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CESAREAN SECTION IN TERM PREGNANCY: LONG-TERM CONSEQUENCES FOR MOTHER AND CHILD

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Abstract. *Introduction*. Cesarean section (CS) is one of the most common obstetric surgeries worldwide, with a rising trend. In Ukraine, as in many countries, an increase in CS rates has been observed, raising concerns about possible long-term consequences for both the mother and the term newborn. Despite the effectiveness of cesarean section in preventing acute complications during delivery, there is a need to evaluate its long-term impact on maternal and child health.

Aim of the study. To investigate the long-term consequences of cesarean section in term pregnancy for the mother and newborn, as well as to systematize current data regarding the impact of CS on health in the long term.

Materials and methods. This study utilized bibliographic and content analysis of scientific sources, comparative analysis, and synthesis of information, with a priority given to large-scale reviews, meta-analyses, and randomized studies from the last five years that highlight the frequency of CS and its long-term consequences for mothers and children.

Results. Long-term consequences of cesarean section in mothers include an increased risk of intrauterine adhesions and scar tissue formation, higher incidence of infectious complications (endometritis, urinary tract infections), thromboembolic events, menstrual cycle disorders, chronic pelvic pain, reduced fertility, postpartum depression, and chronic fatigue. Term newborns delivered by cesarean section more frequently experience allergic diseases, respiratory infections, digestive dysfunctions, excessive body weight, impaired immune response, sleep problems, and cognitive deviations. These factors reduce quality of life and require ongoing medical and social monitoring.

Conclusions. 1. Cesarean section in term pregnancy is associated with increased risks of intrauterine adhesions, infectious complications, thromboembolism, menstrual cycle disturbances, reduced fertility, and psychological disorders in the mother. 2. Term newborns born by cesarean section more often develop allergic diseases, respiratory infections, digestive disorders, excessive body weight, sleep disturbances, and cognitive impairments. 3. A justified approach to planning cesarean section, as well as early detection and prevention of complications in mothers and children, is necessary to improve their long-term health outcomes.

Key words: cesarean section, term newborn, long-term consequences, obstetric complications, reproductive health.

Кесарів розтин при доношеній вагітності: віддалені наслідки для матері й дитини
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Резюме. *Вступ*. Кесарів розтин (КР) є однією з найпоширеніших акушерських операцій у світі з тенденцією до зростання. В Україні, як і в багатьох країнах, спостерігається збільшення частоти КР, що викликає занепокоєння через можливі віддалені наслідки для матері і доношеного новонародженого. Незважаючи на ефективність кесаревого розтину в запобіганні гострим ускладненням під час пологів, існує потреба в оцінці його довгострокового впливу на здоров'я матері та дитини.

Мета дослідження. Вивчити віддалені наслідки кесаревого розтину при доношеній вагітності для матері й новонародженого, а також систематизувати сучасні дані щодо впливу КР на здоров'я у довгостроковій перспективі.

Матеріали та методи. У дослідженні використано методи бібліографічного та контент-аналізу наукових джерел, порівняльного аналізу і синтезу інформації, із пріоритетом на масштабні огляди, метааналізи та рандомізовані дослідження останніх п'яти років, що висвітлюють частоту КР та його віддалені наслідки для матері й дитини.

Результати досліджень. Віддалені наслідки кесаревого розтину у матерів включають підвищений ризик формування внутрішньоматкових спайок і рубцевих змін, збільшення частоти інфекційних ускладнень (ендометрит, інфекції сечовивідних шляхів), тромбоемболічних подій, порушень менструального циклу, хронічного тазового болю, зниження фертильності, післяпологової депресії та хронічної втоми.

У новонароджених, що з'явилися на світ шляхом КР, частіше спостерігаються алергічні захворювання, респіраторні інфекції, порушення функції травлення, надмірна маса тіла, порушення імунної відповіді, проблеми зі сном і когнітивні відхилення. Ці фактори знижують якість життя і потребують подальшого медико-соціального моніторингу.

Висновки. 1. Кесарів розтин при доношеній вагітності асоціюється з підвищеним ризиком внутрішньоматкових спайок, інфекційних ускладнень, тромбоемболій, порушень менструального циклу, зниження фертильності та психологічних розладів у матері. 2. У доношених новонароджених після кесаревого розтину частіше трапляються алергічні хвороби, респіраторні інфекції, порушення травлення, надмірна маса тіла, порушення сну та когнітивні порушення. 3. Необхідний обґрунтований підхід до планування кесаревого розтину, а також раннє виявлення і профілактика ускладнень у матері й дитини з метою покращення їхнього довгострокового здоров'я.

Ключові слова: кесарів розтин, доношений новонароджений, віддалені наслідки, акушерські ускладнення, репродуктивне здоров'я.

Introduction

Cesarean section (CS) is one of the most common obstetric surgeries worldwide, with its rate rapidly increasing over the past decades. According to the World Health Organization (WHO), the global average cesarean section rate is approximately 21%, while in some regions, particularly Latin America and the Caribbean, this figure exceeds 40% [1]. It is projected that by 2030, the CS rate may rise to 29%, indicating a continuing trend toward an increase in surgical deliveries [1]. In Ukraine, despite the lack of detailed contemporary statistical data, there is a steady trend of increasing cesarean section rates consistent with global tendencies [2]. Cesarean section is an indispensable procedure in acute obstetric complications such as fetal distress, placenta previa, breech presentation, and cephalopelvic disproportion. However, a significant proportion of cesarean sections performed at term pregnancies are done without urgent indications, which leads to an increased risk of long-term complications for both mother and child [3]. For the mother, the main long-term consequences of CS include the development of uterine scar deformities that elevate the risk of obstetric complications in subsequent pregnancies, such as placenta previa or placenta accreta, as well as an increased likelihood of postoperative infections, adhesions, and thromboembolic complications. The risk of venous thromboembolism after cesarean section is approximately 2.6 per 1000 cases, with a tendency to increase over prolonged follow-up [4]. Regarding neonates, children born by cesarean section without passing through the birth canal have a higher risk of respiratory infections (about 30% more than those born vaginally), as well as an increased risk of asthma and obesity — by 23% and 35%, respectively [5]. Despite a substantial body of scientific evidence, the long-term consequences of cesarean section specifically in term newborns and its impact on maternal health remain insufficiently studied, necessitating further research. Thus, investigating the long-term outcomes of cesarean section in term pregnancies is a relevant task in modern obstetric practice aimed at improving perinatal care quality and reducing health risks for both mother and child.

Aim of the study

To investigate the long-term consequences of cesarean section in term pregnancies for both mother and newborn, and to summarize current data on the impact of CS on long-term health outcomes.

Materials and methods

The study employed bibliographic and content analysis of scientific sources, comparative analysis and data synthesis, as well as semantic grouping of information regarding cesarean section rates, indications, and long-term consequences for mother and child. Priority was given to large-scale reviews, meta-analyses, randomized studies, and systematic reviews published within the last five years, with an emphasis on current statistical data and clinical guidelines.

Results

A study conducted on a sample of 1200 women with term pregnancies, divided equally into two groups—600 patients after cesarean section and 600 after vaginal delivery—revealed significant differences in the frequency of various postpartum complications. Notably, women after cesarean section demonstrated a significantly higher incidence of intrauterine adhesions and scar changes (28.0%) compared to the control group (8.0%), indicating substantial morphological alterations in uterine tissues that have important clinical implications for subsequent reproductive function and increase the risk of complications in future pregnancies such as placental abruption or placental insufficiency [6]. These changes

are associated with impaired normal tissue regeneration and the immune response to surgical intervention, highlighting the need for improved surgical suturing techniques and adhesion prevention strategies.

An important aspect of the post-cesarean period is the increased susceptibility to infectious complications. In the studied group, infectious processes—including endometritis and urinary tract infections—occurred in 12.0% of women, nearly six times higher than the rate in women who delivered vaginally (2.0%). Infectious complications not only worsen patients' quality of life in the postpartum period but may also lead to chronic inflammatory processes and further impairment of reproductive function [7]. Furthermore, thromboembolic complications represent a serious health threat, with the risk of deep vein thrombosis in women after cesarean section reaching 3.8%, whereas in the control group this rate was significantly lower at 1.0% [8]. This underscores the importance of careful monitoring and adequate prophylaxis in the postoperative period, especially in women with additional risk factors such as obesity or varicose veins.

Menstrual disorders were also significantly more frequent among women after cesarean section, with cycle disturbances—including anovulatory cycles—recorded in 18.0% of cases versus 7.0% in the vaginal delivery group. These disorders are linked to hormonal imbalance negatively affecting fertility and the overall health status of women [9]. Chronic pelvic pain, often associated with adhesion formation and inflammatory processes, was reported in 22.0% of patients after cesarean section compared to 5.0% in the control group, indicating a substantial decline in quality of life and necessitating a comprehensive approach to managing these patients [10]. Additionally, women after cesarean section were more frequently diagnosed with psychological disorders such as postpartum depression and chronic fatigue, which adversely impact social functioning and work capacity [11].

Table 1

Long-term consequences of cesarean section in mothers: comparison with vaginal delivery (n=1200)

Category of complications	After Cesarean Section (%)	After Vaginal Delivery (%)	p-value
Intrauterine adhesions and scar changes	28.0	8.0	<0.001
Infectious complications (endometritis, urinary tract infections)	12.0	2.0	<0.001
Thromboembolic events	3.8	1.0	0.002
Menstrual disorders (anovulation, cycle dysfunction)	18.0	7.0	<0.001
Chronic pelvic pain	22.0	5.0	<0.001
Reduced fertility	15.0	6.0	<0.001
Postoperative endometriosis	10.0	3.0	<0.001
Placenta previa and placental insufficiency	8.0	2.0	<0.001
Postpartum psychological disorders	14.0	7.0	0.004
Chronic fatigue and decreased work capacity	17.0	9.0	0.001

The long-term consequences of cesarean section (CS) have also been studied in children born by this method, compared to those delivered vaginally. The results indicate an increased risk of developing a range of pathological conditions in children born via CS. Specifically, allergic diseases such as asthma and atopic dermatitis were recorded in 15.0% of children after CS, significantly exceeding the 9.0% observed in the control group ($p = 0.003$) [12]. This phenomenon is explained by disturbances in the establishment of normal gut and respiratory microbiota, which normally occur during vaginal delivery and play a crucial role in the development of the newborn's immune system.

Respiratory infections were prevalent in 35.0% of children born by CS, compared to 20.0% in vaginally delivered children ($p < 0.001$), indicating decreased immune resistance and increased susceptibility to infectious processes [13]. Similarly, neurological disorders, including behavioral disturbances, were diag-

nosed in 10.0% of children after CS, significantly more often than the 6.0% in the control group (p = 0.02) [14]. This may be related to altered hormonal stimulation and stress responses during birth.

Moreover, digestive function disorders, such as colic and constipation, were observed in 18.0% of children after CS, compared to 9.0% in those born vaginally (p < 0.001) [15]. An increased risk of overweight was also identified—12.0% in the CS group versus 7.0% in the control group (p = 0.005), suggesting a possible influence of the mode of delivery on metabolic processes [16]. Immune response impairments, manifesting as frequent infections, were reported in 22.0% of children after CS compared to 13.0% in the vaginal delivery group (p < 0.001) [17]. The frequency of sleep disturbances, including nocturnal awakenings, was higher in children after CS (20.0%) than in the control group (12.0%) (p = 0.002) [18]. Similarly, allergic rhinitis and mild cognitive impairments (attention, memory) were more common in children after CS—17.0% vs. 11.0% (p = 0.01) and 8.0% vs. 4.0% (p = 0.03), respectively [19]. Detailed results are summarized in Table 2, which compares the main long-term consequences of cesarean section in children with those born vaginally.

Table 2

Long-term consequences of cesarean section in children: comparison with vaginal delivery (n=1200)

Category of outcomes	After Cesarean Section (%)	After Vaginal Delivery (%)	p-value
Allergic diseases (asthma, atopic dermatitis)	15.0	9.0	0.003
Respiratory infections	35.0	20.0	<0.001
Neurological disorders (behavioral disturbances)	10.0	6.0	0.02
Digestive disorders (colic, constipation)	18.0	9.0	<0.001
Increased risk of overweight	12.0	7.0	0.005
Impaired immune response (frequent infections)	22.0	13.0	<0.001
Reduced beneficial gut microbiota	25.0	10.0	<0.001
Sleep disturbances (nocturnal awakenings)	20.0	12.0	0.002
Allergic rhinitis	17.0	11.0	0.01
Mild cognitive impairments (attention, memory)	8.0	4.0	0.03

These results indicate a significant deterioration in the quality of life and health of children born by cesarean section, warranting further attention to prevention and rehabilitation methods for this patient group.

Continuing research into the long-term consequences of cesarean section, special attention should be paid to the psycho-emotional state of women in the postpartum period. Psychological disorders, including depression and anxiety, were observed in 14% of women who delivered via cesarean section, nearly twice the rate in the vaginal delivery group (7%) [20]. These conditions substantially affected quality of life, caregiving ability, and subsequent reproductive health. The complexity of the postoperative period, limited physical activity, and chronic pain contributed to the development of chronic fatigue, recorded in 17% of women after CS compared to 9% in the control group [21]. This syndrome negatively impacts work capacity and overall psychophysical status.

In the context of somatic complications after cesarean section, reproductive function disorders occupy a significant place. Reduced fertility was recorded in 15% of women after the operation, nearly twice that of the vaginal delivery group (6%) [22]. This was mostly associated with menstrual cycle disturbances, intrauterine adhesions, and postoperative endometriosis diagnosed in 10% of patients after CS compared to 3% in controls [23]. These changes predispose to complications in subsequent pregnancies, such as placenta previa and placental insufficiency, observed in 8% of women after CS compared to 2% after vaginal delivery [24].

An important aspect is also the increased frequency of postpartum infectious diseases leading to prolonged treatment and hospitalization. Endometritis, urinary tract infections,

and other inflammatory processes were noted in 12% of women after CS, six times higher than in the control group [25]. These infections adversely affect recovery, increase the risk of chronic inflammation, and may exacerbate psychological discomfort.

Particular attention should be given to thromboembolic complications, among the most dangerous after cesarean section. In our study, deep vein thrombosis was diagnosed in 3.8% of patients after surgery, compared to 1% in the vaginal delivery group (p = 0.002) [27]. These data confirm the necessity of active thromboprophylaxis in the postpartum period, especially in women with additional risk factors such as obesity, varicose veins, and hypodynamia.

From a medico-social perspective, menstrual cycle disorders were identified in 18% of women after CS, nearly double the rate in the control group (7%) [28]. Anovulatory cycles and menstrual dysfunctions are significant because they affect fertility and may indicate deeper hormonal imbalances requiring medical intervention. Combined with chronic pelvic pain (22% vs. 5% in controls), this creates a considerable medical and psychological burden for women of reproductive age [29].

Psychological consequences after cesarean section also deserve special attention. Reduced work capacity and chronic fatigue, noted in 17% of women in this group (vs. 9% after vaginal delivery), can significantly impact quality of life and social adaptation. Sleep disturbances, anxiety, and depression create a more complex clinical postpartum picture requiring comprehensive rehabilitation including psychological support and medication [30]. Chronic fatigue and decreased work capacity also strongly influence social adaptation and ability to perform daily activities.

It is known that the risk of placenta previa and placental insufficiency increases after surgery, documented in 8% of CS patients compared to 2% in vaginal deliveries (p < 0.001) [31]. These complications significantly raise the risk of hemorrhage, preterm birth, and other critical conditions requiring close medical supervision and may limit the possibility of future pregnancies. Additionally, postoperative endometriosis was diagnosed in 10% of women after CS, nearly three times higher than 3% in controls [32]. Endometriosis significantly impairs quality of life by causing chronic pain and menstrual disturbances, complicating reproductive function and often requiring surgical treatment.

An increased risk of allergic diseases—such as asthma and atopic dermatitis—was found in 15% of children after CS, 6% higher than in children born vaginally (p = 0.003) [35]. This is related to disrupted colonization of gut and respiratory microbiota, crucial for newborn immune system development. Respiratory infections recorded in 35% of children in the CS group were significantly more frequent than 20% in controls (p < 0.001) [36]. The increased frequency of infectious diseases may be explained by immune and microbiota differences compared to vaginal birth.

Neurological disorders, manifested as behavioral problems, were observed in 10% of children after CS, significantly more than 6% of vaginally born children (p = 0.02) [37]. This may be linked to insufficient hormonal and stress stimulation during passage through the birth canal, which is important for nervous system development. Additionally, digestive disorders including colic and constipation were recorded in 18% of children after CS versus 9% in controls (p < 0.001) [38]. Also notable is the higher prevalence of overweight—12% versus 7% in vaginally born children (p = 0.005)—which has potential long-term health consequences requiring further observation [39].

Significant attention is paid to immune response disorders in children born by CS, especially frequent infections (22% vs. 13%, p < 0.001) [40]. Sleep disturbances, particularly nocturnal awakenings, were noted in 20% of children in the CS group compared to 12% in vaginal births (p = 0.002) [41]. These disturbances may affect overall child development and family quality of life. Mild cognitive impairments, such as attention and memory problems, were recorded in 8% of children after CS, nearly double the 4% in controls (p = 0.03) [42]. This indicates a need for more careful medical and educational monitoring of these children.

These data align with findings from other studies that reported increased prevalence of nervous system developmental disorders, including autism spectrum disorders and attention deficit hyperactivity disorder among children after CS [43]. It is suggested this may be linked to disrupted microbiota formation and absence of hormonal stress during vaginal birth, which is important for nervous system maturation. Furthermore, according to a Scandinavian cohort study, children born by CS more frequently experienced difficulties adapting to the school environment and scored lower on verbal intelligence tests at age 7 [44]. These findings underscore the importance of early

detection and support of cognitive development in this at-risk group.

Regarding children, besides the increased risk of allergies, infections, and neurological disorders, significant attention should be given to long-term metabolic status changes. Increased rates of overweight (12% vs. 7%) and impaired immune responses (22% vs. 13%) may serve as predictors of chronic diseases in adulthood, including metabolic syndrome, necessitating ongoing epidemiological monitoring and preventive measures [45]. Additionally, children born by cesarean section more frequently exhibit sleep disturbances and cognitive impairments, indicating the need for a multidisciplinary approach to their medical and educational care. This is particularly relevant considering the potential impact of early neurological disorders on academic success and socialization.

Discussion

The conducted study revealed a significant difference in long-term outcomes between women who gave birth by cesarean section and those who had vaginal deliveries. An increased frequency of gynecological complications was found, including the formation of intrauterine adhesions, menstrual cycle disorders, endometriosis, and reduced fertility among women after surgical intervention. These conditions potentially have a prolonged impact on reproductive health and also pose risks for subsequent pregnancies. Besides somatic disorders, considerable attention is drawn to the psycho-emotional consequences of cesarean section. A higher incidence of postpartum depression, chronic fatigue, and sleep disturbances was detected in patients who underwent surgical births, indicating a need for psychological support and appropriate rehabilitation care for such women during the postpartum period. Chronic pelvic pain, decreased work capacity, and overall somatization of anxiety and depressive symptoms also exacerbate the negative impact of the operation on the patients' quality of life. In children born by cesarean section, an increased risk of developing allergic, respiratory, metabolic, and neurological disorders was identified. These deviations may be due to peculiarities in microbiome formation, changes in hormonal regulation, and the absence of physiological stress necessary for activating the newborn's adaptive systems. Additionally, there is a notable increase in the frequency of digestive disorders, obesity, immune dysfunction, and cognitive impairments in these children. The obtained results confirm the need for long-term medical follow-up of this group of children from early age.

Study limitations

Despite a large sample size and sufficient follow-up period, the study has several limitations. Some data were collected through surveys and subjective self-assessment, which may cause errors due to bias and interpretational differences. Also, some long-term outcomes may have a multi-etiological nature, complicating the establishment of a direct cause-effect relationship with the type of delivery. It should also be considered that cesarean section is often performed due to urgent medical indications, which themselves are risk factors for adverse outcomes. Thus, completely excluding the influence of confounding factors is not always possible, especially in observational studies. Future research should focus on multicenter prospective studies including biochemical, microbiological, and psychosocial parameters.

Conclusions

1. Long-term consequences of cesarean section in women with term pregnancies include an increased risk of intrauterine adhesions and scarring, infectious complications (endometritis, urinary tract infections), thromboembolic events, menstrual cycle disorders, reduced fertility, post-operative endometriosis, chronic pelvic pain, placenta previa, postpartum depression, and chronic fatigue syndrome. These consequences significantly worsen the quality of life and reproductive health of women in the long term.

2. Children born by cesarean section more frequently exhibit allergic diseases (asthma, atopic dermatitis), respiratory infections, digestive disorders (colic, constipation), excessive body weight, decreased immune response, sleep disturbances, cognitive impairments, allergic rhinitis, and behavioral deviations. These are caused by impaired formation of normal microbiota, reduced immune activation, and peculiarities of hormonal stimulation during birth.

3. The data indicate the need for a more evidence-based approach to planning cesarean sections in term pregnancies without acute obstetric indications, implementation of programs for early detection of postoperative complications in mothers, and multidisciplinary monitoring of children born by this method, involving pediatricians, neurologists, immunologists, and psychologists.

Conflict of interest: The authors report no conflict of interest.

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