

Article

Trends in caesarean births and socioeconomic and geographic inequalities in Pakistan: a comparative analysis of South Asia

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Abstract: Caesarean section (CS) is a life-saving procedure when medically indicated; however, its increasing use has raised concerns about potential overuse and inequitable access across socioeconomic and geographic groups, particularly in low- and middle-income countries. This study examined trends in CS prevalence and associated socioeconomic and geographic inequalities in Pakistan, with comparisons across South Asian countries. Demographic and Health Survey data from Pakistan (2006, 2012, and 2017) and selected South Asian countries were analysed using the World Health Organization's Health Equity Assessment Toolkit (HEAT). Inequalities were assessed by wealth quintile, educational attainment, place of residence, and subnational region using four summary measures: Difference (D), Ratio (R), Population Attributable Risk (PAR), and Population Attributable Fraction (PAF). Estimates were reported with 95% confidence intervals (CIs). In Pakistan, CS prevalence increased from 8.70% in 2006 to 24.40% in 2017. In 2017, prevalence was substantially higher among women in the richest wealth quintile (46.10%) than among those in the poorest quintile (10.00%), and among women with higher education (51.10%) than among those with no education (12.50%). Urban women had a higher prevalence than rural women (34.90% vs. 19.40%). Punjab recorded the highest provincial prevalence (31.80%), whereas Balochistan recorded the lowest (4.20%). Absolute inequalities increased over time, although relative inequalities declined for wealth, education, and place of residence. Cross-country comparisons showed that Bangladesh had the highest CS prevalence among women in the richest wealth quintile (61.30%), urban women (43.70%), and women with higher education (59.40%), while prevalence and inequality patterns varied across the countries examined. CS prevalence increased substantially in Pakistan between 2006 and 2017, with persistent socioeconomic and geographic inequalities. Policies should promote equitable access to medically indicated CS while strengthening clinical oversight to identify and reduce potentially unnecessary procedures. Addressing both underuse and potential overuse is essential to improving maternal healthcare equity.

Keywords: caesarean section; socioeconomic inequalities; geographic disparities; maternal health; health equity

1. Introduction

Caesarean section (CS) is a frequently performed surgical procedure that is essential for managing complications during childbirth. When medically indicated, it can significantly reduce maternal and neonatal morbidity and mortality (Molina *et al.*, 2015). However, although CS is a life-saving intervention when necessary, its increasing use without clear medical indications can lead to short- and long-term complications for women and infants (Larsson *et al.*, 2021). These complications include increased maternal morbidity, uterine rupture, abnormal placentation, bowel obstruction, incisional hernias, and chronic abdominal pain, particularly among women with multiple CS deliveries, obesity, or smoking habits (Sandall *et al.*, 2018; Larsson *et al.*, 2021). Babies born via CS may also experience altered immune development, higher rates of allergies and asthma, and changes in their gut microbiome, some of which may persist into childhood (Sandall *et al.*, 2018).

In 1985, the World Health Organization (WHO) established a guideline suggesting that the CS rate (CSR) should ideally not exceed 10–15% at the population level (Betrán *et al.*, 2015). Nevertheless, the global prevalence of CS has increased substantially, with considerable variations across countries and healthcare systems attributable to medical, institutional, and socioeconomic factors (Thomaidi *et al.*, 2025). In high-income countries, reported CSRs include 30.3% in the United States, 22% in the United Kingdom, 26% in Canada, 19% in France, 28% in Germany, and 30% in Australia (Amjad *et al.*, 2018). Increasing trends have also been observed in low- and middle-income countries (LMICs). For example, CSR increased from 2% in 2000 to 17% in 2011 in Bangladesh, from 3% in 1992 to 11% in 2006 in India, and from 1% in 2000 to 5% in 2011 in Nepal (Neuman *et al.*, 2014). In Sri Lanka, CSR increased from 9% in 1986 to 39.1% in 2018, while Vietnam experienced an increase from 3.4% in 1994 to 27.5% in 2014 (Betrán *et al.*, 2021; Ekanayake *et al.*, 2021). Pakistan has also experienced a substantial increase in CS deliveries over recent decades. Studies conducted in different regions of Pakistan have reported CSRs of approximately 16–20%, while another study found that 13.6% of women who had given birth during the preceding five years had undergone CS (Qazi *et al.*, 2013; Betrán *et al.*, 2015).

The increasing prevalence of CS presents a dual public health challenge: preventing unnecessary surgical interventions among populations with high utilization while ensuring timely access to medically necessary CS among disadvantaged women. The determinants of increasing CS utilization are multifaceted, encompassing clinical indications, healthcare provider practices, financial incentives, maternal preferences, and socioeconomic circumstances (Thomaidi *et al.*, 2025). Financial incentives may encourage healthcare providers to perform surgical interventions, while women from higher socioeconomic backgrounds may have greater access to antenatal care and may be more likely to choose CS delivery (Milcent and Zbiri, 2018). Clinical and sociocultural factors also contribute to higher CSR in urban settings, where the perception of CS as a safer and more controlled mode of delivery may influence maternal preferences (Giang *et al.*, 2022).

Furthermore, obstetricians may perceive CS deliveries as easier to schedule and more efficient to perform than vaginal births. Financial incentives and potential gaps in training for vaginal delivery procedures may also influence clinical decision-making (Panda *et al.*, 2018). In well-resourced healthcare systems, elective CS may be influenced by healthcare professionals' preferences, hospital policies, maternal requests, financial incentives, liability concerns, and access to advanced medical resources, particularly in private healthcare institutions (Amjad *et al.*, 2018).

In Bangladesh, although only 21% of births occurred in healthcare facilities in one study, approximately half of these births took place in private or charitable institutions, where 73% of deliveries were performed by CS (Qazi *et al.*, 2013). Similarly, a significantly higher proportion of women delivered by CS in private hospitals than in public hospitals in Vietnam (Giang *et al.*, 2022). An analysis of Demographic and Health Survey (DHS) data from 26 countries in South Asia and sub-Saharan Africa found that CSRs were highest among urban and affluent populations across the countries studied, whereas rural and impoverished populations had the lowest rates in 18 countries (Betrán *et al.*, 2007). Educational attainment also appears to influence CS utilization, as highly educated women were more likely to undergo CS in private healthcare facilities in both urban India and rural Bangladesh (Neuman *et al.*, 2014). In Pakistan, substantial socioeconomic inequalities in maternal healthcare have been reported (Afridi *et al.*, 2025). Urban areas, including Islamabad, have generally reported higher CSRs, reflecting better healthcare access and higher socioeconomic status, whereas poor and rural households have experienced lower utilization because of poverty and inadequate healthcare infrastructure (Mumtaz *et al.*, 2017). Limited obstetric services and shortages of skilled birth attendants in rural and economically disadvantaged areas may further exacerbate these inequalities (Mumtaz *et al.*, 2017). Despite this evidence, the coexistence of potentially excessive CS utilization among advantaged women and insufficient access among disadvantaged women remains an important concern for maternal healthcare planning in Pakistan and the wider South Asian region.

Despite previous research on cesarean section (CS) prevalence and its determinants, evidence remains limited on the temporal changes in socioeconomic and geographical inequalities in Pakistan and their comparison with other South Asian countries. Although previous studies examined CS trends in Pakistan from 1990 to 2013 (Mumtaz *et al.*, 2017), updated comparative assessments using standardized absolute and relative inequality measures are needed. The World Health Organization's Health Equity Assessment Toolkit (HEAT) provides a systematic framework for assessing such inequalities (Kirkby *et al.*, 2022).

The study addressed two research questions: How did CS prevalence and socioeconomic and geographical inequalities change in Pakistan between 2006 and 2017? How did these patterns compare with those in selected countries in South Asia? This study hypothesized that CS prevalence increased in Pakistan between 2006 and 2017, with persistent inequalities favoring wealthier, more educated, and urban women and those in more advantaged regions. It also hypothesized that inequality patterns would differ across South Asian countries because of variations in socioeconomic conditions and healthcare access. Accordingly, the study assessed temporal trends and inequalities across wealth quintiles, educational levels, residence, and subnational regions using the WHO HEAT framework. Absolute and relative measures, including Difference (D), Ratio (R), Population Attributable Risk (PAR), and Population Attributable Fraction (PAF), were used to provide a comprehensive assessment. The study's novelty lies in combining temporal and cross-country comparisons of CS inequalities using standardized measures. The findings may help policymakers identify populations facing barriers to medically necessary CS and areas where high utilization warrants further assessment, supporting more equitable maternal healthcare and progress towards the Sustainable Development Goals (SDGs).

2. Materials and Methods

2.1. Ethical approval

This study used publicly accessible, de-identified secondary data obtained through the World Health Organization's (WHO) HEAT (<https://whoequity.shinyapps.io/heat>). As the analysis involved no direct contact with participants and no access to identifiable personal information, additional ethical approval was not sought. The original surveys were conducted under the ethical procedures applicable in the participating countries.

2.2. Study design and setting

This study employed a cross-sectional comparative analysis of repeated survey data to examine trends in CS prevalence and socioeconomic and geographic inequalities in Pakistan between 2006 and 2017. Data were retrieved from HEAT, a WHO-developed software application designed to explore, analyse, and report health inequalities using standardized indicators and summary measures (Hosseinpour *et al.*, 2016). The analysis primarily used data from Demographic and Health Surveys (DHS), which are nationally representative household surveys implemented in low- and middle-income countries under the international DHS programme. HEAT provides a platform for analysing and comparing health indicators across population subgroups and countries.

2.3. Sampling and country selection

The Pakistan Demographic and Health Survey (PDHS) used a two-stage stratified cluster sampling design. In the first stage, enumeration areas were selected across the country based on the sampling frame derived from the population census. These areas served as primary sampling units. In the second stage, households were systematically selected from the sampled enumeration areas for participation in the survey. Further details of the sampling design are available in the relevant PDHS report (Siddiqi *et al.*, 2022). For the comparative analysis, Pakistan was examined alongside Bangladesh, India, Sri Lanka, and Nepal using HEAT. These countries were selected based on their geographic proximity to Pakistan and the availability of relevant survey data for comparison. Afghanistan was excluded because suitable recent data were unavailable for the study period (Figure 1).

2.4. Outcome variable

The outcome variable was the use of CS for the most recent delivery within the two to three years preceding each survey. The variable was dichotomous, with responses classified as "yes" if the woman's most recent delivery was by CS and "no" otherwise. These responses were coded as 1 and 0, respectively.

2.5. Equity dimensions

Four equity dimensions were examined to assess inequalities in CS use: household wealth, educational attainment, place of residence, and subnational region. Household wealth was categorized into five quintiles:

poorest, poorer, middle, richer, and richest. These quintiles were derived from a composite wealth index constructed using principal component analysis (PCA) based on household asset indicators (Budu *et al.*, 2022). Educational attainment was classified into four categories: no schooling, primary education, secondary education, and higher education (Hosseinpoor *et al.*, 2016). Place of residence was categorized as urban or rural. In Pakistan, subnational comparisons were conducted across four provinces: Sindh, Punjab, Balochistan, and Khyber Pakhtunkhwa (KPK), formerly known as the North-West Frontier Province (NWFP). For the cross-country comparative analysis, the same four equity dimensions—wealth quintile, educational attainment, place of residence, and subnational region—were examined using the most recent available data in the WHO HEAT. Comparisons were conducted among different countries in the South Asia.



Figure 1. Geographic distribution of the South Asian countries included in the comparative analysis.

2.6. Statistical analysis

Inequalities in CS use were assessed using the WHO's HEAT, following the methodological guidance described by Hosseinpoor *et al.* (2016) and Schlottheuber and Hosseinpoor (2022). CS prevalence was estimated across survey years and population subgroups, with corresponding 95% confidence intervals (CIs). The estimated annual percentage change (EAPC) was used to characterize the average annual change in CS prevalence over the study period. EAPC was estimated using a linear regression-based approach, following Hankey *et al.* (2000). Four summary measures were used to quantify inequality, including D, R, PAR, and PAF. D and R were treated as simple measures, whereas PAR and PAF were treated as complex measures that account for the population distribution across subgroups. D and PAR measure absolute inequality, while R and PAF measure relative inequality. These measures were selected because they can be applied to both ordered and non-ordered equity dimensions and provide complementary information on the magnitude and distribution of inequalities (Schlottheuber and Hosseinpoor, 2022). Their use was also consistent with WHO guidance recommending the complementary interpretation of absolute and relative measures to support policy-relevant assessments of health inequality (Hosseinpoor *et al.*, 2016; Thomaidei *et al.*, 2025). Detailed methodological descriptions and calculation procedures for these measures are provided in the WHO technical guidance (Hosseinpoor *et al.*, 2016; Schlottheuber and Hosseinpoor, 2022).

For ordered dimensions, such as household wealth and educational attainment, D and R were calculated by comparing the extreme categories. D quantified the absolute difference in CS prevalence between the highest and lowest categories, while R quantified the ratio of prevalence between these categories. For example, for

wealth, the prevalence in the richest quintile was compared with that in the poorest quintile; for education, the prevalence among women with higher education was compared with that among women with no schooling. For non-ordered dimensions, such as place of residence and subnational region, the groups with the highest and lowest observed CS prevalence were used to calculate D and R. D represented the absolute difference between the highest and lowest prevalence, whereas R represented the ratio of the highest prevalence to the lowest prevalence (Ahinkorah *et al.*, 2021). The direction and magnitude of inequality were interpreted in relation to the distribution of CS use across population subgroups and the groups experiencing the highest or lowest prevalence.

3. Results

3.1. Temporal trends in caesarean section prevalence across socioeconomic and geographic subgroups in Pakistan

The overall prevalence of CS in Pakistan increased from 8.70% in 2006 to 15.90% in 2012 and 24.40% in 2017. This increase was observed across all wealth quintiles, educational categories, and residential settings, although the magnitude of change varied among subgroups (Table 1). CS prevalence increased across all wealth quintiles between 2006 and 2017, with consistently higher prevalence among wealthier women. Among women in the poorest quintile, prevalence increased from 1.80% in 2006 to 5.20% in 2012 and 10.00% in 2017. The corresponding estimates for the richest quintile were 23.40%, 36.20%, and 46.10%, respectively. Thus, although CS use increased substantially among women in every wealth group, prevalence remained markedly higher among the wealthiest women throughout the study period. A pronounced educational gradient was also evident. Among women with no formal education, CS prevalence increased from 4.10% in 2006 to 7.70% in 2012 and 12.50% in 2017. In comparison, prevalence among women with higher education rose from 30.50% to 40.00% and 51.10% over the same years. Women with primary and secondary education also experienced increases, reaching 21.60% and 36.50%, respectively, in 2017. CS prevalence was consistently higher among urban than rural residents. In rural areas, prevalence increased from 5.90% in 2006 to 11.80% in 2012 and 19.40% in 2017. Among urban residents, the corresponding estimates were 15.30%, 25.80%, and 34.90%. Although prevalence increased in both settings, the urban–rural disparity persisted throughout the study period. CS prevalence varied considerably across Pakistan’s provinces. Punjab had the highest prevalence among the four provinces in each survey year, increasing from 10.70% in 2006 to 19.50% in 2012 and 31.80% in 2017. In Sindh, prevalence rose from 8.10% to 16.90% and 25.80%, respectively. Khyber Pakhtunkhwa recorded lower estimates of 4.10%, 4.70%, and 8.00%, while Balochistan had the lowest prevalence in 2006 and 2017, at 1.60% and 4.20%, respectively. In Balochistan, prevalence declined slightly to 1.30% in 2012 before increasing in 2017. Additional estimates were available for selected regions in individual survey years: prevalence was 3.90% (95% CI: 1.70–8.70) in Gilgit-Baltistan and 26.90% (95% CI: 21.70–32.70) in Islamabad in 2012. In 2017, prevalence was 3.10% (95% CI: 1.50–6.20) in the Federally Administered Tribal Areas (FATA) and 31.90% (95% CI: 26.80–37.50) in Islamabad.

Table 1. Trends in caesarean section prevalence across wealth, educational, residential, and subnational groups in Pakistan, 2006–2017.

Inequality dimension	Year						EAPC estimate (95% CI)
	2006		2012		2017		
	n	Estimate (95% CI)	n	Estimate (95% CI)	n	Estimate (95% CI)	
Wealth quintiles							
Poorest	2153	1.8 (1.1-3.1)	2864	5.2 (3.8-7.2)	2382	10.0 (7.2-13.7)	16.95 (13.98- 20)
Poorer	1925	2.3 (1.4-3.7)	2535	8.9 (6.4-12.0)	2104	12.1 (9.4–15.4)	16.58 (6.35 - 27.79)
Middle	1829	6.6 (4.9–8.9)	2346	12.7 (9.9–16.1)	2178	21.5 (17.7–25.9)	11.34 (11.1 - 11.58)
Richer	1651	13.0 (10.5-16.0)	2349	22.7 (19.6–26.0)	2001	35.7 (31.5–40.3)	9.62 (9.48 - 9.77)
Richest	1563	23.4 (19.9–27.5)	1883	36.2 (31.0-41.8)	1830	46.1 (41.6-50.7)	6.4 (4.96 - 7.86)
Educational level							
No education	5986	4.1 (3.3-5.0)	6852	7.7 (6.4-9.2)	5178	12.5 (10.3-15.0)	10.68 (10.18 - 11.18)
Primary education	1354	9.8 (7.4-13.0)	2039	17.6 (14.5-21.2)	1746	21.6 (17.8-25.9)	7.54 (4.19 - 11)
Secondary education	1260	19.3 (15.7-23.6)	2114	26.9 (23.6-30.4)	2251	36.5 (32.1-41.2)	5.95 (5.62 - 6.29)
Higher education	522	30.5 (24.4-37.5)	973	40.0 (34.5-45.8)	1319	51.1 (46.0-56.3)	4.8 (4.58 - 5.02)

Table 1. Contd.

Inequality dimension	Year						EAPC estimate (95% CI)
	2006		2012		2017		
	n	Estimate (95% CI)	n	Estimate (95% CI)	n	Estimate (95% CI)	
Place of residence							
Rural	6422	5.9 (4.9-7.0)	8488	11.8 (10.2-13.7)	7143	19.4 (16.5-22.6)	11.46 (10.46 - 12.46)
Urban	2699	15.3 (13.3-17.5)	3489	25.8 (22.5-29.5)	3351	34.9 (31.5-38.5)	7.83 (6.23 - 9.45)
Subnational region							
Balochistan	400	1.6 (0.7-3.6)	590	1.3 (0.6-2.9)	572	4.2 (2.6-6.6)	8.73 (-6.47 to 26.4)
Khyber Pakhtunkhwa	1312	4.1 (2.8-5.9)	1654	4.7 (3.6-6.2)	1684	8.0 (4.9-12.7)	6.13 (1.28 to 11.22)
Sindh	2284	8.1 (6.5-10.0)	2740	16.9 (14.6-19.5)	2420	25.8 (22.6-29.4)	11.17 (8.83 to 13.56)
Punjab	5125	10.7 (9.3-12.3)	6859	19.5 (16.9-22.4)	5492	31.8 (27.8-36.0)	10.41 (10.28 to 10.55)
Overall trend							
Overall prevalence	9121	8.7	11977	15.9	10494	24.4	9.85 (8.94 to 10.77)

*CS=caesarean section; CI=confidence interval; EAPC= estimated annual percentage change; NWFP=Khyber Pakhtunkhwa (KPK) formerly known as North-West Frontier Province.

3.2. Estimated annual percentage change (EAPC) in caesarean section prevalence

The EAPC indicated an overall annual increase of 9.85% in CS prevalence between 2006 and 2017 (Table 1). The magnitude of this change varied across socioeconomic and geographic subgroups, with larger estimated annual increases generally observed among groups with lower baseline prevalence.

By wealth quintile, the EAPC was highest among women in the poorest quintile at 16.95% (95% CI: 13.98–20.00), followed by those in the poorer quintile at 16.58% (95% CI: 6.35–27.79). The EAPC declined progressively across the middle, richer, and richest quintiles, with estimates of 11.34%, 9.62%, and 6.40%, respectively. A similar pattern was observed across educational categories: women with no formal education had an EAPC of 10.68% (95% CI: 10.18–11.18), compared with 7.54% among women with primary education, 5.95% among those with secondary education, and 4.80% among those with higher education.

Differences were also apparent by place of residence. Rural residents had a higher EAPC of 11.46% (95% CI: 10.46–12.46) than urban residents, whose EAPC was 7.83% (95% CI: 6.23–9.45). Across the four provinces, the estimated annual increase was highest in Sindh at 11.17% (95% CI: 8.83–13.56), followed by Punjab at 10.41% (95% CI: 10.28–10.55). The corresponding estimates were 8.73% for Balochistan (95% CI: –6.47–26.40) and 6.13% for Khyber Pakhtunkhwa (95% CI: 1.28–11.22). The confidence interval for Balochistan included zero, indicating that its estimated annual change was not statistically distinguishable from zero at the conventional 5% significance level.

3.3. Socioeconomic and geographic inequalities in caesarean section prevalence in Pakistan

Substantial socioeconomic and geographic inequalities in CS prevalence were observed across wealth quintiles, educational levels, place of residence, and subnational regions (Table 2). The inequality measures indicated persistent disparities, although their magnitude and temporal patterns varied across dimensions. Absolute inequality was assessed using the D and PAR, whereas relative inequality was assessed using the R and PAF. Wealth-related relative inequality declined between 2006 and 2017, although the absolute prevalence difference increased. The ratio of CS prevalence between the richest and poorest wealth quintiles decreased from 12.90 (95% CI: 7.40–22.40) in 2006 to 6.90 (95% CI: 4.90–9.80) in 2012 and 4.60 (95% CI: 3.30–6.40) in 2017. In contrast, the absolute difference in prevalence increased from 21.60 percentage points (95% CI: 17.70–25.60) in 2006 to 31.00 percentage points (95% CI: 25.30–36.60) in 2012 and 36.10 percentage points (95% CI: 30.60–41.70) in 2017. The PAF declined from 168.50 (95% CI: 168.20–168.70) to 89.10 (95% CI: 89.00–89.20), whereas the PAR increased from 14.70 percentage points (95% CI: 12.60–16.80) to 21.70 percentage points (95% CI: 19.20–24.30).

Educational inequalities remained pronounced throughout the study period. The ratio of CS prevalence between women with higher education and those with no formal education declined from 7.50 (95% CI: 5.60–10.10) in 2006 to 5.20 (95% CI: 4.10–6.50) in 2012 and 4.10 (95% CI: 3.30–5.10) in 2017. However, the absolute difference increased from 26.50 percentage points (95% CI: 19.90–33.10) in 2006 to 38.70 percentage points (95% CI: 33.00–44.30) in 2017. Similarly, the PAF decreased from 249.80 (95% CI: 249.20–250.30) to 109.80 (95% CI: 109.60–109.90), while the PAR rose from 21.80 percentage points (95% CI: 17.10–26.50) to 26.80

percentage points (95% CI: 23.60–29.90). Thus, the relative inequality associated with educational attainment declined, but the absolute prevalence difference between the highest and lowest educational groups increased.

CS prevalence remained higher among urban than rural residents, although the relative disparity narrowed over time. The prevalence ratio declined from 2.60 (95% CI: 2.10–3.30) in 2006 to 2.20 (95% CI: 1.80–2.70) in 2012 and 1.80 (95% CI: 1.50–2.20) in 2017. Conversely, the absolute difference increased from 9.40 percentage points (95% CI: 7.10–11.70) to 15.50 percentage points (95% CI: 10.90–20.20) over the same period. The PAF decreased from 75.10 (95% CI: 74.90–75.20) in 2006 to 43.20 (95% CI: 43.10–43.20) in 2017, whereas the PAR increased from 6.60 percentage points (95% CI: 5.30–7.80) to 10.50 percentage points (95% CI: 8.90–12.10). These results demonstrate a narrowing relative urban–rural disparity alongside a widening absolute difference in CS prevalence.

Geographic inequalities across Pakistan’s provinces varied considerably over time. The absolute difference in CS prevalence between the provinces with the highest and lowest prevalence increased from 9.20 percentage points (95% CI: 7.20–11.10) in 2006 to 25.50 percentage points (95% CI: 19.90–31.10) in 2012 and 28.80 percentage points (95% CI: 23.00–34.60) in 2017. The corresponding prevalence ratio increased from 6.80 (95% CI: 3.00–15.80) in 2006 to 20.10 (95% CI: 9.10–44.10) in 2012, before declining to 10.20 (95% CI: 5.00–20.90) in 2017. The PAF rose from 22.80 (95% CI: 22.70–22.90) in 2006 to 68.90 (95% CI: 67.90–70.00) in 2012, then declined to 30.80 (95% CI: 30.30–31.40) in 2017. Similarly, the PAR increased from 2.00 percentage points (95% CI: 1.40–2.60) to 11.00 percentage points (95% CI: 5.50–27.40) between 2006 and 2012, before decreasing to 7.50 percentage points (95% CI: 5.40–20.50) in 2017.

Table 2. Absolute and relative inequality in caesarean section prevalence across socioeconomic and geographic dimensions in Pakistan, 2006–2017.

Inequality dimension (summary measure)	Year					
	2006		2012		2017	
	Estimate	(95% CI)	Estimate	(95% CI)	Estimate	(95% CI)
Wealth quintile						
D	21.60	17.70-25.60	31.00	25.30-36.60	36.10	30.60-41.70
R	12.90	7.40-22.40	6.90	4.90-9.8	4.60	3.30-6.40
PAF	168.50	168.20-168.70	127.80	127.70-128	89.10	89.00-89.20
PAR	14.70	12.60-16.80	20.30	17.90-22.8	21.70	19.20-24.30
Level of education (4 groups)						
D	26.50	19.90- 33.10	32.30	26.5-38.1	38.70	33.00-44.30
R	7.50	5.60-10.10	5.20	4.1-6.50	4.10	3.30-5.10
PAF	249.80	249.20-250.30	151.50	151.3-151.80	109.80	109.60-109.90
PAR	21.80	17.10-26.50	24.10	20.5-27.70	26.80	23.60-29.90
Place of residence						
D	9.40	7.10-11.70	14.00	10.1-18.0	15.50	10.9-20.20
R	2.60	2.10-3.30	2.20	1.8-2.70	1.80	1.5-2.20
PAF	75.10	74.90-75.20	62.60	62.5-62.70	43.20	43.1-43.20
PAR	6.60	5.30-7.80	10.00	8.5-11.40	10.50	8.9-12.10
Sub-national region						
D	9.20	7.20-11.10	25.50	19.90-31.10	28.80	23.00-34.60
R	6.80	3.00-15.80	20.10	9.10-44.10	10.20	5.0-20.90
PAF	22.80	22.70-22.90	68.90	67.90-70.00	30.80	30.3-31.40
PAR	2.00	1.40-2.60	11.00	5.50-27.40	7.50	5.4-20.50

*D=Difference; R=Ratio; PAF= population attributable fraction, PAR= population attributable risk; CI=confidence interval. D and PAR represent absolute measures, whereas R and PAF represent relative measures.

3.4. Comparative analysis of caesarean section prevalence across Pakistan and other South Asian countries

Using the World Health Organization’s Health Equity Assessment Toolkit (HEAT), Pakistan was selected as the benchmark country to compare caesarean section (CS) prevalence across socioeconomic and geographic subgroups in South Asia (Figure 2). The comparison revealed substantial cross-country variation in CS prevalence and persistent inequalities associated with household wealth, place of residence, and educational attainment.

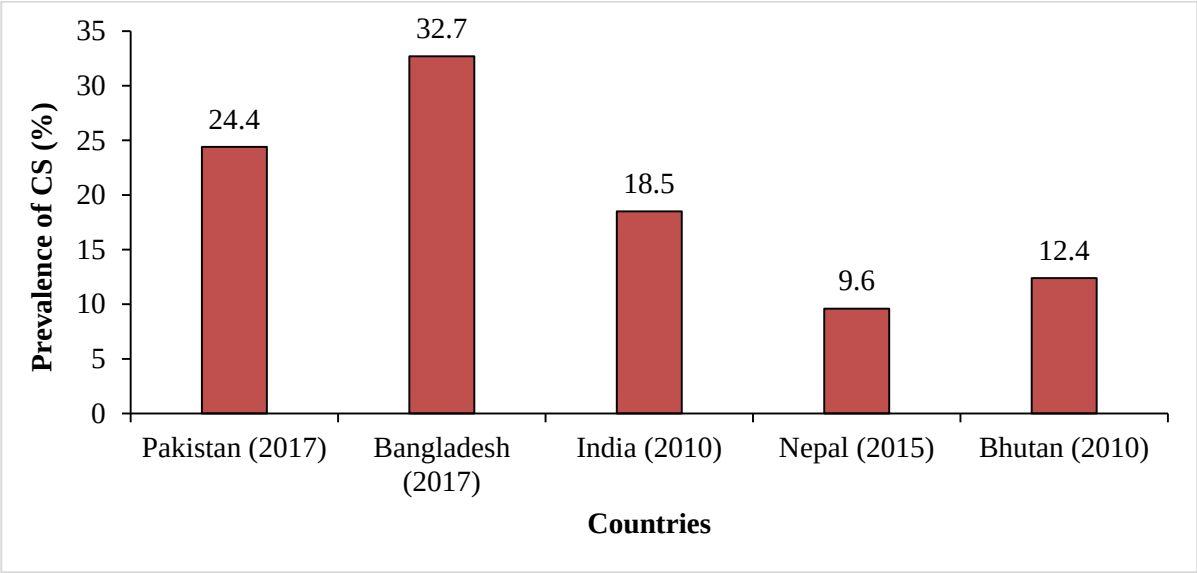


Figure 2. Overall prevalence of caesarean section in Pakistan compared with other South Asian countries.

Wealth-related differences were evident in all five countries. Bangladesh recorded the highest CS prevalence among women in the richest wealth quintile (61.30%), followed by Pakistan (46.10%), India (37.80%), Nepal (28.40%), and Bhutan (20.40%). In contrast, prevalence among the poorest quintile ranged from 2.20% in Nepal to 13.00% in Bangladesh, with Pakistan at 10.00%, Bhutan at 7.30%, and India at 5.00%.

Urban–rural differences were also observed across all five countries. Bangladesh had the highest prevalence in both urban (43.70%) and rural populations (28.70%), followed by Pakistan (34.90% and 19.40%, respectively) and India (30.20% and 14.00%, respectively). The corresponding prevalence was lower in Bhutan, at 18.20% among urban residents and 10.10% among rural residents, and in Nepal, at 12.00% and 6.80%, respectively. The absolute urban–rural differences were 15.00 percentage points in Bangladesh, 15.50 in Pakistan, 16.20 in India, 8.10 in Bhutan, and 5.20 in Nepal. Thus, India showed the largest absolute urban–rural difference, closely followed by Pakistan and Bangladesh.

Educational inequalities followed a similar pattern in most countries, with higher CS prevalence among women with greater educational attainment. Among women with higher education, prevalence was highest in Bangladesh (59.40%), followed by Pakistan (51.10%), India (40.10%), Nepal (24.50%), and Bhutan (18.70%). Among women with no formal education, the corresponding estimates were 16.40%, 12.50%, 6.40%, 5.50%, and 10.70%, respectively. The difference between women with higher education and those with no education was therefore greatest in Bangladesh and Pakistan. Bhutan showed a less pronounced educational gradient, while its estimate for women with higher education had a wide 95% confidence interval (9.20–34.20%), indicating considerable uncertainty (Table 3).

Table 3. Prevalence of caesarean section across wealth, place of residence, and educational attainment in Pakistan and other South Asian countries.

Inequality dimensions	Pakistan (2017)	Bangladesh (2017)	India (2015)	Nepal (2016)	Bhutan (2010)
	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)
Wealth quintile					
Poorest	10 (7.2-13.7)	13 (10.6-15.9)	5 (4.7-5.3)	2.2 (1.3-3.7)	7.3 (4.9-10.7)
Poorer	12.1 (9.4-15.4)	22.3 (19.3-25.7)	10.6 (10.1-11.2)	4.1 (2.5-6.7)	8.1 (5.9-11.0)
Middle	21.5 (17.7-25.9)	30.8 (27.3-34.5)	20.5 (9.7-21.3)	8.1 (5.4-12.1)	12.3 (9.3-16.0)
Richer	35.7 (31.5-40.3)	38.1 (34.6-41.7)	28.6 (27.6-29.5)	10.9 (8.2 -14.5)	14.1 (10.8-18.2)
Richest	46.1 (41.6-50.7)	61.3 (57.7-64.8)	37.8 (36.6-39.0)	28.4 (22.0-35.8)	20.4 (16.5-25)
Place of residence					
Rural	19.4 (16.5-22.6)	28.7 (26.4-31.1)	14.0 (13.7-14.4)	6.8 (4.9-9.2)	10.1 (8.5-11.9)
Urban	34.9 (31.1-38.5)	43.7 (40.6-46.9)	30.2 (29.2-31.1)	12.0 (9.8-14.6)	18.2 (14.6-22.4)

Table 3. Contd.

Inequality dimensions	Pakistan (2017)	Bangladesh (2017)	India (2015)	Nepal (2016)	Bhutan (2010)
	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)
Level of education					
No education	12.5 (10.3-15.0)	16.4 (12.2-21.8)	6.4 (6.0-6.8)	5.5 (3.6-8.4)	10.7 (8.9-12.8)
Primary	21.6 (17.8-25.9)	17.9 (15.5-20.6)	12.1 (11.3-13.1)	6.3 (4.4-9.0)	12.8 (9.1-17.9)
Secondary	36.5 (32.1-41.2)	34.0 (31.6-36.5)	22.4 (21.8-22.9)	8.6 (6.5-11.2)	16.5 (12.9-20.9)
Higher	51.1 (46.0-56.3)	59.4 (55.5-63.2)	40.1 (38.8-41.4)	24.5 (19.6-30.2)	18.7 (9.2-34.2)

*CI=confidence interval.

3.5. Comparison of socioeconomic and geographic inequalities in caesarean section prevalence across South Asian countries

The magnitude and pattern of inequalities in CS prevalence varied across South Asian countries and socioeconomic dimensions (Table 4). Wealth-related inequalities were greatest in Bangladesh in absolute terms, with a D value of 48.30 (95% CI: 43.90–52.70), followed by India at 32.80 (95% CI: 31.60–34.00) and Pakistan at 36.10 (95% CI: 30.60–41.70). However, the relative inequality measure (R) was highest in Nepal at 13.00 (95% CI: 7.30–23.00), followed by India at 7.60 (95% CI: 7.00–8.10). Bhutan showed the smallest absolute and relative wealth-related inequalities, with D and R values of 13.10 (95% CI: 8.10–18.20) and 2.80 (95% CI: 1.80–4.30), respectively. These findings indicate that the ranking of countries differed depending on whether inequality was assessed on an absolute or relative scale.

Educational inequalities were most pronounced in absolute terms in Bangladesh, where D was 43.00 (95% CI: 36.90–49.10), followed by Pakistan at 38.70 (95% CI: 33.00–44.30) and India at 33.70 (95% CI: 32.30–35.10). India had the highest relative inequality by education, with an R value of 6.30 (95% CI: 5.90–6.70), followed by Nepal at 4.50 (95% CI: 2.80–7.20) and Pakistan at 4.10 (95% CI: 3.30–5.10). Bhutan showed the smallest educational inequalities, with D and R values of 8.00 (95% CI: 4.50–20.50) and 1.80 (95% CI: 0.90–3.50), respectively. Overall, the results indicate that educational inequalities in CS prevalence differed substantially between countries, with larger absolute gaps in Bangladesh and Pakistan and larger relative inequality in India.

Geographic inequalities also varied considerably. India had the largest absolute subnational disparity, with a D value of 51.80 (95% CI: 48.20–55.40), substantially exceeding the estimates for Pakistan (28.80; 95% CI: 23.00–34.60), Bangladesh (20.10; 95% CI: 12.80–27.40), Bhutan (18.40; 95% CI: 8.50–28.30), and Nepal (15.70; 95% CI: 9.50–21.90). Relative regional inequality was also high in India, with an R value of 8.40 (95% CI: 7.00–10.20), while Bangladesh had the lowest value at 1.90 (95% CI: 1.50–2.40). Pakistan showed a relatively high regional R value of 10.20 (95% CI: 5.00–20.90), although its confidence interval was wide, indicating uncertainty in the estimate.

Urban–rural inequalities were greatest in India in absolute terms, with a D value of 16.10 (95% CI: 15.10–17.20), followed by Pakistan at 15.50 (95% CI: 10.90–20.20) and Bangladesh at 15.00 (95% CI: 11.10–18.90). India also had the highest relative urban–rural inequality, with an R value of 2.10 (95% CI: 2.10–2.20). Bangladesh had the lowest relative estimate at 1.50 (95% CI: 1.40–1.70), while Pakistan, Nepal, and Bhutan each had an R value of 1.80, although the confidence intervals differed. The absolute urban–rural gaps were smaller in Nepal and Bhutan than in the other countries.

The PAF and PAR estimates also varied across countries and inequality dimensions. The highest reported PAF values occurred for subnational regional inequality in India (272.70; 95% CI: 272.50–272.90) and wealth-related inequality in Nepal (197.60; 95% CI: 197.30–198.00). India also had a high education-related PAF of 116.70 (95% CI: 116.70–116.70). The largest PAR estimates included wealth-related inequality in Bangladesh (28.60; 95% CI: 25.70–31.40) and education-related inequality in Pakistan (26.80; 95% CI: 23.60–29.90). These estimates should be interpreted according to the definitions and scales used by HEAT, particularly because some PAF values exceed 100.00.

Table 4. Comparative analysis of absolute and relative inequalities in caesarean section prevalence across South Asian countries.

Inequality dimensions (summary measures)	Pakistan (2017)	Bangladesh (2017)	India (2015)	Nepal (2016)	Bhutan (2010)
	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)	Estimate (95% CI)
Wealth quintile					
D	36.1 (30.6-41.7)	48.3 (43.9-52.7)	32.8 (31.6-34.0)	26.2 (19.2-33.2)	13.1 (8.1-18.2)
R	4.6 (3.3-6.4)	4.7 (3.8-5.8)	7.6 (7.0-8.1)	13 (7.3-23.0)	2.8 (1.8-4.3)
PAF	89.1(89.0-89.2)	87.3 (87.2-87.4)	104.3 (104.2-104.3)	197.6 (197.3-198.0)	64.0 (63.8-64.3)
PAR	21.7 (19.2-24.3)	28.6 (25.7-31.4)	19.3(18.7-19.9)	18.9(15.4-22.4)	8.0 (4.8-11.1)
Place of residence					
D	15.5 (10.9-20.2)	15.0 (11.1-18.9)	16.1 (15.1-17.2)	5.2 (2.0-8.4)	8.1 (3.8-12.3)
R	1.8 (1.5-2.2)	1.5 (1.4-1.7)	2.1 (2.1-2.2)	1.8 (1.2-2.6)	1.8 (1.4-2.4)
PAF	43.2 (43.1-43.2)	33.6 (33.5-33.6)	63.1 (63.1-63.2)	25.4 (25.3-25.5)	45.9 (45.8-46.1)
PAR	10.5 (8.9-12.1)	11.0 (8.8-13.2)	11.7 (11.3-12.0)	2.4 (1.5-3.4)	5.7 (3.5-8.0)
Level of education					
D	38.7 (33.0-44.3)	43.0 (36.9-49.1)	33.7 (32.3-35.1)	19.0 (13.2-24.8)	8.0 (4.5-20.5)
R	4.1 (3.3-5.1)	3.6 (2.7-4.9)	6.3 (5.9-6.7)	4.5 (2.8-7.2)	1.8 (0.9-3.5)
PAF	109.8 (109.6-109.9)	81.6 (81.5-81.7)	116.7 (116.7-116.7)	156.8 (156.5-157.2)	50.3 (49.6-51.0)
PAR	26.8 (23.6-29.9)	26.7 (23.7-29.7)	21.6 (20.9-22.3)	15.0 (11.7-18.3)	6.3 (2.5-15.0)
Sub-national regions					
D	28.8 (23.0-34.6)	20.1 (12.8-27.4)	51.8 (48.2-55.4)	15.7 (9.5-21.9)	18.4 (8.5-28.3)
R	10.2 (5.0-20.9)	1.9 (1.5-2.4)	8.4 (7.0-10.2)	7.9 (3.7-17.1)	6.0 (2.6-13.7)
PAF	30.8 (30.3-31.4)	30.5 (30.4-30.6)	272.7 (272.5-272.9)	88.0 (87.7-88.3)	77.7 (76.7-78.7)
PAR	7.5 (5.4-20.5)	10.0 (5.8-14.2)	43.0 (40.4-45.6)	8.4 (5.4-11.4)	9.7 (2.6-21.9)

D= difference measure; R= ratio measure; PAF= population attributable fraction; PAR= population attributable risk; CS= caesarean section; CI= confidence interval.

4. Discussion

This study demonstrates a substantial increase in CS prevalence in Pakistan, from 8.70% in 2006 to 24.40% in 2017. This trend is consistent with previous research documenting an increase from 3.20% in 1990 to approximately 20.00% in 2018 (Colomar *et al.*, 2021). The PDHS 2017–2018 also reported a CS rate of 22.00% (Khowaja *et al.*, 2021; Jadoon *et al.*, 2024). Although CS is a lifesaving intervention when medically indicated, increasing prevalence raises concerns about potential overuse and unequal access to appropriate obstetric care. Unnecessary procedures may increase maternal and neonatal morbidity and mortality (Mumtaz *et al.*, 2017; Khowaja *et al.*, 2021). Our findings therefore reinforce the sustained increase in CS use reported in Pakistan (Amjad *et al.*, 2018).

The EAPC was 9.85%, with relatively higher growth among several disadvantaged groups, including the poorest women and rural residents. Nevertheless, CS prevalence remained substantially higher among wealthier, more educated, and urban women. The rapid expansion of private healthcare may partly explain the overall increase, as private facilities have been associated with higher CS rates and potential financial incentives for performing procedures without clear medical indications (Puro *et al.*, 2022). Other contributing factors reported in previous studies include perceptions of CS as a marker of socioeconomic status, fear of labour pain, beliefs about the safety of CS, and changes in urban lifestyles associated with obesity and pregnancy complications (Torloni *et al.*, 2013; Khan *et al.*, 2017; Latifnejad-Roudsari *et al.*, 2014).

Wealth-related inequalities remained pronounced throughout the study period. In 2017, CS prevalence was 46.10% among women in the richest quintile, compared with 10.00% among those in the poorest quintile. Similar socioeconomic gradients have been reported in Pakistan and across 72 low- and middle-income countries (Mumtaz *et al.*, 2017; Boatin *et al.*, 2018). Wealthier women may be better able to afford CS and access private healthcare services (Ahmed *et al.*, 2023). Perceptions of CS as safer or less painful, greater autonomy in childbirth decisions, and more frequent antenatal care may also influence its use (Colomar *et al.*, 2021; Gebeyehu *et al.*, 2022).

Educational inequalities followed a similar pattern: prevalence reached 51.10% among women with higher education, compared with 12.50% among those with no formal education. Education may influence income, healthcare-seeking behaviour, access to specialist care, and childbirth preferences (Yadav *et al.*, 2021;

Suwanrath *et al.*, 2021; Yunitawati *et al.*, 2024). These patterns are consistent with evidence that financial constraints and limited access to obstetric services may restrict CS use among disadvantaged women (Amjad *et al.*, 2018). Maternal age and preferences may also contribute to CS utilisation, as older mothers may face increased pregnancy-related risks or concerns about vaginal delivery (Khan *et al.*, 2017). Delayed childbearing and concerns about the physical effects of vaginal birth have also been discussed in previous research, although these factors were not directly examined in our analysis (Amjad *et al.*, 2018).

Residential and provincial differences further highlight the uneven distribution of CS prevalence. In 2017, prevalence was higher in urban than rural areas (34.90% versus 19.40%), and the absolute gap widened between 2006 and 2017. Differences in healthcare infrastructure, affordability, and the availability of skilled personnel may contribute to this pattern (Abate *et al.*, 2025). Urban women may also have greater access to specialist services and greater autonomy in healthcare decisions (Kamal *et al.*, 2016; Mascarenhas *et al.*, 2024). However, rural–urban patterns vary across settings; for example, higher rural CS prevalence has been reported in China, potentially reflecting policy changes and investment in rural healthcare (Kang *et al.*, 2020; Adepoju *et al.*, 2025). Within Pakistan, Punjab recorded the highest provincial prevalence in 2017 (31.80%), whereas Balochistan recorded the lowest (4.20%). Low prevalence in Balochistan may reflect barriers such as long travel distances, inadequate transport, shortages of equipment and medicines, and limited availability of skilled birth attendants (Gabrysch *et al.*, 2011). Conversely, greater availability of institutional delivery services and antenatal care may contribute to Punjab's higher prevalence (Ali *et al.*, 2018). Provincial and residential differences should nevertheless be interpreted cautiously because prevalence alone cannot distinguish inadequate access from differences in clinical need or unnecessary intervention.

The inequality indices provide additional insight into these patterns. Between 2006 and 2017, absolute inequality increased for wealth, education, residence, and subnational regions, even as relative inequality declined for wealth, education, and residence. For example, the wealth-related absolute difference reached 36.10 in 2017, while the relative measure declined to 4.60. This indicates that proportional differences between groups narrowed in some dimensions, but gaps measured in percentage points widened (Xiong and Wei, 2025). Regional inequality remained substantial, with an absolute difference of 28.80 in 2017 and a relative measure of 10.20, although the latter had a wide confidence interval. These findings demonstrate why absolute and relative measures should be considered together. The reported PAF values, some of which exceeded 100.00, require verification against the relevant HEAT definitions and calculation methods before they can be interpreted substantively.

The comparison across South Asian countries showed considerable variation in both CS prevalence and inequality. Bangladesh recorded the highest prevalence among the richest women (61.30%) and women with higher education (59.40%), while Pakistan recorded corresponding estimates of 46.10% and 51.10%. These findings align with evidence of increasing CS use and socioeconomic disparities in Bangladesh (Kundu *et al.*, 2024). India showed substantial subnational variation, with previous studies reporting rates ranging from 3.00% to 70.00%, suggesting the possible coexistence of underuse and overuse in different settings (Guilmoto and Dumont, 2019; Singh *et al.*, 2020; Chauhan and Radkar, 2024). Nepal had comparatively low prevalence among several disadvantaged groups, consistent with reported barriers to emergency obstetric care, particularly in rural areas. Bhutan also showed socioeconomic differences, although its prevalence was generally lower than that of Pakistan and Bangladesh (Dhakal *et al.*, 2025). The inequality indices further demonstrated that country rankings depended on the dimension assessed: Bangladesh had the largest absolute wealth-related inequality, Nepal the highest relative wealth-related inequality, and India the largest absolute subnational disparity.

A major strength of this study is its use of the WHO's HEAT to assess temporal trends and both absolute and relative inequalities using nationally representative survey data. The inclusion of five South Asian countries provides a broader regional perspective. However, differences in survey timing, socioeconomic classifications, healthcare systems, and cultural contexts may limit direct cross-country comparisons. The observational analysis cannot establish causality or determine whether individual CS procedures were clinically appropriate. Self-reported delivery information may also be subject to recall or reporting bias. Furthermore, the analysis did not directly account for clinical indications, maternal age, parity, obstetric risk, or facility type.

These findings highlight the need for policies that address both potential overuse among advantaged populations and possible underuse among disadvantaged groups. Improving access to skilled obstetric care, reliable referral systems, transport, and essential resources in underserved rural areas is important for ensuring timely, medically necessary CS. At the same time, evidence-based clinical guidelines and audits of CS indications could help identify potentially avoidable procedures. Balanced information for healthcare professionals and expectant parents should support informed decisions about the benefits and risks of different delivery modes. Further research incorporating clinical indications, maternal and neonatal outcomes, provider practices, and women's experiences is needed to clarify the causes of observed inequalities and inform targeted interventions.

5. Conclusions

This study identified substantial socioeconomic and geographic inequalities in CS prevalence in Pakistan between 2006 and 2017. Prevalence was consistently highest among wealthier, more educated, and urban women, and in Punjab, while Balochistan recorded the lowest provincial prevalence. Across South Asia, Bangladesh had the highest CS prevalence among the richest, urban, and highly educated women, while inequality patterns varied across countries and dimensions. These findings highlight the need for a dual policy approach: improving equitable access to medically necessary CS among disadvantaged populations while strengthening evidence-based clinical guidelines and facility-level audits, including the Robson classification, to identify and reduce potentially unnecessary procedures. Ensuring that CS use reflects clinical need rather than socioeconomic or geographic advantage is essential to improving maternal healthcare equity.

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Data availability statement

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Generative AI statement

No generative AI was used during preparation of this article.

Authors' contributions

Anjlee Sawlani: conceptualization, investigation, writing— first original draft of the manuscript, review and revision of the manuscript; Rabia Akhtar: methodology, formal analysis, writing— first original draft of the manuscript; Rida Masood: conceptualization, writing— first original draft of the manuscript; Kh Shafiur Rahaman: formal analysis, writing— review and revision of the manuscript; Owais Raza: formal analysis, writing—review and revision of the manuscript. All authors have read and approved the final article.

Conflict of interest

None to declare.

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