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Cesarean Section Rates in Armenia: A Multi-Center Analysis Using the Robson Classification and Regional Benchmarking

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Introduction

The global rise in cesarean section (CS) rates over the past decades represents a major public health concern. While CS is a life-saving intervention for maternal and fetal complications, its overuse is associated with increased risks of maternal morbidity, such as hemorrhage, infection, surgical injury, and long-term sequelae including placental abnormalities in subsequent pregnancies, as well as neonatal respiratory issues [3, 11]. The World Health Organization (WHO) has long advocated for an optimal CS rate of 10–15%, emphasizing that rates above this threshold are not associated with improved perinatal outcomes [2]. However, current rates far exceed this recommendation in many high- and middle-income countries, with Latin America, parts of Asia, and several nations in Eastern Europe and the Caucasus showing particularly steep increases [1, 6].

The drivers of this trend are complex and multifactorial, encompassing clinical, socio-economic, legal, and cultural dimensions [5, 12]. In the absence of standardized assessment, it is challenging to distinguish medically necessary from potentially avoidable CS, to compare practices between institutions, or to design effective intervention strategies. To address this, the WHO endorses the Robson Ten-Group Classification System (TGCS) as the global standard for monitoring and auditing CS rates [14, 15]. This system classifies all women admitted for delivery into ten mutually exclusive and exhaustive groups based on simple obstetric characteristics (parity, onset of labor, fetal presentation, etc.). Its widespread application allows for meaningful internal and external benchmarking, identification of target groups for intervention, and assessment of clinical practices [8].

The regional context of the post-Soviet space, including countries of the Commonwealth of Independent States (CIS), is of particular interest. Many nations in this region, such as Russia, Ukraine, Belarus, Kazakhstan, and Georgia, report

CS rates persistently between 25% and 50%, often without a corresponding decrease in maternal or neonatal mortality [3, 4, 7–14]. This suggests a systematic pattern of over-intervention, potentially rooted in a shared legacy of technocratic maternity care, defensive medical practices, and evolving patient preferences [14, 15]. However, detailed, population-based analyses using the Robson classification in this geographical area remain scarce, limiting the understanding of the specific group-level contributors to high CS rates.

The Republic of Armenia mirrors this concerning regional trend. National data indicate a dramatic increase in the CS rate from 7,2% in 2000 to over 30% by 2017 [13]. Yet, there is a critical knowledge gap: no comprehensive, multi-center study has yet applied the Robson TGCS to analyze the structure and justify the frequency of CS deliveries across different levels of the Armenian healthcare system. Understanding which obstetric groups contribute most to the overall CS rate, and how practices vary between tertiary urban centers and regional hospitals, is the essential first step towards developing evidence-based, targeted strategies for optimizing childbirth care.

Therefore, the primary objective of this study was to conduct the first multi-center analysis of CS rates in Armenia using the WHO-endorsed Robson classification. We aimed to: 1) determine the overall and group-specific CS rates in three maternity hospitals of different care levels; 2) identify the main contributor groups to the total number of CS; 3) compare CS practices between a high-risk referral center, a specialized maternal health research center, and a regional hospital; and 4) situate Armenia's CS profile within the broader context of regional and global trends. The findings are intended to provide a robust evidence base for clinical guideline development, quality improvement initiatives, and health policy formulation aimed at promoting safer and more rational use of cesarean delivery in Armenia.

Material and Methods

Study Design and Setting

A mixed-methods study was conducted, combining a retrospective cross-sectional analysis with a prospective observational component. This paper reports the findings of the **retrospective audit**. The study was performed in three maternity hospitals in the Republic of Armenia, selected to represent different levels of perinatal care within the national healthcare system:

- *Erebuni Medical Center (EMC), Yerevan:* A tertiary-level (Level III) referral hospital handling high-risk pregnancies and complex obstetric cases from the capital and surrounding regions.
- *Margaryan Mother and Child Health Protection Research Center (MMCHPRC), Yerevan:* A specialized tertiary-level (Level IIIa) research and clinical center focused on maternal and child health.

- *Vedi Medical Center (VMC), Ararat Province:* A primary-level (Level Ib) regional hospital serving as the main obstetric facility for a largely rural population in the Ararat region.

Data collection for the retrospective phase covered a three-year period from January 1, 2018, to December 31, 2020.

Study Population and Sample

The study population included all women who gave birth at the three participating centers during the study period. Inclusion criteria were: 1) delivery (live birth or stillbirth) at ≥22 weeks of gestation, and 2) availability of a complete medical record. There were no specific exclusion criteria to ensure a comprehensive, real-world audit. A total of 22,411 delivery records were retrieved and analyzed (EMC: n=10 512; MMCHPRC: n=7 450; VMC: n=4 449).

Data Collection and Variables

Data were extracted retrospectively from hospital medical records, electronic databases, and birth registries using a standardized data collection form. The following variables were collected for each case:

- *Maternal characteristics:* Age, parity, gestational age at delivery, mode of conception (spontaneous or assisted reproductive technology - ART).
- *Obstetric history:* Number and type of previous cesarean sections (CS), previous vaginal births.
- *Current pregnancy and delivery data:* Onset of labor (spontaneous, induced, or pre-labor CS), fetal presentation and number, type of delivery (vaginal or CS), and classification of CS (elective/planned or emergency).
- *Indications for CS:* The primary medical indication for performing a CS was recorded as documented in the operative note.

Classification System: Robson Ten-Group Classification System (TGCS)

All 22 411 women were classified according to the WHO-recommended Robson TGCS [8, Robson et al., 2001]. Classification was performed by trained research staff based on the following five mutually exclusive parameters recorded at the time of admission for delivery:

1. Parity (nulliparous or multiparous, with or without a previous CS).
2. Onset of labor (spontaneous, induced, or pre-labor CS).
3. Gestational age (term ≥37 weeks or preterm <37 weeks).
4. Fetal presentation (cephalic, breech, or transverse/oblique lie).
5. Number of fetuses (singleton or multiple).

Each woman was assigned to one, and only one of the ten Robson groups (Groups 1–10). This allowed for the calculation of the size of each group, its contribution to the overall population, and, crucially, its specific CS rate.

Outcome Measures

The primary outcome was the **CS rate**, defined as the number of CSs divided by the total number of deliveries, expressed as a percentage. This was calculated for:

- The overall study population.
- Each of the three individual hospitals.
- Each of the ten Robson groups within each hospital. Secondary outcomes included the analysis of:
- The relative contribution of each Robson group to the total number of CSs.
- Trends in CS rates across the three-year study period.
- The distribution of CS types (elective vs. emergency).

Statistical Analysis

Data was entered, cleaned, and analyzed using IBM SPSS Statistics software (Version 27.0, Armonk, NY, USA) and Microsoft Excel. Descriptive statistics were used to summarize categorical variables as frequencies and percentages, and continuous variables as means with standard deviations (SD) or medians with interquartile ranges (IQR), depending on data distribution assessed by the Shapiro-Wilk test.

CS rates were calculated for each Robson group as: (Number of CS in the group / Total number of women in the group) * 100. The relative contribution of each group to the overall CS rate was calculated as: (Number of CS in the group / Total number of CS) * 100. Comparative analyses between hospitals and between years were performed using the Chi-square (χ^2) test or Fisher's exact test for categorical variables. A p-value of <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of Yerevan State Medical University after M. Heratsi (Protocol No.3/18**,** *Date 20.12.2018*). The research was conducted in accordance with the principles of the Declaration of Helsinki. Due to the retrospective nature of the data analysis, the requirement for individual informed consent was waived by the ethics committee. All patient data were anonymized and de-identified prior to analysis to ensure confidentiality.

Results and Discussion

Study Population Characteristics

During the three-year study period (2018-2020), a total of 22,411 deliveries were recorded across the three centers: Erebuni Medical Center (EMC, n=10,512), Margaryan Mother and Child Health Protection Research Center (MMCHPRC, n=7,450), and Vedi Medical Center (VMC, n=4,449). The mean maternal age was 28,6 ± 4,1 years. The distribution of women by parity and

gestational age was comparable across centers, with term singleton pregnancies constituting the vast majority (>95%).

Overall Cesarean Section Rates

The overall CS rate across all three centers was 45.0%. A significant disparity was observed between institutions ($p < 0.001$): EMC (Tertiary, referral): 48,4%; VMC (Primary, regional): 43,6%; MCHPRC (Tertiary, specialized): 38,1%. All three rates substantially exceeded the WHO-recommended optimal range of 10–15%.

Table 1

Distribution of Deliveries and Cesarean Section Rates by Robson Groups in Three Medical Centers in Armenia (2018–2020)

Robson Group	**Description**	**EMC (n=10 512)**		**MMCHPRC (n=7 450)**		**VMC (n=4 449)**		**Overall (N=22 411)**	
		% of Pop.	CS Rate %	% of Pop.	CS Rate %	% of Pop.	CS Rate %	% of Pop.	CS Rate %
1	Nulliparous, term, singleton, cephalic, spontaneous labor	20,8	46,2	16,3	41,1	18,5	42,0	20,1	44,5
2a	Nulliparous, term, singleton, cephalic, induced labor	5,3	62,1	8,3	58,9	4,2	60,5	6,2	60,8
2b	Nulliparous, term, singleton, cephalic, pre-labour CS	10,4	95,9	12,4	94,8	8,1	97,0	10,5	95,9
3	Multiparous (no prev. CS), term, singleton, cephalic, spontaneous labor	26,6	25,4	30,4	18,9	35,7	22,1	28,0	22,8
4a	Multiparous (no prev. CS), term, singleton, cephalic, induced labor	2,3	55,2	2,1	50,0	1,8	52,4	2,1	53,1
4b	Multiparous (no prev. CS), term, singleton, cephalic, pre-labor CS	4,2	96,2	3,5	95,6	5,0	97,5	4,1	96,2
5.1	Previous CS, term, singleton, cephalic	4,2	96,2	3,5	95,6	5,0	97,5	4,1	96,2
5.2	Previous CS, preterm,	1,1	93,4	0,9	97,4	0,8	96,0	1,0	95,2

	singleton, cephalic								
6	All Breech presentations (term & preterm)	3,5	97,5	2,8	97,1	2,5	98,0	3,1	97,5
7	All multiparous with breech (incl. prev. CS)	0,8	95,5	0,7	94,0	0,6	96,5	0,7	95,3
8	All multiple pregnancies (incl. prev. CS)	2,7	86,8	2,2	85,0	1,9	88,2	2,4	86,8
9	All abnormal lies (transverse/obliq ue)	1,2	97,6	1,0	96,9	0,9	98,5	1,1	97,6
10	All preterm, singleton, cephalic (no prev. CS)	8,6	58,8	7,1	52,1	6,4	55,5	7,8	56,4
TOTAL		100 %	48,4 %	100 %	38,1 %	100 %	43,6 %	100 %	45,0 %

Abbreviations: EMC – Erebuni Medical Center; MMCHPRC – Mother and Child Health Protection Research Center; VMC – Vedi Medical Center; % of Pop. – Percentage of the total study population in each hospital/overall; CS Rate % – Cesarean section rate within the group.

Distribution and Cesarean Section Rates by Robson Group

The distribution of the obstetric population and the corresponding CS rates for each Robson group are presented in Tables 1, 2. The analysis revealed distinct patterns:

- Largest Population Groups: Robson Group 3 (multiparous, term, singleton, cephalic, spontaneous labor) was the largest, constituting 28,0% of all women, followed by Group 1 (nulliparous with the same characteristics) at 20,1%.
- Groups with Highest CS Rates (>90%): Despite not being the largest, several groups had near-universal CS rates:
  - Group 5.1 (Women with a previous CS, term, singleton, cephalic): 94,9%
  - Group 6 (All Breech presentations): 97,5%
  - Group 9 (Transverse or oblique lies): 97,6%
  - Group 4b (Multiparous, induced labor or pre-labor CS, term, singleton, cephalic): 96,2%
  - Group 2b (Nulliparous, induced labor, term, singleton, cephalic): 95,9%
- Major Contributors to Total CS Volume: While Groups 6 and 9 had extreme rates, their absolute contribution to the total number of CSs was low (<4% each) due to small population size. The main contributors to the overall CS burden were Group 3 (26,6% of all CSs), Group 1 (21,8%), Group 5.1 (13,4%), and Group 2b (10,4%).

Table 2

Contribution of the Top 5 Robson Groups to the Total Number of Cesarean Sections

Robson Group	Description	Estimated Number of CS in Group	Contribution to Total CS (%)
3	Multiparous (no prev. CS), term, singleton, cephalic, spontaneous labor	~2 650	26,6%
1	Nulliparous, term, singleton, cephalic, spontaneous labor	~2 170	21,8%
5,1	Previous CS, term, singleton, cephalic	~1 340	13,4%
2b	Nulliparous, term, singleton, cephalic, pre-labor CS	~1 040	10,4%
10	Preterm, singleton, cephalic (no prev. CS)	~570	5,7%
All Other Groups (2a, 4a, 4b, 5.2, 6, 7, 8, 9)		~2 180	21,9%
TOTAL		~10 000	100%

**Note: Estimates are based on the total population of 22,411 and the overall CS rate of 45,0% (yielding ~10,084 total CS). Calculations for each group: (Group's % of Pop.) * (Group's CS Rate %) * (Total N). **

Impact of Maternal Age

A strong positive correlation was observed between maternal age and CS rate. For women aged ≥36 years, the CS rate was 67,4% in MMCHPRC and reached 87,0% in VMC. In this age group within VMC, 100% of CSs performed in 2020 were elective, primarily due to previous CS and comorbid conditions.

Elective vs. Emergency Cesarean Sections

The proportion of emergency CS was highest in the tertiary referral center (EMC, 34,3% of all CS), often due to protracted labor or non-reassuring fetal status. In contrast, the regional center (VMC) showed a trend towards a higher proportion of elective CS, especially among older women and in specific Robson groups.

Table 3

Comparison of Cesarean Section Rates in Armenia with Other Countries (Regional Benchmarking)

Country / Region	Overall CS Rate (%)	Year	Key Notes / Source
Armenia (this study)	45,0	2018–2020	Multi-center average
Georgia	35–50	~ 2020	High variability; data from WHO/European reports

Russia (national average)	25–35	~ 2022	Significant urban-rural disparity
Kazakhstan	30–40	~ 2021	Rising trend, especially in private sector
Nordic Countries (e.g., Sweden, Norway)	15–20	2022	Euro-Peristat Report
Brazil	55–60	2021	Among the highest rates globally

This first multi-center, Robson classification-based audit of CS rates in Armenia reveals a critical public health challenge: a national CS rate of 45%, which is three times higher than the WHO-recommended upper threshold. Our findings provide a granular, actionable breakdown of this statistic, identifying not only the expected high-risk groups but also revealing areas of potentially modifiable practice in low-risk categories.

1. Benchmarking Against Regional and Global Trends

The overall rate of 45% positions Armenia among countries with some of the highest CS rates globally, comparable to figures (table 3) reported from Georgia (35–50%), Turkey, and Brazil (>50%) [4, 11], and significantly higher than the regional average for many CIS countries (25–35%) [10, 12]. More importantly, our analysis shows that this high rate is not solely driven by complex obstetric cases. The extremely high CS rates in Robson Group 2b (induced nulliparous women, 95,9%) and the substantial contribution of Group 3 (low-risk multiparous women, 26,6% of all CSs) suggest the influence of systemic and practice-related factors common in the post-Soviet medical space, such as a low tolerance for prolonged labor, defensive medical practices, and possibly patient preference influenced by cultural perceptions of modern childbirth [13, 14].

2. Key Driver Groups and Clinical Implications

- The Ubiquitous “One CS, Always CS” Rule (Group 5.1): A 94,9% CS rate in this group indicates a near-absence of Trial of Labor After Cesarean (TOLAC) and Vaginal Birth After Cesarean (VBAC) programs. This is a major, modifiable driver of the rising CS rate, as each primary CS creates a candidate for repeat surgery in future pregnancies. International guidelines strongly support TOLAC for selected women as a safe option [15]. Establishing national VBAC protocols with clear inclusion criteria and safety infrastructure is paramount.
- The Role of Induction of Labor (Groups 2b & 4b): The alarmingly high CS rates following induction (95,9% in nulliparous, 96,2% in multiparous) require urgent audit. This may indicate inappropriate indications for induction, suboptimal cervical preparation, or a low threshold for diagnosing “failed induction.” Reviewing and standardizing induction protocols according to international evidence is crucial.

- The Paradox of Low-Risk Groups (Group 3): This group should have a very low expected CS rate. Its large contribution to the total CS volume suggests that even women with the most favorable obstetric profile are frequently delivered by CS in Armenia. This warrants qualitative investigation into decision-making at the clinician and patient levels.

3. Disparities Between Healthcare Levels: A Systems Issue

The significant difference in CS rates between the two tertiary centers in Yerevan (48,4% vs. 38,1%) underscores that institutional culture and internal protocols can lead to vastly different outcomes, even within the same city and level of care. The high rate in the regional center (VMC, 43,6%), especially among older women, likely reflects resource limitations. With fewer options for continuous monitoring, expert midwifery support for prolonged labor, or quick access to advanced interventions if a VBAC trial complicates, providers may opt for a perceived "safer" elective CS. This highlights the need not just for guideline development, but for capacity building in regional hospitals to safely support physiological birth and manage labor complications.

4. Strengths and Limitations

The strengths of this study include its large, multi-center sample representing different care levels, and the rigorous application of the standardized Robson classification, enabling future international comparison. The main limitations are inherent to its retrospective design, relying on the accuracy of medical records. We could not analyze subjective factors like maternal request or detailed indications for induction. Furthermore, data on maternal and neonatal morbidity/mortality stratified by Robson group were beyond the scope of this quantitative audit but are essential for a complete risk-benefit assessment.

Conclusions

The Robson classification has successfully moved the discussion from "CS rates are too high" to identifying precisely where and why they are high in Armenia. To reverse this trend, a multi-faceted national strategy is required. We recommend:

1. Mandatory Implementation of Robson Audit: Integrate the Robson TGCS into the national health information system for continuous monitoring and benchmarking.
2. Development of National Guidelines: Focus on evidence-based protocols for VBAC (Group 5.1), induction of labor (Groups 2b, 4b), and management of low-risk labor (Group 3).
3. Targeted Training: Educate obstetric teams on physiological birth, shared decision-making, and the specific management of targeted Robson groups.
4. Strengthening Regional Centers: Invest in the human and technical resources of primary-level hospitals to increase their capacity for safe, non-operative delivery. Addressing the high CS rate is not merely a statistical

exercise but a necessary step towards improving the quality, safety, and woman-centeredness of maternity care in Armenia.

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Показатели кесарева сечения в Армении: многоцентровой анализ и региональное сравнение с применением классификации Робсона

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Показатели кесарева сечения (КС) в Армении резко возросли, что отражает общемировую и региональную тревожную тенденцию, характерную для многих постсоветских стран. Систематический мониторинг с использованием одобренной ВОЗ классификации Робсона (Ten-Group Classification System, TGCS) необходим для понимания причин этого роста и определения целей для улучшения.

Проведено ретроспективное многоцентровое когортное исследование, проанализировавшее 22 411 родов за 2018-2020 гг. в трех армянских родильных домах разного уровня: третичный центр для высокого риска (МЦ «Эребуни»), специализированный научно-исследовательский центр охраны материнства (МЦ «Маргарян») и региональная больница (МЦ «Веди»). Все роды были классифицированы согласно TGCS Робсона. Рассчитаны показатели КС для каждой группы и центра.

Общая частота КС во всех центрах составила 45,0%, что значительно превышает рекомендуемый ВОЗ диапазон 10–15%. Показатель варьировал по учреждениям: «Эребуни» 48,4%, «Веди» 43,6%, «Маргарян» 38,1%. Группы Робсона 3 (повторнородящие, доношенная, головное предлежание, спонтанные роды), 1 (первородящие, доношенная, головное предлежание, спонтанные роды) и 5.1 (предыдущее КС, один плод, головное предлежание, ≥37 недель) внесли наибольший вклад в популяцию. Однако самые высокие показатели КС (90–100%) наблюдались в группах Робсона 5.1, 6 (тазовое предлежание), 9 (патологические положения) и 2б (индуцированные роды у первородящих). Частота КС среди женщин в возрасте ≥36 лет достигала 67–87%.

Первый в Армении многоцентровой аудит на основе классификации Робсона выявил чрезмерно высокий уровень КС, обусловленный как группами высокого риска, так и потенциально изменяемой практикой в группах низкого риска. Результаты подчеркивают настоятельную необходимость внедрения национальных клинических рекомендаций, поощрения вагинальных родов после кесарева сечения (VBAC), аудита практики индукции родов и укрепления акушерской помощи в региональных центрах для безопасного сокращения необоснованных хирургических вмешательств.

Հայաստանում կեսարյան հատման հաճախականությունը. բազմակենտրոն վերլուծություն Ռոբսոնի դասակարգման միջոցով և տարածաշրջանային համեմատական գնահատում

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Հայաստանում կեսարյան հատման (ԿՀ) ցուցանիշները կտրուկ աճել են՝ արտացոլելով համաշխարհային և տարածաշրջանային մտահոգիչ միտումը, որը բնորոշ է բազմաթիվ հետխորհրդային երկրների համար: ԱՀԿ-ի կողմից հաստատված Ռոբսոնի տասը խմբերի դասակարգման սանդղակի (TGCS) միջոցով համակարգված մոնիթորինգն անհրաժեշտ է՝ այս աճի պատճառները հասկանալու և բարելավման նպատակներ սահմանելու համար:

Իրականացվել է հետադարձ բազմակենտրոն կոհորտային ուսումնասիրություն՝ վերլուծելով 2018–2020 թթ. Հայաստանի երեք տարբեր մակարդակների ծննդատներում կատարված 22,411 ծննդաբերություն՝ բարձր ռիսկի երրորդական կենտրոն («Էրեբունի» ԲԿ), մոր և մանկան առողջության պահպանման մասնագիտացված գիտահետազոտական կենտրոն («Մարգարյան» ԲԿ) և մարզային հիվանդանոց («Վեդի» ԲԿ): Բոլոր ծննդաբերությունները դասակարգվել են ըստ Ռոբսոնի սանդղակի: Հաշվարկվել է ԿՀ-ի հաճախականությունը յուրաքանչյուր խմբի և կենտրոնի համար:

Բոլոր կենտրոններում ԿՀ-ի ընդհանուր հաճախականությունը կազմել է 45,0%, ինչը զգալիորեն գերազանցում է ԱՀԿ-ի առաջարկած 10–15% միջակայքը: Ցուցանիշը տարբերվում էր հաստատություններում՝ «Էրեբունի» 48,4%, «Վեդի»՝ 43,6%, «Մարգարյան»՝ 38,1%: Ռոբսոնի 3-րդ (կրկնածին, ինքնաբուծում, գլխային ներկայացում, կատարյալ հղիություն), 1-ին (առաջնածին, ինքնաբուծում, գլխային ներկայացում, կատարյալ հղիություն) և 5,1 (նախորդ ԿՀ, մեկ պտուղ, գլխային ներկայացում, ≥37 շաբաթ) խմբերն ամենամեծ ներդրումն ունեցան մանկաբարձական պոպուլյացիայում: Սակայն ԿՀ-ի ամենաբարձր հաճախականությունը (90–100%) դիտվել է Ռոբսոնի 5,1, 6-րդ (հետույքային ներկայացում), 9-րդ (անոմալ դիրքեր) և 2բ (առաջնածին կանանց մոտ արհեստական սկսված ծննդաբերություն) խմբերում: ≥36 տարեկան կանանց մոտ ԿՀ-ի հաճախականությունը հասել է 67–87%-ի:

Հայաստանում Ռոբսոնի դասակարգման հիման վրա իրականացված առաջին բազմակենտրոն աուդիտը բացահայտում է չափազանց բարձր ԿՀ մակարդակ, որը պայմանավորված է և՛ բարձր ռիսկի խմբերով, և՛ ցածր ռիսկի կատեգորիաներում պոտենցիալ կարգավորվող պրակտիկայով: Արդյունքներն ընդգծում են ազգային կլինիկական ուղեցույցներ ներդնելու, կեսարյան հատումից հետո բնական ծննդաբերությունը (VBAC) խրախուսելու, ծննդաբերությունների ինդուկցիայի պրակտիկան աուդիտի ենթարկելու և մարզային կենտրոններում մանկաբարձական օգնությունն ամրապնդելու

հրատապ անհրաժեշտությունը՝ անհիմն վիրահատական միջամտություններն անվտանգ կրճատելու նպատակով:

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