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Cost analysis - the desirability of natural delivery and caesarean section with decision tree model*

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Abstract--Objective: This article deals with the cost-benefit analysis of natural childbirth and caesarean section with decision tree model. Methods: This is a practical study in which 644 cases of natural and cesarean births (including 317 natural births and 327 cesarean births) were extracted and included in the relevant list. Then mothers who had been at least 3 months after giving birth were included in the study. The data was collected using the researcher's checklist and EQ-5D-3L structured questionnaire by the researcher. SPSS 26 and R Core Team (2021) software were used to perform the analysis. Results: Natural childbirth was more prevalent for pregnant women compared to cesarean delivery, which had a lower cost (26980930.90±16603206.35 Rials vs. 48883938.59 ± 6126709.15 Rials) and better utility (86.91± 4.353vs. 64.16±7.348) for all evaluated outcomes. Conclusions: It is necessary to control and manage cesarean section in cases without clinical indication. Also, other low-cost and easy-to-access strategies should be carried out for the awareness of mothers and cultural and legal foundation in the field of promoting natural childbirth.

Keywords---*Cost - desirability, natural delivery, caesarean section , decision tree model.*

Introduction

Childbirth is one of the most sensitive and important services of the healthcare system of all societies, and like any other service, it should be done in a proper way, at a low cost, and with minimal physical-psychological complications (1, 2). that vaginal delivery is the best mode (3). From a medical point of view, cesarean section saves the life of the mother and the baby, but doing it unnecessarily can lead to more complications and financial costs for families and for the health care system (4,5). According to the latest information from 150 countries of the world, 18.6% of all births are performed by cesarean section. The countries with the highest cesarean rate are: Brazil (55.6%), Dominican Republic in Latin America and the Caribbean (58.1%), Egypt in Africa (51.8%), Iran and Turkey in Asia respectively (47.5% and 47.9%), Italy in Europe (38.1%), United States in North America (32.8%), New Zealand in Oceania (33.4%) (2, 6, 7). The latest available figures show that this trend continues, while the World Health Organization has declared the cesarean rate to be 10-15% (8). For this reason, the country of Iran adopted policies in the health reform plan to reduce the cesarean delivery rate (9). Since the implementation of this plan, the rate of cesarean section in public hospitals has decreased significantly. But in the case of private hospitals, this policy was not successful, and in fact, their caesarean section rate increased (10). Therefore, despite the overall reduction in the rate of cesarean section in Iran after the implementation of the health transformation plan, the desired goal of 10% annual reduction in Iran has not yet been achieved (9). On the other hand, in addition to the extraordinary challenges it has for the health of the mother and fetus, cesarean section imposes additional costs on families and the health system (11, 12). Since the implementation of this plan, the rate of cesarean section in public hospitals has decreased significantly. But in the case of private hospitals, this policy was not successful, and in fact, their caesarean section rate increased (13). Therefore, despite the overall reduction in the rate of cesarean section in Iran after the implementation of the health transformation plan, the desired goal of 10% annual reduction in Iran has not yet been achieved (12). On the other hand, in addition to the extraordinary challenges it has for the health of the mother and fetus, cesarean section imposes additional costs on families and the health system (14, 15). Health costs and its factors are one of the most important topics for policy makers, researchers and planners of the health sector in all countries of the world (2). According to the report of the World Health Organization, health care costs have been growing faster than the global economy in recent years and constitute 10% of the global gross domestic product, which has caused a threat to the health of the population in society. that gynecological care plays an important role in this scenario because it includes 20% of health care (16, 17). Vaginal delivery has lower hospital costs than caesarean section in low-risk pregnancies. On the other hand, obtaining information about the cost of health services is one of the necessities for optimal management and planning and leads to a better use of resources (2). The Ministry of Health in Iran has set one of its goals to reduce the rate of caesarean section in pregnant mothers (18). According to the policies of this ministry, the rate of cesarean section in public

and private hospitals of Iran should be reduced to 20 and 25%, respectively (19). but with

Paying attention to the fact that currently this goal has not been implemented in Iran, and in this regard, it is very important to evaluate the costs and examine the desirability of natural childbirth and cesarean section, and so far a study has been conducted on the cost-desirability of natural childbirth and cesarean section in Iran. The present study was conducted with the purpose of investigating the Cost analysis - the desirability of natural childbirth and caesarean section with a decision tree model.

Methods

Study setting, study design and study population :

The type of study was applied and in terms of descriptive-analytical research method, it was conducted in Ali Ibn Abi Talib Hospital in Zahedan city in 1400. Zahedan city is located in the southeast of Iran and is one of the provinces with the highest number of births in Iran. Our study population was all pregnant women who visited Ali Ibn Abi Talib Hospital in Zahedan in the second 6 months of 1400 for natural delivery and elective cesarean section. The inclusion criteria were pregnant women who referred to Ali Ibn Abi Talib Hospital in Zahedan city in the second 6 months of 1400 for natural delivery and elective cesarean section. Incomplete cases and emergency caesarean sections were also removed.

Sample size and sampling:

Sampling was done through Morgan table according to the information available in the second 6 months of 1400 in Ali Ibn Abi Talib hospital in Zahedan city, 1800 natural births and 2100 cesarean births were performed, according to Morgan table our sample size is 317 cases for natural birth and 327 cases were for caesarean section. Then, the information of 644 cases of natural childbirth and caesarean section in the second 6 months of 1400 was extracted and entered into the relevant list. Then, mothers who had given birth for at least 3 months were included in the study. Again, written informed consent was obtained from each participant in the study before participating in the study.

Data collection and study variables :

The data was collected using the researcher's checklist and EQ-5D-3L structured questionnaire by the researcher. In this study, the researcher received a written letter of introduction after the project was approved by the Health Faculty and the Research Ethics Committee of Tehran Islamic Azad University of Medical Sciences and presented it to the relevant official at Ali Ibn Abitalib Hospital. The relevant checklist contains demographic information (age of pregnant women), variables related to pregnancy (prime par or multipar and the number of prenatal visits and pregnancy complications) and natural childbirth costs (global tariff (consultation, sick bed, medicine, Consumables, surgeon's visit, surgeon's fee, operating room, tests, radiology, ultrasound, nursing services, other services), anesthesia fee fee, newborn visit fee, newborn bed fee, echocardiography fee, CT scan fee, M fee RI,

the cost of the patient's share and the total amount (patient's share, basic insurance share, outside the insurance obligation) and caesarean section (global tariff (consultation, patient bed, medicine, consumables, surgeon's visit, surgeon's fee, operating room, tests, radiology, ultrasound, nursing services, anesthesia fee, other services), newborn visit fee, newborn bed fee, echocardiography fee, CT scan fee, MRI fee, patient fee and total amount (patient fee, insurance fee) The base was outside the insurance obligation. The face validity and content of the checklist were also confirmed by 12 members of the academic faculty of the Faculty of Health, Islamic Azad University of Medical Sciences, Tehran.

Data management and analysis :

In this research, 2 analyzes were performed, which are: descriptive analysis and cost-utility analysis, in which descriptive analysis, using the researcher's checklist, demographic variables, variables related to pregnancy and the costs of natural childbirth and cesarean section were determined. In the demographic variables, the age of pregnant women was considered. And variables related to pregnancy included whether the pregnant women were primiparous or multiparous, the number of prenatal visits, and pregnancy complications. Age was divided into 3 groups: under 20 years, 20-35 years, and over 36 years. And in the variable related to pregnancy, pregnant women were divided into two groups: prime par and multipar, the number of prenatal visits varied from 0 to 4 times. And 13 cases of pregnancy complications were also considered, including 1- Premature rupture of membranes 2- Preeclampsia and eclampsia syndrome 3- Chronic hypertension 4- Preeclampsia syndrome added to chronic hypertension 5- Hypertension caused by pregnancy 6- Diseases Cardiac 7- Kidney diseases 8- Chronic respiratory failure 9- Diabetes 10- Anemia 11- Vaginal bleeding 12- Urinary tract infection 13- Severe and continuous vomiting. Then, the number of participants belonging to each group (age group, prime or multiparous, different prenatal visit times, participants suffering from any of the pregnancy complications) was counted and then the percentages were calculated. And the number of participants who had gone through 2 different delivery methods (including spontaneous natural delivery, elective cesarean section) was counted and then all participants were divided into 2 groups of vaginal delivery and elective cesarean delivery based on the delivery method. And finally, the analysis for the variable of maternal outcomes, Pearson's chi-square test was used to check whether there is a significant difference compared to the vaginal delivery group. In the cost of caesarean section, Global Tariff (consultation, patient bed, medicine, consumables, surgeon's visit, surgeon's fee, operating room, tests, radiology, ultrasound, nursing service, anesthesia fee, other services), newborn visit fee, fee Baby bed, cost of echocardiography, cost of CT scan, cost of MRI, cost of patient contribution and total amount (patient contribution, basic insurance contribution, outside the insurance obligation) and in natural childbirth costs of Global Tariff (consultation, patient bed, medicine , consumables, surgeon's visit, surgeon's fee, operating room, tests, radiology, ultrasound, nursing services, other services), cost of anesthesia fee, cost of newborn visit, cost of baby bed, cost of echocardiography, cost of CT scan, cost MRI, the cost of the patient's share and the total amount (patient's share, basic insurance share, outside the insurance obligation) were considered. In cost-utility analysis, the bottom-up method was first used to estimate all the costs of natural childbirth and cesarean section, and

EQ-SD questionnaire was used to estimate the utility of natural childbirth and cesarean section. This questionnaire has 5 dimensions; Mobility, personal care, normal activity, pain/discomfort, and anxiety/depression, and each dimension has three levels that reflect no problem in that area, somewhat problem, and severe problem in that area. If a person does not have a problem in the next, he is in level 1, if he has some problem in level 2, and if he has a severe problem in the next, he is in level 3. Each health status described by this tool contains a 5-digit number ranging from 11111 for perfect health to 33333 for the worst possible health status. Finally, the EQ-5D questionnaire identifies 243 distinct health conditions. This questionnaire was translated by the researcher, and the face validity and content of the questionnaire translated by the researcher were confirmed by 12 faculty members, and the reliability of the questionnaire was calculated with Cronbach's alpha. Due to the importance of this issue, decision tree and neural network models were used to analyze and estimate the cost-benefit of natural childbirth and cesarean section. For this purpose, the costs and benefits of natural birth and cesarean section were included in these models.

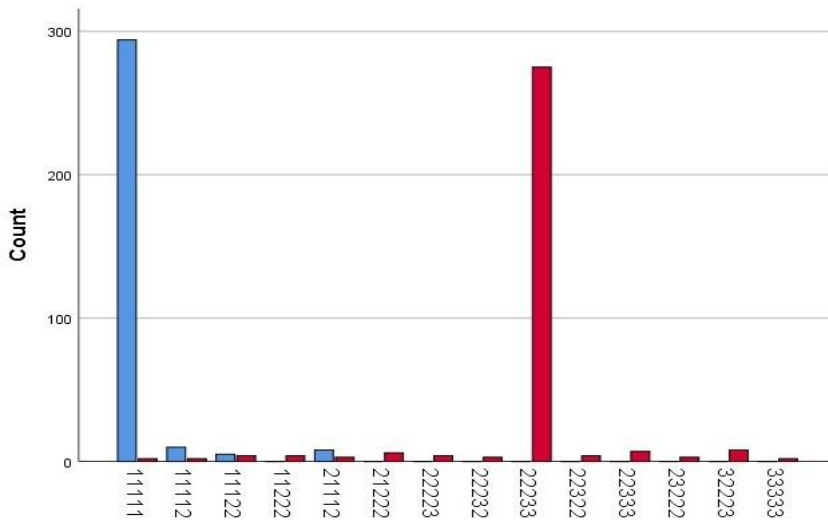
Results

In this study, the cost-effectiveness of natural childbirth and cesarean delivery in Ali Ibn Abi Talib Hospital, Zahedan city, was analyzed for 644 people (317 natural births and 327 cesarean births). In this study, the number of 644 cases of natural birth and cesarean section were examined (including 317 natural births and 327 cesarean births). The average age of pregnant women participating in the study was 27.3 ± 7.2 years. In terms of education level, 22.6% (114) were illiterate, 41% (258) had a cycle, 19% (98) had a diploma and 57% (267) had a university degree. And in terms of employment status, 73.4 percent (379) were housewives and the rest were working mothers. SPSS 26 and R Core Team (2021) software were used to perform the analysis. The summary of central indicators and cost dispersion for these two groups is included in Table 1. In this table, the average is mentioned as the central index and the standard deviation as the dispersion index.

Table 1 central indicators and dispersion of childbirth expenses by type of childbirth

Type of delivery	Variable name	Global tariff	Baby visit fee	The cost of a baby bed	The cost of MRI	Ec of fee	CT scan cost	The cost of the patient's share	Anesthesia fee	Total Amount	Desirability
Natural childbirth	Standard deviation \pm mean	26100500 \pm 0	2286410 \pm 0	2920500 \pm 0	764000 \pm 0	848112.92 \pm 593562.747	336198.74 \pm 182543.08	381957.99 \pm 2394790.32	4745511.44 \pm 2969591.3	26980930.90 \pm 16603206.3	86.91 \pm 4.353
Cesarean delivery	Standard deviation \pm mean	30854340.06 \pm 2035234.95	2412267.43 \pm 522260.195	4489412.84 \pm 1403583.18	764000 \pm 0	1271878.29 \pm 554842.080	408394.50 \pm 104397.660	5105980.963 \pm 1074322.23	00 \pm 0	48883938.59 \pm 6126709.15	64.16 \pm 7.348

In addition, analyzes were performed regarding the level of desirability. The degree of desirability of these people is presented in the column chart by type of delivery (Chart 1).



Desirability

Figure 1. Bar graph related to the level of desirability in two groups of natural delivery and cesarean section

■ Natural childbirth
■ Cesarean delivery

According to the results obtained in Figure 1, the degree of desirability is higher in the scores of 11111 in the natural delivery group and 22233 in the cesarean section group. According to these results, the desirability code in the group of natural childbirth is better than that of cesarean.

The decision tree method was used to classify the type of delivery according to cost-desirability. For this purpose, the data were divided into two groups of training and experimental data with the ratio (75% and 25%) and then the decision tree classification method was applied to the training data. The information of the confusion matrix and the model's accuracy and accuracy evaluation indicators for this method are as follows:

Table 2. Decision tree complexity matrix for all variables

		the truth	
		1) Natural childbirth	2) Cesarean delivery
Forecast	1) Natural childbirth	28	0
	2) Cesarean delivery	0	34

Table 3. Evaluation indicators of the accuracy and correctness of the created decision tree

Accuracy	1
Sensitivity	1
Specificity	1
Pos Pred Value	1
Neg Pred Value	1
Prevalence	0.4561
Detection Rate	0.4516
Detection Prevalence	0.4516
Balanced Accuracy	1

These results indicate that the obtained tree had a proper classification in the data. The result of this tree is shown in Figure 2.

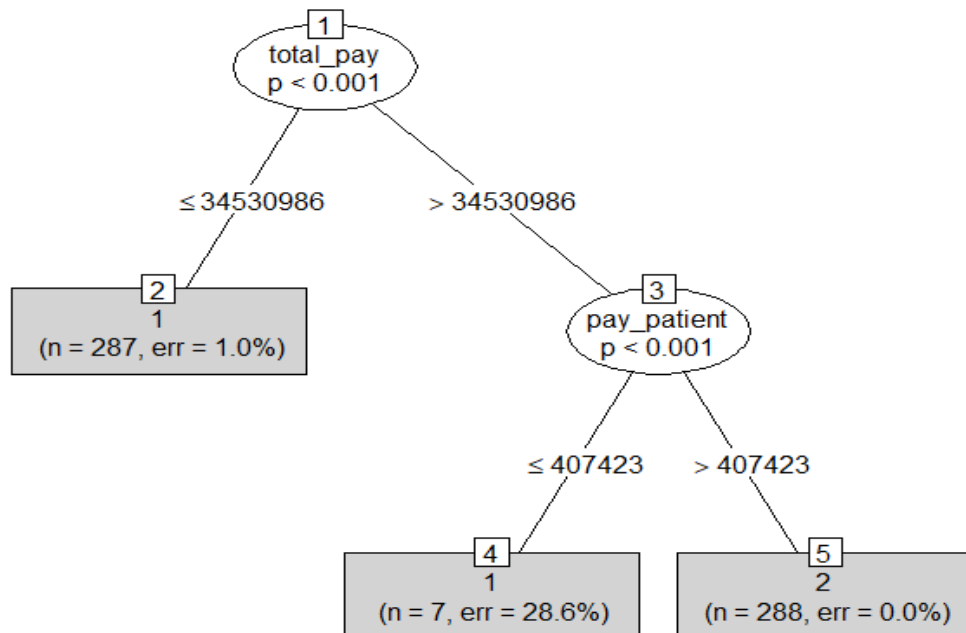


Figure 2. The result of the decision tree for all cost-benefit variables (group 1 means natural birth and group 2 means cesarean birth)

As you can see in Figure 2, the above classification means that if the total cost of the disease is less than or equal to 34530986, the patient is in group 1 (natural delivery) with an error of 1%, and if it is greater than this value, it should be attributed to The patient paid attention. If the cost of the patient is less than or

equal to 407423, with an error of 28.6%, the patient is in group 1 (natural delivery) and if it is more than this value, it belongs to group 2 (cesarean section). The pi values in each section confirm the validity of the model ($p < 0.001$).

The desirability factor was examined separately. This factor is a qualitative variable and the result of the decision tree for it was obtained as follows:

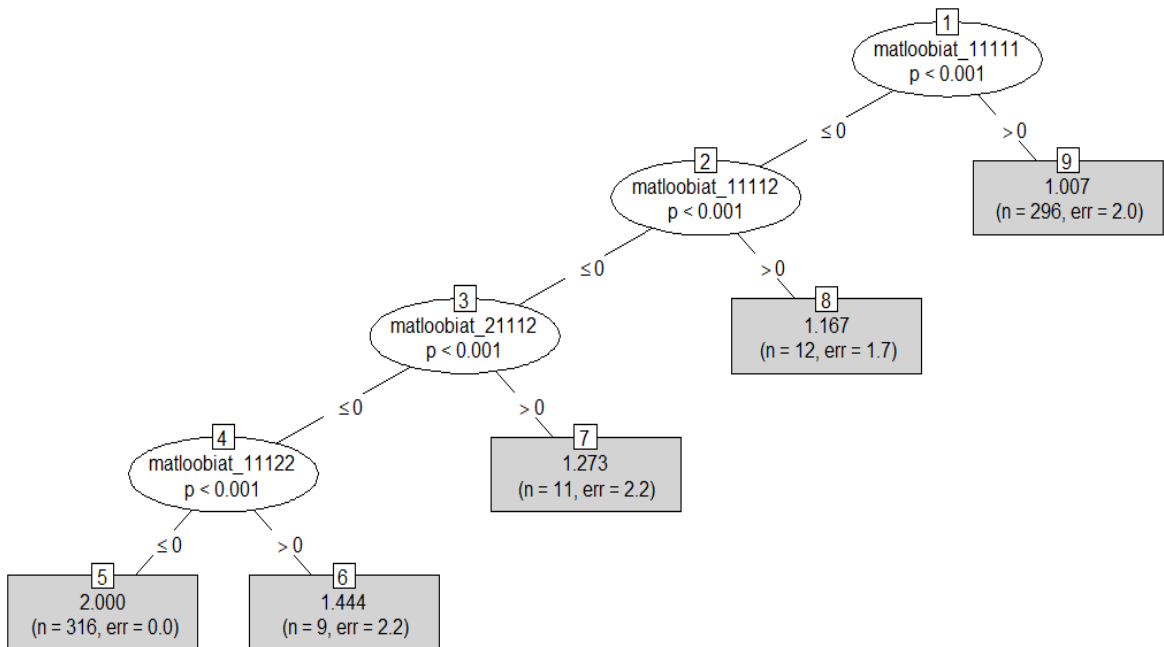


Figure 3. The result of the decision tree for the utility variable (group 1 means natural delivery and group 2 means cesarean delivery)

The result obtained from this tree indicates that if the codes 11111, 11112, 21112 or 11122 are registered in the desirability, the patient belongs to group 1 (natural birth) and otherwise the patient belongs to group 2 (cesarean section). The results indicate that the results are significant ($p < 0.05$) and the model error is insignificant.

The information of the confusion matrix and the model's accuracy and accuracy evaluation indicators for this tree are as follows:

Table 4. Complexity matrix for utility decision tree

		the truth	
		1) Natural childbirth	2) Cesarean delivery
Forecast	1) Natural childbirth	28	0
	2) Cesarean delivery	1	33

Table 5. Evaluation indicators of accuracy and precision of the decision tree for desirability

Accuracy	0.9839
Sensitivity	0.9655
Specificity	1
Pos Pred Value	1
Neg Pred Value	0.9706
Prevalence	0.4677
Detection Rate	0.4516
Detection Prevalence	0.4516
Balanced Accuracy	0.9828

According to these results and the results of Figure 1, the desirability codes with better scores are related to the natural delivery group, and the person with a desirability code worse than 11122 and 21112 is predicted to belong to the cesarean section group.

Discussion

The findings of this study showed that the rate of cesarean delivery was higher than natural delivery (1800 natural deliveries and 2100 cesarean deliveries were performed in the second 6 months of 1400 in Ali Ibn Abi Talib Hospital in Zahedan). In the study of Reofi et al., the rate of cesarean delivery was higher than natural delivery (20). In a study conducted by Afshari et al., 69% of them had a cesarean section and 31% had a natural delivery (21). Also, in the study of Moslehi and his colleagues in West Azarbaijan province, it is predicted that the rate of cesarean section will still be higher than natural birth in the next three years (19). Noorzaman Khan and his colleagues observed in the study they conducted in Bangladesh that Bangladesh is faced with a double burden of cesarean delivery (23). which was similar to the present study. This fact is mentioned in the studies of Abdul Raouf Al-Hassan and Nivedita Royo, who stated that the prevalence of recorded cesarean delivery was high compared to other previous studies. (24) In a study conducted in India, it was also shown that the rate of cesarean section is very high compared to natural childbirth (25). However, in the study of Mojtabaian et al., which was conducted in public and private hospitals in Mashhad, it showed that a total of 9% has been added to the prevalence of natural childbirth (26).

In Yaqoubi et al.'s study, the average total cost for each case of natural delivery was 8500000 Rials and for cesarean delivery was 18000000 Rials (13). According to Hamed Zandian et al.'s research in Ardabil city, the average total cost of natural childbirth was 352/778/899 and cesarean delivery was 352/878/751(27). Also, in a study conducted by Peter Binaruka and Amani Thomas Murray in Tanzania, it was shown that caesarean section increases the probability of paying for health care by 16% compared to natural delivery. (28). In our research, the mean and standard deviation of the total cost for natural delivery and cesarean section were $26980930.90 \pm 16603206.35$ and $6126709.15 \pm 48883938.59$, respectively. In the research of Alain Pivozan Intriger and her colleagues, it was observed that natural delivery was less expensive for primiparous pregnant women compared to elective cesarean section (\$5,210.96 versus \$5,753.54) (29). An increase in cesarean delivery increases direct payments and out-of-pocket costs and dramatically undermines the sustainability of health care systems. (8). One of the strengths of the present study is the cost-benefit analysis of natural childbirth and cesarean section.

Yaqoubi et al.'s study in Isfahan showed that the patients' payment for natural childbirth before the health system transformation plan was 8100000 Rials (19% of the total cost) and after the health system transformation plan was 297000 Rials (3.5% of the total cost) and for cesarean section was also The arrangement was 1,180,000 Rials (18% of the total cost) and 2,470,000 Rials (12% of the total cost). In our study, the average patient contribution for natural delivery was 381,957 Rials and for cesarean delivery was 5,105,980 Rials. In the study of Maryam Yaqoubi et al., the therapist (surgeon and anesthesiologist) received 2,400,000 Rials for each unit of natural delivery and 2,880,000 Rials for each unit of cesarean delivery. In the present study, the cost of anesthesia for normal delivery was 4745511 rials on average and 0 for cesarean section. This finding contradicts the research results of Yaqoubi et al.

In the present study, it was shown that the desirability of natural childbirth was more than caesarean section, which is similar to the study of Entringer et al. Also, in our research, the desirability of natural delivery was 86.91 ± 4.353 and the desirability of cesarean delivery was 64.16 ± 7.348 . In the study conducted by Hongian Chen and Dingliang Tan, it was shown that cesarean delivery is more harmful to health than natural delivery (30), which was similar to our study. The results in the study of Mahmoudian and his colleagues showed that sexual problems caused by childbirth included: lack of sexual desire, discomfort at the episiotomy site, insufficient lubrication, pain during intercourse, and fatigue were more common in the vaginal delivery group than in the cesarean delivery group. (31). which contradicted the current research.

Conclusion

The results of this research showed that the cost-effectiveness of natural childbirth is better than cesarean delivery. Also, the results of this study can be generalized for Iranian hospitals. Considering the significant difference in the cost-benefit of natural birth and cesarean section, which indicates that the cost-benefit of natural birth is better than cesarean birth. Therefore, other low-cost

and easy-to-access strategies should be carried out for the awareness of mothers and cultural and legal foundation in the field of promoting natural childbirth.

Competing interests

The authors do not report any conflicts of interest.

Funding statement

None.

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