 2014 in all hospitals affiliated to MoHME (university hospitals) (21). The Natural Delivery Promotion Package encourages mothers to have a vaginal birth and natural childbirth in hospitals affiliated to MoHME is free of charge. In addition, during this phase to motivate obstetricians, gynaecologists and midwives to encourage vaginal delivery, the promotional tariff of 30K (K is the fee of a surgical operation which in 2013 was set at 88000 Rials for the public sector and social security (quasi-public) and 380000 Rials for the private sector) for natural childbirth (added to the tariff of natural delivery), was considered for all deliveries performed in hospitals affiliated to MoHME within a time interval from 5 May 2014 to 23 September 2014. In case of vaginal delivery under the supervision of a full-time gynaecologist and obstetrician, the inventive was shared as follows: 70% for physicians, 10% for midwives 10% for staff, and 10% for the delivery unit.

However, during this period the C-section tariff did not change in hospitals and remained at 17K. In addition, with the implementation of the Natural Delivery Promotion Package in hospitals affiliated to MoHME, the private sector hospitals and social security hospitals were also required to reduce their C-section rate; accordingly, the reduction in the rate of C-section was considered as an important factor in their annual accreditation.

The second phase of the HTP was focused on screening chronic diseases and promoting health indicators in rural and marginalized areas and in the suburbs of large cities, and started in June 2014. The second phase is not related to the current study.

In the third phase of HTP, the new book of health services’ valuation was issued and implemented in the health system from October 2014 to set tariffs for medical services and promote equality in various medical specialties. To implement the third phase, there was an increase in medical services tariffs in all sectors (public, private, and quasi-public). During this phase, the relative tariffs for vaginal delivery service and C-section service, respectively, were set at 50K and 40K (18,21).

Given the elimination of costs for natural childbirth in hospitals affiliated to MoHME, requiring hospitals to reduce the number of C-sections, and increasing the tariffs for normal delivery, it is expected to observe changes in the behaviour of mothers and health service providers in choosing natural delivery. In the current study, the immediate and long-term effects of HTP are
investigated on the rate of C-section in hospitals affiliated to MoHME (university hospitals) and those not affiliated to MoHME Social Security and private sector hospitals) in Kurdistan province. The results of this study can provide feedback to healthcare policy-makers to assess the success of HTP and revise health reforms in order to enhance them.

Methods

The HTP (intervention) was implemented in May 2014. We conducted an interrupted time series (ITS) study and analysed monthly C-section rate to assess immediate and long-term effects of HTP on C-section rate in all hospitals affiliated to MoHME and hospitals not affiliated to MoHME in Kurdistan province (Table 1). The study was approved by the Ethics Committee of Tehran University of Medical Sciences.

We detected abrupt drops or increases in the C-section rate and investigated gradual changes in trends during the interruption time. An interrupted time series study does not require a concurrent "control group" to establish a causal link between an intervention and an outcome (22,23). ITS analysis is perhaps the strongest quasi-experimental research design and is particularly useful when a randomized trial is not feasible or unethical (23,24). Using hospitals’ health information systems we obtained the data on deliveries. We modeled data using segmented regressions to assess causal links between the intervention were and the outcome of interest. Our sample included 50 observations (i.e., one per month) starting 25 months before (March 2012 to April 2014) and 24 months after the HTP (June 2014 to May 2016).

Several diagnostic tests were conducted. The results of Dickey–Fuller test suggested the presence of stationary residuals. We estimated the Jarque–Berastatistic to check the normality of the residuals. The results suggested a normal residual distribution. We performed ITS analysis using Newey OLS regression-based approaches available in the official Stata package. The Newey estimates the coefficients by OLS regression, but in addition to possible heteroskedasticity, it presents Newey–West standard errors to handle autocorrelation (25). First, the model was estimated using Newey with lag (0). To ensure the estimation of a model that accounts for the correct autocorrelation structure, we used Actest, lag (6) to investigate autocorrelation. Based on the output table, there was an autocorrelation of error terms at lag 4 (P = 0.039) and lag 1 (P = 0.016) in C-section rate data in hospitals affiliated to MoHME and hospitals not affiliated to MoHME, respectively.

Thus, our initial model was adjusted with lag (4) and lag (1) to account for this autocorrelation. The standard ITSA regression model was formed as follows:
\[ Y_t = \beta_0 + \beta_1 t + \beta_2 \text{intervention}_t + \beta_3 \text{time after intervention} \quad (1) \]

In equation 1, \( Y_t \) is C-section rate per month; time is a continuous variable indicating time in months at time \( t \) from the start of the observation period; intervention is an indicator for time \( t \) occurring before (intervention = 0) or after (intervention = 1) the HTP, which was implemented at the 26th month in the series, and time after intervention is counting the number of months after the HTP at time \( t \); \( \beta_0 \) represents the intercept, or starting level of the outcome variable; \( \beta_1 \) is the slope, or trajectory of the outcome variable until the introduction of the intervention. \( \beta_2 \) represents the change in the level of the outcome that occurs in the period immediately following the introduction of the intervention (compared to the counterfactual); \( \beta_3 \) represents the difference between pre- and post-intervention slopes of the outcome. The sum of \( \beta_1 \) and \( \beta_3 \) is the post-intervention slope. Thus, we look for significant P-values in \( \beta_2 \) to indicate an immediate treatment effect, or in \( \beta_3 \) to indicate a treatment effect over time \((24,25)\). Analyses were conducted using STATA statistical software version 13.

**Results**

Table 2 reports the total number of deliveries and C-section rate in all hospitals from March 2012 to May 2016. As shown in the regression table (Table 3), the starting level of C-section rate in the hospitals affiliated to MoHME was estimated to be 0.3716, and C-section rate appeared to significantly increase by 0.001 every month prior to May 2014 (\( P < 0.05 \)) (Table 3). The regression model for C-section rate in the hospitals affiliated to MoHME is shown in equation 2:

\[ Y_t = 0.37159 + 0.00104 t - 0.06288 \text{intervention}_t - 0.00118 \text{time after intervention}_t \quad (2) \]

Figure 1 presents the visual display of these results.

As shown in the regression table, the starting level of C-section rate in the hospitals not affiliated to MoHME was 0.3783; the C-section rate significantly increased by 0.0013 before the intervention (\( P < 0.05 \)). The regression model for C-section rate in the hospitals not affiliated to MoHME is shown in equation 3:

\[ Y_t = 0.37831 + 0.0013 t - 0.0314 \text{intervention}_t - 0.0011 \text{time after intervention}_t \quad (3) \]
Discussion

When a patient is receiving healthcare services delivered by healthcare providers, one of the important issues that cannot be neglected is the cost of the services. Altering the costs of different services and changing the reimbursement system can have an impact on healthcare providers’ policies and decision, and consequently the C-section rate may change in turn (16,17). Therefore, it is necessary to assess the reimbursement system and other factors that can alter the rate of caesarean delivery. In the current study, we evaluated the effects of the HTP on C-section rate in the Islamic Republic of Iran.

The implementation of HTP significantly decreased the level (immediate effect) of C-section rate in the hospitals affiliated to MoHME. The reduction observed in the hospitals affiliated to MoHME may be due to the elimination of costs of natural delivery (to encourage pregnant women to choose natural delivery), utilizing promotional tariffs for physicians to perform vaginal delivery (after the implementation of the first phase, a promotional tariff of 30K was added to the natural delivery tariff in hospitals affiliated to MoHME), and increasing the tariff of natural delivery within the new book of tariffs published in the third phase (the tariff of natural delivery was increased to 50K) (18). Despite the two years since the beginning of the HTP, the elimination of costs of natural childbirth for mothers, and increasing the tariffs of natural delivery for medical personnel, the rate of C-section in hospitals affiliated to MoHME in Kurdistan province still varies considerably with the standard rate recommended by WHO. There is no significant reduction in the slope of C-section in this group of hospitals.

The implementation of HTP significantly decreased the level (immediate effect) of C-section rate in non-university hospitals. The decrease in C-section observed in hospitals not affiliated to MoHME may be attributed to the fact that the hospitals were obliged (by Kurdistan University of Medical Sciences) to reduce their rates of C-section during the implementation of the HTP. As ordered by MoHME, non-university hospitals must decrease their rate of C-section by 10% annually, as compared with the baseline; the reduction will be considered as a factor in their annual accreditation (18).

The results of a study by Kim et al. in the Republic of Korea suggested that the type of the reimbursement system was associated with higher probability of C-section. To reduce the rate of caesarean delivery in the Republic of Korea, the payment method for caesarean delivery changed from Fee-For-Services (FFS) to Diagnostic Related Groups (DRG) and the tariff of

Figure 2 provides a visual display of these results.
natural delivery was increased by 50%. After taking these measures, the rate of C-section was significantly reduced (17). In line with the results of previous studies, the results of the current study indicated that women’s decision to undergo C-section is affected by the related costs (10,26,27). However, some studies found no relationship between the costs of the procedure and women’s decision to undergo C-section (28,29). For example, the results of a study by Lo in Taiwan (29) showed that the policy of fee equalization for vaginal and caesarean deliveries had no influence. Accordingly, as decided by the National Health Insurance (NHI) in Taiwan, the costs of vaginal birth and C-section were equalized. In an insurance reform in California, United States, the costs of vaginal and caesarean deliveries had been equalized, as studied by Keeler and Fok (28). Based on the results of their study, after adjusting for case-mix, there was an insignificant reduction (0.7%) in C-section rate after the reform (28).

The current study aimed to assess the impact of HTP on the rate of C-section; however, it did not consider the effects of birth order and previous caesarean, and these two factors might have an impact on interventions utilized in HTP and on the rate of C-section. Studies have shown that most mothers who already had a caesarean delivery are forced to undergo a caesarean again in subsequent pregnancies (29). According to the results of a study in Taiwan (29), the rate of C-section increased with the birth order, rising from 29% in the first birth to 37.4% in the second birth and 39.3% in the third birth. This observation was mainly attributed to the previous history of C-section, where the primary rates were 29%, 11.8%, and 12.1%, respectively. In that study the increasing fee for vaginal deliveries did not influence the C-section rate (29). However, based on our findings, cost has an impact on the choice made by physicians and patients for a specific medical procedure.

**Limitations**

This study was carried out in Kurdistan province in the west of the Islamic Republic of Iran; hence, the results may not represent a full picture of the impact of HTP on C-section rate across the whole country. Moreover, in this study we assessed the effects of HTP on C-section without taking into account the previous C-section and medical risk factors. Given the high rate of C-section in the years before the implementation of HTP in the Islamic Republic of Iran and Kurdistan, it might have reduced (distorted) the real effect of the HTP on the rate of C-section. Thus, further studies are needed to more accurately study this issue at an individual level.

**Conclusion**

In general, based on the results of this study, after the implementation of HTP the rate of C-section was significantly reduced in Kurdistan province; however, the reduction observed was less than the expected level. The rate of C-section in Kurdistan province is still significantly higher than the standard rate recommended by WHO. Apparently, in order to further reduce the rate of C-section it is necessary not only to promote financial incentives for mothers and health service providers, but also focus on policies to change mothers’ choice behaviours through
awareness-raising programmes on natural childbirth and the negative consequences of C-section. However, our study has provided some evidences for policy-makers and suggests that health providers are under the influence of the existing reimbursement system. Accordingly, healthcare providers’ decisions on the mode of delivery might be largely influenced by economic factors and advantages. As a result, it is necessary to design and adopt proper strategies for reimbursement in order to decrease the rate of superfluous procedures.

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**Competing interests:** None declared.

**Effets du plan national de transformation du secteur de la santé sur le taux de césarienne en République islamique d’Iran : série chronologique interrompue**

**Résumé**

**Contexte**: Au cours des dernières décennies, on a observé une augmentation du taux de césarienne en République islamique d’Iran. Une réforme du système de santé iranien – le plan national de transformation du secteur de la santé – a été lancée en 2014. L’un des objectifs de ce plan vise à réduire le taux de césarienne.

**Objectifs**: La présente étude vise à évaluer les effets du plan national de transformation du secteur de la santé sur le taux de césarienne en République islamique d'Iran.

**Méthodes**: La présente étude constitue une analyse d’une série chronologique interrompue basée sur une analyse de régression segmentée afin d’évaluer les effets immédiats et à long terme du plan de transformation du secteur de la santé sur le taux de césarienne dans deux groupes d’hôpitaux affiliés et non affiliés au ministère de la Santé et de l’Éducation médicale dans la province du Kurdistan. Les échantillons de l’étude ont été choisis en utilisant les données relatives au taux mensuel de césariennes, collectées sur une période de quatre ans.

**Résultats**: Nous avons observé une diminution sensible du taux de césarienne immédiatement après la mise en place du plan de transformation du secteur de la santé dans les deux groupes...
d'hôpitaux, s'élevant respectivement à 0,0629 et 0,0013, (p