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Abstract

The increase in caesarean section (CS) rates across countries has caused several health, social, and economic problems. The objectives are to estimate the prevalence and trend of caesarian sections and to investigate the determinants of such a dynamic. Secondary data from multiple indicator cluster surveys (MICS) were used for a set of countries in Central, Eastern, and Southeastern Europe. A meta-analysis was performed and multivariable logistic models were fitted. The findings showed high heterogeneity of CS rates among the study countries, with rates ranging from 11.1% in Ukraine to 40.4% in the Republic of Macedonia. In terms of the dynamics of C-section use over time, the results showed, within countries, that the rates are increasing sharply for all women. The inequalities between subgroups in these countries have been revealed, notably by area and region. Except for mother's age and baby size at birth (for specific countries), univariate and multivariate logistic regression revealed that none of the determinants were significantly associated ($p>0.05$) with the use of C-section. The results show that inequalities in the C-section exist within and between countries. However, considering the rationale for the use of caesarean sections, we need to implement different and flexible approaches with respect to the characteristics of each country in terms of demography, health systems, and economic levels.

Key words: Caesarean section; Prevalence; Delivery; Maternal Health.

1 Introduction

Caesarean section is an intervention that has been practiced for several centuries (1). Dreaded and even deadly in its infancy, it has become a common intervention owing to the diversity and multiplicity of these indications. Delivering the child in the best possible condition and without maternal harm has helped increase the frequency of this surgical practice in both developed and developing countries (1–3). However, According to WHO statistics, caesarean section use continues to rise globally, now accounting for more than 1 in 5 (21%) of all childbirths.

The World Health Organization (WHO) has warned that cesarean delivery has become the most prevalent worldwide and that natural childbirth has become an exception, threatening the lives of millions of women and children if this surgery is performed without a medical need (4, 5). While a caesarean section can be an essential and lifesaving surgery, it can put women and babies at unnecessary risk of short- and long-term health problems if performed when there is no medical need (6). Accordingly, the rising trend in caesarean section rates compared to vaginal deliveries puts more pressure and costs from economic or maternal/child perspectives (7).

On the other hand, different studies have focused on investigating the main determinants of C-section rates (8–10). There is some consensus regarding the potential factors associated with caesarean section. Specifically, these include maternal age, place of residence, mother's education level, baby size at birth, and number of antenatal care (ANC) visits (11- 14).

Different studies have been performed in nearly all regions, for instance, in Asia (13, 14). In the African regions (10–12). However, to the best of the authors' knowledge, no epidemiological studies have been conducted in Central, Eastern and Southeastern European Countries. Using the household data of the MICS survey, the objectives are to estimate the prevalence and trend of caesarian sections and to investigate the determinants of such a dynamic in this region.

The rest of the paper is organized as follows; Section2 presents a brief overview of the data and statistical methods. Section3 is devoted to the results of descriptive and regression analyses. In Section4 the results are discussed, and the conclusions are presented in the last section.

2 Methods

The datasets were provided via a personal request presented to the MICS Survey Department of UNICEF. The Multiple Indicator Cluster Survey (MICS) is an international household survey program developed and supported by the UNICEF. The MICS is designed to collect estimates of the key indicators used to assess the situation of children and women. Further details on the survey design and questionnaires are available on the UNICEf-MICS website (https://mics.unicef.org/).

To assess the event of cesarean section for a given child, mothers were asked if the child was delivered by caesarean section. Through this question, we can estimate the C-section rates in each country and the distribution of C-section by age, region, educational levels, and regions, and the responses to this question construct the dependent variable in the logistic regression (15). As the selected samples in each survey departed from the reference population according to specific sampling variables (age, gender, education, etc.), the MICS methodology estimated the weights (for post-stratification) as the inverse of the probability of selection (for households, women, or children). Accordingly, we applied the weights (which are available in each data set of the MICS) before estimating either for descriptive statistics or regression analysis; this step is to adjust the sample distribution to the population reference (mainly a census).

To investigate the determinants of the variation and level of C-section in these countries, five socioeconomic factors were selected: three at the individual level: mother's age, mother's educational attainment, and baby's size at birth, and two at the household level, place of residence (urban or rural), and the household wealth index. The selection of the sample of

countries was mainly based on the availability of access to data from the UNICEF website. Statistical analysis was conducted using the SPSS V.26 software for logistic regression and the R V.4.1 program for the Meta analysis, specifically the "meta" package (16).

3 Results

The results summarized in Table1 showed that the caesarean rates are on the higher side of Republic of North Macedonia (40.45%), followed by Serbia (28.96%), Montenegro (26.91%), Belarus (25.49%), Moldova (16.36%), and Ukraine (11.15%). Except for Ukraine, all other study countries exceeded the threshold recommended by WHO (15%). Based on the area of residence (rural vs. urban), the findings showed a non-significant difference between the C-section rates of women in rural and urban areas in all countries.

Table1 Cesarean section based on area or residence in Central, Eastern and Southeastern European Countries

Country	Total		Urban		Rural	
	N	CS%	n	CS%	n	CS%
Belarus	1322	25.49	987	25.53	335	25.37
Moldova	715	16.36	403	15.88	312	16.98
Montenegro	431	26.91	261	26.43	170	27.64
Republic of North Macedonia	571	40.45	306	43.46	265	36.98
Serbia	953	28.96	599	29.04	354	28.81
Ukraine	1560	11.15	988	11.43	572	10.66

***Note**: All births for this table cover the last five year preceding each survey. (**) significant difference at 0.05 of statistical significance level*

Figure 1 shows the percentage distribution of C-section rates based on mothers' age intervals in selected countries. The results show that the rates of c-section are significantly high for women in the age category of (40-44 years) in four countries: Serbia, North Macedonia, Montenegro, and Moldova. On the other hand, for the other two countries (Belarus and Ukraine), women

aged between 35 and 39 years recorded the maximum C-section rate. However, we found homogeneous C-section rates for the other age categories, particularly for women in the age categories (15-19), (20-24) and (25-29). However, and in general, the results of the difference test (based on the chi-square test) revealed a statistically significant difference (with a p-value<0.05) in the levels of CS rates between the age categories, and in all these countries.

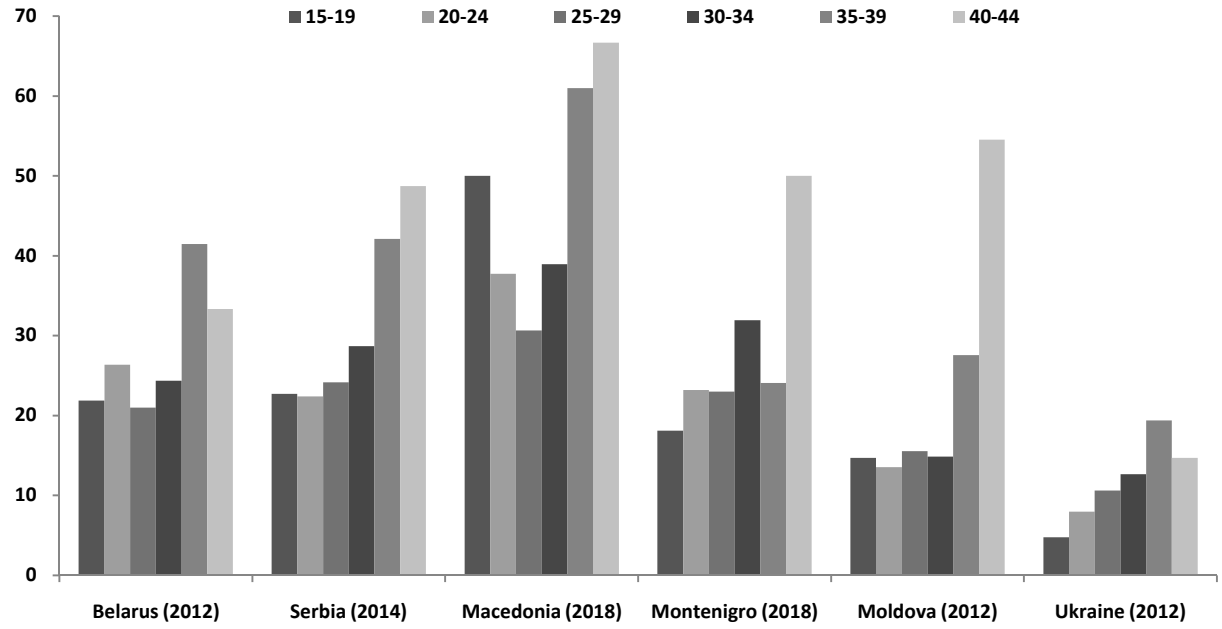

Figure1. Caesarean section rates based on mother's age-interval in Central, Eastern and Southeastern European Countries.

Figure 2 shows the trend of caesarean section rates in the countries studied across different MICS surveys during the period 2001-2019. The main finding was that the rate of caesarean sections followed an increasing pattern over the study period. For example, in Belarus, the overall rate of C-section increased from 16.3% in 2001 to 31.2% in 2019, an increase of almost 100% compared to the reference year.

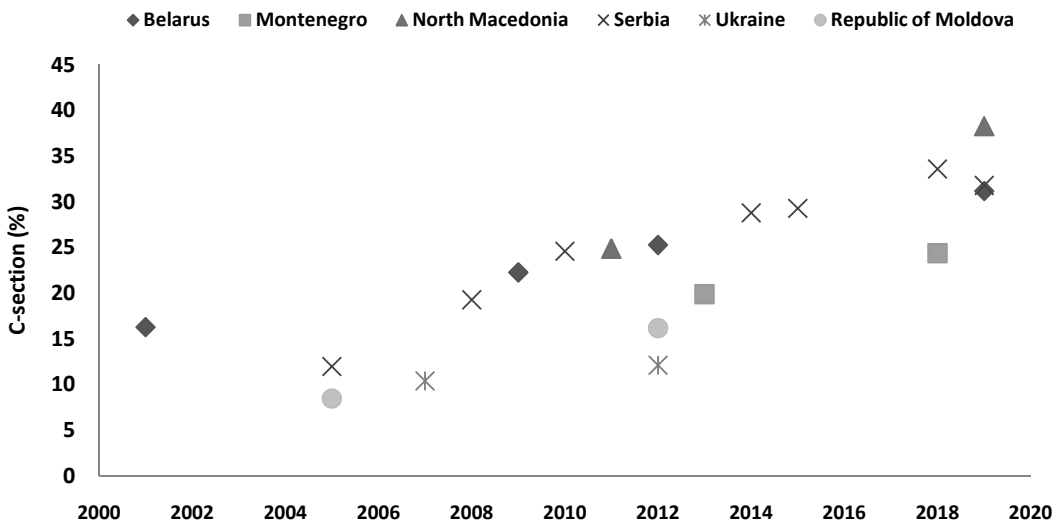

Figure2. Change over time in caesarean section rates in Central, Eastern and Southeastern European Countries.

To assess homogeneity among the study countries, a meta-analysis was performed, as shown in Figure 3. Specifically, a random and fixed effects model was estimated for meta-analysis using the Mantel-Haenszel method to assess the homogeneity between regions (rural vs. urban) and between countries of the utilization of CS delivery (17). According to these findings, ample heterogeneity was identified ($I^2 \approx 87\%$).

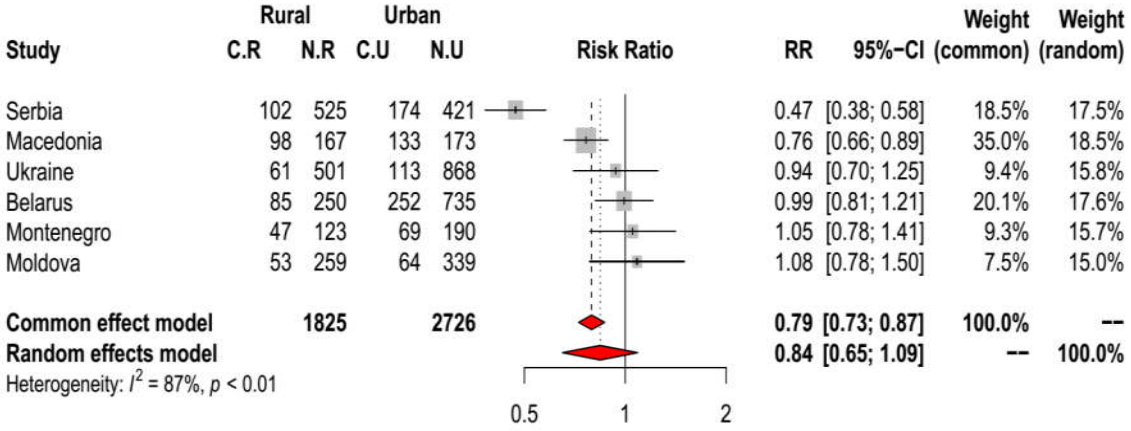

Figure 3. Forest plot of the sub-group meta- analysis on association of urban and rural CS rates.

Beyond the area of residence, an association analysis (using a bilateral chi-square test of association) was used to test the hypothesis of homogeneity of the levels of C-section rates between the different regions of these countries. The results are presented in Table 1. Based on

these results, among the six countries, there was a significant difference in CS rates between regions in Belarus and Serbia. Specifically, in Belarus, the minimum CS section rate was 17.17% in the Vitebsk region, and the maximum rate was 32.53% in the Gomel region. In Serbia, the minimum CS rate was 24.31% in the Vojvodina region, whereas the highest CS rate was 34.08% in Sumadija and West Serbia.

Table 2. Output of comparison of caesarean section rates between regions of each country.

	$\chi^2_{\alpha=0.05}$ (*p.value*)	Lowest	Highest
Belarus	19.43 (**0.003**)	17.18	32.51
Moldova	2.134 (0.545)	13.66	18.93
Montenegro	2.771 (0.251)	22.06	30.18
Republic of North Macedonia	3.246 (0.861)	35.38	45.16
Serbia	14.26 (**0.027**)	24.13	34.08
Ukraine	5.262 (0.261)	7.665	12.74

Note: $\chi^2_{\alpha=0.0\ 5}$means the estimated chi sqaure test for different degree of freedom and at 5% level of significance.

The estimated coefficients of the bivariate regression (here, refers to the unadjusted odds ratios) are summarized in Table2. Results showed that for all study countries, the covariate of the area of residence was not significantly associated with caesarean section; the exception was in the case of North Macedonia (UOR=1.31, 95% CI(0.93–1.83), p=0.042). Among the study countries, the estimated unadjusted odds ratios of the babies' size covariates showed different patterns of association with the mode of delivery. This covariate was categorized into three modalities (average size, smaller than average, and larger than average), and the results revealed that the highest C-section rates were significant in mothers with babies weighing larger than average in Moldova and Ukraine. However, only Ukrainian women with fetal weight smaller than the average recorded the highest C-section rates compared to women with babies having average weight (UOR=2.61, 95% CI (1.62–4.16), p=0.01). Except for North Macedonia and Serbia, the UOR showed that mothers from low- or high-income families did not make a significant difference in CS rates.

Table 3. Unadjusted odds ratios (UORs) for the probability of C-section in Central, Eastern and Southeastern European Countries

	Belarus	Serbia	Macedonia	Montenegro	Moldova	Ukraine
Area (ref.: rural)	1.01 (0.76, 1.34)	1.09 (0.63, 1.89)	**1.31** (**0.93**, **1.83**)	1.05 (0.68, 1.62)	1.08 (0.73, 1.61)	0.93 (0.67, 1.30)
Baby 's size (ref.: average)						
Smaller than average	1.07 (0.79, 1.45)	1.68 (0.84, 3.37)	0.92 (0.60, 1.41)	0.94 (0.54, 1.63)	1.77 (1.03, 3.05)	**2.6 1**(**1.62**, **4.16**)
Larger than average	**0.43** (**0.30**, **0.61**)	1.22 (0.52, 2.83)	0.74 (0.46, 1.20)	0.97 (0.46, 2.04)	**3.13** (**1.81**, **5.39**)	**1.98** (**1.08**, **3.63**)
Mother's Education (ref.: none)						
Primary	0.68 (0.33, 1.38)	0.99 (0.05, 18.1)	1.16 (0.72, 1.85)	0.97 (0.50, 1.88)	0.47 (0.07, 3.02)	0.12 (0.01, 1.91)
Secondary	0.88 (0.59, 1.22)	**0.32** (**0.12**, **0.83**)	1.16 (0.72, 1.85)	0.97 (0.50, 1.88)	0.48 (0.09, 2.48)	0.12 (0.01, 1.91)
Higher	0.88 (0.67, 1.17)	0.42 (0.16, 1.09)	1.04 (0.66, 1.64)	1.15 (0.58, 2.31)	0.64 (0.13, 3.24)	0.13 (0.08, 2.11)
Wealth index	1.06 (0.91, 1.24)	**0.73** (**0.50**, **1.05**)	**0.87** (**0.73**, **1.04**)	1.03 (0.83, 1.28)	1.02 (0.84, 1.26)	1.01 (0.86, 1.21)
Mother's Age	**0.96** (**0.94**, **0.98**)	0.90 (0.72, 1.13)	**0.94** (**0.91**, **0.97**)	**1.22** (**1.01**, **1.49**)	**1.06** (**1.02**, **1.09**)	**1.06** (**1.03**, **1.09**)

Similar to the binary analysis, the estimated coefficients of the multivariate analysis (here, refer to the adjusted odds ratios of the logistic regression) are summarized in Table 3. The results do not differ from those of the univariate analysis in terms of the significance effects and heterogeneity pattern of association between the models for each country. Precisely, Table 2 shows that mothers from urban areas are more likely to exercise CS delivery than their peers from rural areas; however, this coefficient is not statistically significant. The results also revealed that the highest C-section rates were significant in mothers with babies weighing larger than the average in Moldova and Ukraine. For mother's age, we revealed different patterns of association with the likelihood of using CS practice.

Table 4. Adjusted odds ratios (UORs) for the probability of C-section in Central, Eastern and Southeastern European Countries

	Belarus	Serbia	Macedonia	Montenegro	Moldova	Ukraine
Area (ref.: rural)	1.03 (0.72, 1.48)	1.05 (0.56, 1.95)	1.21 (0.83, 1.77)	1.09 (0.69, 1.72)	1.26 (0.72, 2.19)	0.99 (0.63, 1.56)
Baby 's size (ref.: average)						
Smaller than average	1.06 (0.78, 1.45)	1.66 (0.81, 3.41)	1.01 (065, 1.55)	0.93 (0.54, 1.62)	1.59 (0.91, 2.79)	**2.53** (**1.57**, **4.07**)
Larger than average	**0.44** (**0.30**, **0.62**)	1.31 (0.55, 3.08)	0.72 (0.44, 1.18)	1.02 (0.48, 2.15)	**4.07** (**2.33**, **7.09**)	**2.12** (**1.15**, **3.89**)
Mother's Education (ref.: none)						
Primary	1.15 (0.51,2.95)	6.38 (0.11, 403.1)	1.59 (0.89, 2.85)	1.03 (0.49, 2.18)	0.41 (0.06, 3.15)	0.56 (0.01, 4.12)
Secondary	1.16 (0.53,2.53)	2.23 (0.03, 146.1)	1.59 (0.89, 2.85)	1.03 (0.49, 2.18)	0.43 (0.08, 2.28)	**0.06** (**0.01**, **1.05**)
Higher	1.34(0.60, 2.98)	3.78 (0.05, 284.8)	2.15 (0.06, 15.6)	1.14 (0.49, 2.64)	0.62 (0.11, 3.35)	**0.07** (**0.01**, **1.11**)
Wealth index	1.05 (0.85, 1.28)	0.67 (0.37, 1.21)	0.85 (0.69, 1.06)	0.98 (0.76, 1.27)	1.02 (0.76, 1.38)	0.96 (0.75, 1.22)
Mother's Age	**0.95** (**0.93**, **0.98**)	0.89 (0.69, 1.15)	**0.94** (**0.91**, **0.97**)	**1.22** (**0.99**, **1.49**)	**1.06** (**1.02**, **1.10**)	**1.06** (**1.02**, **1.09**)

For example, in the case of Montenegro, Moldova, and Ukraine, there is a positive effect; in contrast, in North Macedonia and Belarus, the ORs (0.94 and 0.95, respectively) showed the existence of a slight negative association between the mother's age and the use of CS delivery. Nearly for almost all countries, mothers with high educational attainment were more likely to use cesarean section delivery than mothers with no education, and the estimated coefficients were not significant. Mothers from low- or high-income families do not make a significant difference in CS rates in these countries.

4 Discussions

In this article, we provide an update on the social and economic factors related to inequalities in caesarean section rates in Central, Eastern and Southeastern European Countries. We focused on these countries because few studies have been carried out to investigate the trend, prevalence, and factors associated with Caesarean section. The main findings showed that the C-section rates estimated for the six countries were greater than 15%, except for Ukraine. In this framework, a statistical note of the non-significance of nearly all explanatory variables should be clarified, as shown in Table 3 for unadjusted ORs and Table4 for Adjusted ORs. This result is in accordance with those revealed (at a macro level analysis) by Boerma et al. (18), they reported that none of the determinants were statistically significant with the C-section rates for countries with potential overuse of C-section (15% or more).

According to our results, we reported an increase in caesarean section rates over time in the study countries. This upward trend has been indicated by several reports of the World Health Organization, as well as by UNICEF for all countries around the world. In previous studies, the same finding was reported; for instance, Boatin et al.(3) and Soto-Vega et al (19), who studied the pattern and trend of C-section in 28 countries, the authors found that 26 of 28 countries showed a significant increase in C-section rates over time. In a recent study, the authors

investigated the dynamics in C-section over a long period from 1950 to 2020 and found that it is very difficult to deal with the rising C-section rates (20).

Of course, various factors influence the trend and variation in the C-section in different countries. In this study, we analyzed the effects of different determinants. The first determinant included in the regression models is the area of residence; we did not find a significant difference in C-section rates between mothers from rural and urban areas. Similar to our study, a previous study reported the same finding (3). In contrast, other studies have shown that C-section rates are higher among women from urban areas than among those from rural areas (12). The second determinant is baby size at birth, and the findings of the current study depicted a heterogamous pattern of association with C-section rates in the study countries. Compared with previous studies, this child factor was found to be significantly associated with C-section use in sub-Saharan African countries (10). Furthermore, in Bangladesh, researchers indicated that a maternal perception of a large newborn size was statistically significantly associated with the likelihood of C-section use (13). However, in Pakistan, the authors concluded that baby size was not associated with caesarean delivery (21).

The third determinant was the mother's educational level, and we found that educated women had no significant difference in C-section use compared to less-educated women in the study countries. Our study was in accordance with previous studies; for example, a study in Iran revealed that mothers with a high education level were not positively associated with the likelihood of cesarean section use (22). Similarly, in some countries in southern Asia, a previous study reported that higher education is negatively associated with C-section rates (23). However, the majority of previous studies have suggested that educated women are more likely to use C-section delivery than women with less or no education (12, 24).

Another determinant included in the study is the wealth index of the household, and the estimation shows an insignificant linkage between C-section delivery and the family wealth

index. This result is not in agreement with other studies that have revealed that mothers from wealthy families were more likely to use C-section delivery than mothers from low-income families. In the Middle East and North African countries, researchers have reported that C-section use was highest among mothers in the richest households compared to the poorest households (11). The last determinant was maternal age, and the findings showed a heterogeneous pattern of association with cesarean section delivery across the study countries. This result is consistent with several studies in different regions, in South and South-East Asia by Verma et al. (14), and in sub-Saharan African countries (10).

In a general context, some reviews have been reported over the past two decades concerning the different strategies in an attempt to master or reduce the CS rates; these strategies cover psychological, clinical, and structural axes (25). We also argue that working to provide a supportive, secure environment for mothers can potentially rationalize the spike in "unnecessary" surgical deliveries. At the same level of perspective, some specific analyses such as the Robson Ten Group Classification tool can help policymakers (stakeholders) reduce unnecessary C-section (26).

The strength of this study is that we focused on a specific region and developed a national study for the first time. However, the limitations of the current work are mainly because the current study was limited to countries with available MICS datasets. Furthermore, the MICS survey methodology does not adequately cover the obstetric history of women, which generates a lack of several variables. In this line, we suggest that the upcoming rounds of the MICS surveys include a new axis in the questionnaire that encounters if the caesarean sections were done by the mother request or by the medical team.

5 Conclusions

Summing up the results, it can be concluded that we are faced with a dynamic and exceptional pattern of association between the C-section rates and the different socioeconomic (wealth's index, level of education) and geographic (urban vs. rural) variables of households and mothers. Policymakers in these countries should implement national and central strategies covering all areas and target all social categories without exception. These strategies must focus on the ultimate objective of containing and reducing the upward trend in C-section rates in these countries.

CONFLICTS OF INTEREST

The authors declare that no conflicts of interest exist.

FUNDING

This study was carried out without external funding.

ETHICAL APPROVAL

As the data used were publicly available on the UNICEf-MICS website (https://mics.unicef.org/), where the surveys were fully anonymous, ethical approval by a research ethics committee was not needed.

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