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Article

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ORIGINAL ARTICLE

Open Access



Impact of women's reproductive health and empowerment on female labour force participation

Surbhi Mishra^{1*}  and Dukhabandhu Sahoo¹

Abstract

The study aims to investigate the long and short-run impacts of women's reproductive health and women's empowerment on their economic opportunities in South Asia. The paper employs panel autoregressive distributed lag for eight South Asian countries from 1991 to 2021. The results reveal that awareness about contraceptives and the prevalence of prenatal care for pregnant women have a long-run and short-run positive relationship with female labour force participation (FLFP). These results reflect country-level patterns in which family planning, the use of modern contraceptives, and better health facilities for pregnant women enhance their economic opportunities. Additionally, female tertiary education has a long-run positive effect on FLFP, indicating that higher education, vocational training, and adequate skills support female's entry into the workforce. Further, the study finds that the maternal mortality rate has a long-run positive relationship with FLFP. This phenomenon might be influenced by household coping mechanisms, wage increases due to labour shortages, and gender roles in a segmented labour market, which is extensively discussed in the paper. The study suggests that policymakers improve reproductive healthcare and increase female higher education to reduce gender inequality in the South Asian labour market.

Keywords Women's reproductive health, Female labour force participation, Family planning, South Asia

JEL classification I15, J21, J13, O53

1 Introduction

Women's participation in the labour market is widely recognized as a cornerstone of economic growth and development. However, across many parts of the world—particularly in low- and middle-income countries—women continue to face substantial barriers to employment. These barriers are deeply rooted in structural inequalities, including limited access to education, discriminatory social norms, and inadequate healthcare

systems. Among these, reproductive health remains an underappreciated yet critical determinant of women's economic agency. Ensuring access to quality reproductive healthcare not only supports women's physical and mental well-being but also enhances their capacity to make informed life choices, pursue education, and participate in economic activities. In this context, reproductive health emerges not just as a health issue, but as a development and empowerment imperative.

Improving women's access to reproductive healthcare has a multifaceted impact across individual, economic, and intergenerational dimensions. First, it directly enhances women's health and well-being by reducing adolescent fertility and maternal mortality rates (Canning

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and Schultz 2012). Access to contraception has also been linked to greater agency among women, delayed marriage, and protection from unwanted pregnancies and sexually transmitted infections (Finlay and Lee 2018; Tsui et al. 2010). Second, investing in women's reproductive health yields significant economic benefits. It narrows gender disparities and could increase global GDP by an estimated \$1 trillion by 2040 (Perez et al. 2024). Improved reproductive health supports women in completing their education (Goldin and Katz 2002), enhances their participation and productivity in the labour market (Onarheim et al. 2016), and contributes to poverty reduction (Canning and Schultz 2012). As pointed by Ajakaiye and Mwabu ((Ajakaiye 2010)), reproductive health, economic growth, and poverty alleviation are closely interlinked, jointly influencing the functioning of labour and product markets. Third, the benefits of reproductive health-care extend across generations. Access to family planning and quality pre- and post-natal care promotes the birth of healthier children who experience better physical, cognitive, and emotional development (Bloom et al. 2015).

Despite these benefits, access to reproductive health-care remains deeply unequal across the globe. Women in developing countries are 33 times more likely to die from maternal causes than those in developed nations (World Health Organization, (World 2015)), and 218 million women in low- and middle-income countries lack access to modern contraception (Sully et al. 2020). Limited reproductive healthcare forces many women in developing regions to juggle early childbearing and employment, often pushing them out of the workforce (Gammage et al. 2019). These disparities are deeply rooted in South Asia, where colonial legacies and patriarchal norms restrict access to sexual and reproductive health services (Ravindran and Desai 2022). This contributes to persistently low female labour force participation (FLFP), at just 25.6% compared to 74.7% for men (World Bank 2022).

Much of the existing literature attributes the lower FLFP in South Asia to rising female educational enrolment, restrictive gender norms, limited job opportunities, and rising household incomes (Chaudhary et al., 2014; Amber 2023; Mishra, 2024). However, it largely overlooks the critical role of reproductive health as a determinant of women's economic participation. Further, existing literature often examines reproductive indicators—such as fertility, family planning, and contraceptive use—independently, rather than exploring their combined impact within an integrated framework, which is a conceptual gap that this study aims to address. Methodologically, most studies on women's reproductive health rely on micro-level, individual-level data from primary surveys (Canning and Schultz 2012; Joshi and Schultz 2012; Finlay and Lee 2018) or focus on country-specific analyses using census or fertility survey data (Ananat et

al. 2006; Goldin and Katz 2002). Although microdata is valuable for understanding individual behaviours, it limits the generalizability of findings to the broader population. Moreover, the reliance on primary data introduces key limitations, including small sample sizes, temporal constraints, and inconsistent measurement standards across studies. These factors hinder the ability to draw region-wide or long-term conclusions. In contrast, the macro-level data capture broader national-level dynamics, including health infrastructure, policy environments, and institutional frameworks that directly shape women's labour market outcomes. Therefore, there is a need for macro-level research that explicitly links women's reproductive health to labour market outcomes in the South Asian context.

To the best of our knowledge, there is little research that address women's reproductive health in the South Asian regions. Hence, the research question of the paper is: How do women's reproductive health and empowerment, measured through education and decision-making, affect female labour force participation in the South Asian region? To answer the question and bridge the research gap, the study uses Amartya Sen's capability approach and Kabeer's empowerment framework to build the conceptual framework. Further, the study utilises longitudinal data of reproductive health indicators recognised by the Sustainable Development Goals (SDGs) and the World Health Organisation (WHO) (2020). The paper employs advanced econometrics techniques, including the Kao cointegration test, panel autoregressive distributed lag model (PARDL) and Dumitrescu-Harlin (D-H) causality test to achieve the objective. The PARDL deals with potential endogeneity (Chudik et al. 2015) and simultaneously provides short-run and long-run estimates, while D-H causality provides information regarding the direction of causality among the variables. In doing so, it broadens the discourse, contributes novel empirical insights, and supports policy development aimed at achieving the SDGs and fostering inclusive growth across the region.

The paper is organised as follows: after this introductory section, the second section presents the theoretical framework, the third section develops the literature review, the fourth section highlights the conceptual framework for the study, and the fifth section discusses facts about South Asian economies, socioeconomic conditions, and the labour market. The sixth section deals with data, methods and model specification, the seventh section analyses the results, and the eighth section discusses the results. The final section concludes the paper with policy implications.

2 Theoretical model: linking reproductive health, empowerment, and labour participation

The earlier theories of women's reproductive health revolved around fertility. Becker's (1960) neoclassical fertility model conceptualised children as the commodity of consumption and investment. The decisions regarding fertility are made by weighing the marginal cost and benefits of children, along with the preference, household income and women's opportunity cost of time. However, this framework does not consider social and institutional factors affecting women's autonomy and agency regarding reproductive health. As the economy progresses, the fertility and mortality patterns evolve. The pre-industrial stage is characterised by high fertility and mortality. In the transitional stage, improvements in healthcare led to a reduction in mortality; however, fertility remains high. During the last stage, i.e., late industrialisation, an increase in urbanisation, better access to reproductive health care and increased education led to a decline in mortality and fertility rate. These shifts also reshaped women's roles in the labour market, as declining fertility improves women's health and provides time to enter the labour market.

Building on this demographic foundation, Goldin's (1994) U-shaped hypothesis provides a more dynamic perspective on how women's fertility and labour participation evolve alongside economic development. As per the hypothesis, women's fertility patterns and employment change as society moves from an Agrarian to Industrialization, followed by a Service-oriented economy. In the agrarian stage, both fertility and FLFP were high due to economic necessity and the unavailability of contraceptives. In the earlier industrial phase, due to the nature of the work and gender norms, FLFP is reduced, and fertility remains high to moderate. However, it gradually declined during the transition stage of the economy from an industrial to a service-oriented economy. This structural change opens new opportunities for women to get a good education, better health care, and enter the labour market. This indicates two aspects of development. First, declining fertility, improving women's reproductive health and rising female employment are longitudinal processes with short-run fluctuations. Second, with a decline in fertility, women increasingly prioritise careers over family. This pattern suggests a close interlink between women's empowerment, reproductive health, and labour force outcomes. Hence, the hypotheses to be tested in this paper are:

H₁ *Women's reproductive health and empowerment do affect female labour force participation in the South Asian region.*

H₂ *Women's empowerment affects female labour force participation in the South Asian region.*

3 Literature review

Kabeer (1999) emphasizes that empowerment is fundamentally linked to how individuals perceive their own value and sense of self-worth. In this context, women's empowerment is defined as a process by which women increase their ability to make choices and control their own lives. Complementing this perspective, the United Nations Population Fund (2002) articulates five essential components of women's empowerment: a sense of self-worth; the right to determine life choices; access to opportunities and resources; control over one's life within and beyond the home; and the ability to influence the direction of social and economic change at all levels. Further refining this framework, UN Women (2023) categorises women's empowerment into five mutually inclusive dimensions: life and good health, education and skill-building, labour and financial inclusion, decision-making power, and freedom from violence. These dimensions offer a comprehensive lens through which women's empowerment can be understood and measured.

Among the most studied dimensions is education, which serves as both a driver and outcome of empowerment. Education significantly enhances women's agency within households, strengthening their decision-making power in both financial and non-financial domains (Le and Nguyen 2020). It also increases their participation in the labour force and improves household living standards (Alaoui 2015). Furthermore, education equips women with the knowledge and confidence to make informed choices about their health, family planning, and resource management (Bui, (Bui, 2023)). Further, political participation also plays a crucial role in advancing women's empowerment. UN Women (2019) highlights that women's involvement in political leadership and decision-making enables them to influence outcomes that affect their lives and communities. For instance, González-Malabet (2022) demonstrates how participation in social movements and NGOs enhances women's political agency, fosters collective action, and strengthens their representation in formal political structures, particularly through collaborations with local governance in Colombia.

Yet, while education and political inclusion are critical, women's health—specifically reproductive health—is a foundational dimension of empowerment. Good reproductive health enables women to exercise autonomy over their bodies and reproductive choices, which is essential for their social and economic advancement. However, existing global indices, including the UN Women Empowerment Index (UN Women, 2023), typically use only a limited set of indicators—such as contraceptive

prevalence and adolescent fertility rate to capture this dimension, overlooking several other vital aspects of reproductive well-being.

To address this gap, the present study adopts a broader and more inclusive understanding of reproductive health, in line with WHO guidelines. According to the WHO, women's reproductive health encompasses maternal health, fertility patterns, access to skilled care, and family planning services. These factors are particularly important due to the unique biological, economic, and developmental implications of reproduction. Biologically, women require specialized care related to menstruation, pregnancy, childbirth, and menopause (Bloom et al. 2015). Economically, their reproductive years coincide with their most productive working years, making uninterrupted access to reproductive healthcare essential for labour market participation (Gammage et al. 2019). Developmentally, improved reproductive health yields intergenerational benefits by enhancing not only women's education and employment but also outcomes for their children (Canning and Schultz 2012).

However, there is no universally accepted definition of women's reproductive health. To address this gap, Edmeades et al. (2018) introduced the concept of reproductive empowerment as "both a transformative process and an outcome, whereby individuals expand their capacity to make informed decisions about their reproductive lives, amplify their ability to participate meaningfully in public and private discussions related to sexuality, reproductive health, and fertility, and act on their preferences to achieve desired reproductive outcomes, free from violence, retribution or fear". In this context, women's reproductive empowerment refers to women's autonomy to make voluntary decisions regarding their sexuality and reproductive health, free from discrimination and social pressure. This includes the right to access family planning services, use contraceptives, and seek reproductive healthcare.

Building on this idea, global targets in terms of SDGs are formulated, emphasising the reduction of total fertility rates (TFR), adolescent fertility rates (AFR), and maternal mortality ratios (MMR) to enhance women's well-being. These outcomes have significant spillover effects on women's education, employment, and economic autonomy. For example, a systematic review by Onarheim et al. (2016) referenced a study conducted in the United States, which found women's access to higher education and their participation in the labour market were significantly higher in regions where women had control over their fertility. In contrast, Ranchhod et al. (2024) reported that teenage motherhood in Cape Town was linked to long-term negative effects on educational attainment and personal income. Similarly, Conde-Agudelo et al. (2005) found that adolescent women

(under 16 years of age) in Latin America faced a fourfold increased risk of dying from pregnancy-related causes compared to women in their twenties. In India, Tiwari et al. (2022) showed that women with more than three children were 3.5% points more likely to exit the labour market than those with two or fewer children, even when controlling for other socio-demographic factors.

Further, Canning and Schultz (2012) emphasised that reduced fertility and maternal mortality increase the working-age population, thereby positively impacting economic growth. Finlay (2021) investigates a direct relationship between economic growth, TFR and FLFP, revealing distinct patterns across income levels. In low-income countries, both TFR and FLFP tend to be high. This is due to economic necessity and the absence of income-sharing arrangements within households that compel women to participate in the labour force while simultaneously managing child-rearing responsibilities. In contrast, middle-income countries practice strategies such as birth spacing and switching jobs to balance work and family life, leading to a gradual decline in fertility alongside stable or increasing FLFP. High-income countries typically exhibit both low TFR and high FLFP; however, they continue to grapple with persistent gender wage gaps and structural barriers to full gender equality in the labour market. These trends highlight two key insights: first, the decline in fertility and rise in female labour participation are closely linked and evolve alongside economic development; second, access to family planning and contraceptives plays a critical role in enabling women to navigate their dual roles in reproductive and economic spheres.

Besides fertility, family planning programmes and contraceptive also plays a significant role in reproductive health. Canning and Schultz (2012) found that family planning programmes in Bangladesh led to a 30% decline in child mortality, a 23% reduction in fertility, and a 17% drop in maternal mortality. Additionally, women aged 25–54 experienced over a 1 kg/m² improvement in body mass index, women's earnings increased by 40% in the programme areas, and married women reported a 25% rise in household physical assets. Similarly, Goldin and Katz (2002) found that the availability of contraceptives in the U.S led to delaying women's marriage, increasing their educational attainment and labour force participation. However, the use of contraceptive pills was also associated with negative mental health outcomes. Valder (2022), using longitudinal data from 1960 to 1977, found that women with access to contraceptive pills reported 27% higher depression scores. The study further suggested that pill usage could increase the genetic risk of developing mental health disorders.

Further, education also plays a critical role in enabling women to make informed decisions regarding sexual

health, contraceptive use, family planning, and abortion policies. Wang (2024) pointed out several reasons why higher education contributes to reducing the fertility rate. First, education enables women to get better jobs, which increases the opportunity cost of time-intensive activities like child care. Second, educated parents trade off children's quality and quantity and invest more in children's human capital. Third, education increases women's knowledge about contraceptives and family planning, which helps them to make informed decisions. Finally, education enhances women's household bargaining power and empowers them to break their traditional role in the family. Additionally, women's participation in higher law-making positions also plays a crucial role, from raising voices and awareness to formulating policies for the better accessibility of reproductive healthcare services. Ananat et al. (2006) pointed out that the liberalised abortion policies in the U.S. lead to increased female college education, as it lowers unwanted pregnancies.

Despite increasing interest in the link between reproductive health and socio-economic outcomes, most studies examine indicators such as fertility, family planning, and contraceptive use in isolation. To address the gap, the next section presents an integrated framework linking women's reproductive health with long and short-term reproductive outcomes.

4 Conceptual framework: linking women's reproductive health to reproductive outcomes

This study draws on Amartya Sen's capability approach and Kabeer's empowerment framework (1999) to examine how improvements in female reproductive health influence FLFP in South-East Asia. The capability approach argues that actual development not only focuses on material wealth but also on enhancing people's capabilities. The capability is people's substantive freedom or opportunity to achieve what they value. Similarly, Kabeer defines empowerment as a "process of change" resulting from one's "ability to make choices". Kabeer gave three inter-related dimensions for empowerment: (1) resource (also referred to as assets), defined as both traditional material resources as well as human and social resources which enhance the ability to exercise choices; (2) agency, defined as a mediator between individual's desire to bring change and achievement of the targeted goal; (3) achievements is the outcome that encompasses women's well-being.

Taking the lead from Kabeer, Edmeades et al. (2018) conceptualised reproductive empowerment through three interrelated processes: (1) choice, which implies an individual's ability to make decisions that affect their life. In our context, it implies the women's autonomy to make strategic decisions regarding family planning, contraceptives and pregnancy-related choices. (2) Voices, which

imply the ability to express one's interests, convey opinions and desires, advocate for change, and participate in meaningful discussions that impact one's life. In terms of reproductive health, it indicates women's ability to speak about their reproductive rights and needs, demand better health care and participate in the decision about health care policies. To capture this, the study has taken education, as it enables them to make informed decisions. (3). Power, the exercise of power by individuals, both towards and from others, plays a key role in either limiting or enhancing voice and choice, as the dynamics of relationships largely shape these. In terms of reproductive health, this indicates the power dynamic between the partners, within the family and among societies, to empower or limit women's ability to make decisions regarding reproductive health. To capture the impact of voice, the study used women's representation in parliament as a variable.

This approach also reflects the argument that reproductive health is not merely a health issue, but a structural enabler of economic participation. When women can safely manage childbearing, space pregnancies, and access maternal care, they are better positioned to invest in their education, maintain employment, and return to the labour market after childbirth. These effects are not limited to the short term—there are long-run intergenerational consequences, including healthier children and improved economic outcomes for future generations (Canning and Schultz 2012).

The framework in Fig. 1 illustrates a nested model where long-term impacts are embedded within short-term individual impacts of women's reproductive health. Women's reproductive empowerment is pivotal in influencing both short- and long-term reproductive outcomes. In the short run, it directly enhances women's health by facilitating a shift from traditional practices to the use of modern contraceptives, access to family planning services, skilled birth attendance, and comprehensive prenatal and postnatal care. These improvements strengthen women's autonomy and ability to make informed decisions regarding their reproductive lives. In the long run, greater control over fertility contributes to sustained improvements in health and well-being, enabling women to pursue education and participate more fully in the labour market.

5 Some stylised facts on South Asia

South Asia comprises eight independent developing nations with similar historical, geographical, and cultural linkages. The region is predominantly rural, with the population engaged in agriculture as the primary activity for their livelihood. The traditionally diverse region has cultural similarities, especially caste-class hierarchies and patriarchal dominance (Rustagi 2005). To foster regional growth, the countries are linked with an economic and

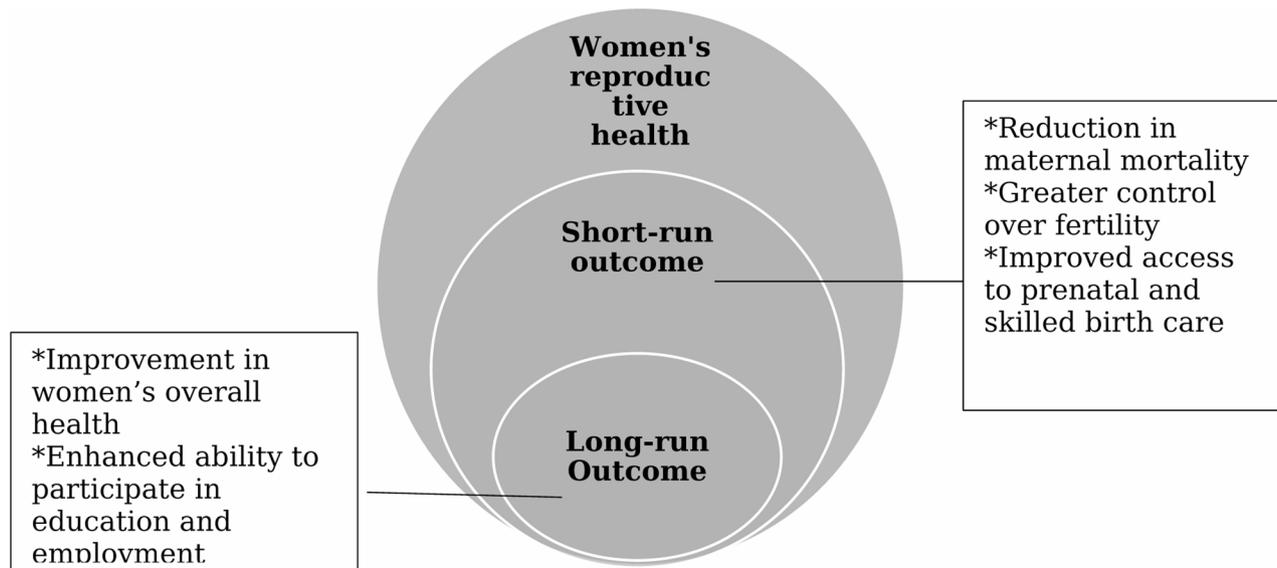


Fig. 1 Linking reproductive empowerment to reproductive outcomes. Source: Author's construct

political organisation, the South Asian Association for Regional Cooperation (SAARC). The SAARC countries together account for 3% of the world's area and 21% of the world's population as of 2019 (World Population Review 2025). Most of the economy opened up over the last three decades, leading to regional economic, social, and political globalisation.

The region is going through unprecedented changes in terms of regional growth and development. South Asia's Gross Domestic Product (GDP) annual growth percentage is 5.60%, compared to 2.90% of world statistics from 1991 to 2021. The region's annual average GDP per capita growth is 3.87% compared to 1.58% globally from 1991 to 2021 (World Development Indicator, 2022). The South Asian region also experienced considerable improvement in human capital over the last three decades. The human development scores of the region have been trending upward since 1990, despite the region's overall performance remaining below world statistics (United Nations 2024).

6 Data and methods

The study employed panel data from eight South Asian nations (Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka) from 1991 to 2021. The data used for the empirical analysis were sourced from World Development Indicators (WDI), World Bank. Since the data from a few countries were missing, some data were interpolated and extrapolated (For further details, see Appendix Table A.1). Table 1 briefly describes the variables and data sources used in the study. The study uses variables from three indicators, i.e., reproductive health, employment and empowerment.

Target 3.7 of the SDGs seeks to ensure universal access to sexual and reproductive healthcare, including family planning, education, and integration into national strategies by 2030. This study uses six indicators, aligned with WHO standards and SDG targets, grouped into three dimensions: fertility behaviour (adolescent fertility rate, SDG 3.7.2; total fertility rate), access to services (contraceptive prevalence, SDG 3.7.1; prenatal care coverage, SDG 3.1, 3.8), and maternal health outcomes (maternal mortality ratio; skilled birth attendance, SDG 3.1, 3.1.2). These collectively capture behavioural patterns, service access, and health outcomes in South Asia. Women's enrolment in tertiary education and the share of parliamentary seats held by women are included as control variables. Table 1 details definitions, explanations, and data sources.

6.1 Model specification

The study employs the Panel Autoregressive Distributed Lag (PARDL) model to investigate the impact of women's reproductive health and women's empowerment on their economic opportunities, which can be expressed in the following equation:

$$FLFP_{it} = f(TFR_{it}, MMR_{it}, AFR_{it}, BASS_{it}, PWRPC_{it}, CP_{it}, WSP_{it}, FTES_{it}) \quad (1)$$

In Eq. (1), female labour force participation (FLFP), is the function of total fertility rate (TFR), maternal mortality rate (MMR), adolescent fertility rate (AFR), birth attended by skilled staff (BASS), pregnant women receiving prenatal care (PWRPC), contraceptive prevalence by married women (CP), proportion of seats held by women in national parliaments (WSP), and female tertiary school

Table 1 Description, explanation and data sources of the variables

Pillars	Variable	Acronyms	Explanation	Source
Economic Opportunity	Labour force participation rate, female (% of female population ages 15+)	FLFP	FLFP is a crucial driver and outcome of economic growth and development, a coping mechanism of shock and a way to eradicate poverty in developing countries (Verick, (Verick, 2014))	WDI, 2022
Women's Reproductive Health	1. Fertility rate, total (births per woman)	TFR	Total fertility is associated with family size and women's health (Payne, (Payne, 2004))	WDI, 2022
	2. Contraceptive prevalence, any modern method (% of married women ages 15–49)	CP	SDG (3.7.1 & 3.7.2): To ensure universal access to sexual and reproductive healthcare services, including family planning, information and education, and the integration of reproductive health into national strategies and programmes by 2030.	WDI, 2022
	3. Adolescent fertility rate (births per 1,000 women ages 15–19)	AFR		
	4. Pregnant women receiving prenatal care (%)	PWRPC		
	5. Maternal mortality ratio (modelled estimate per 100,000 live births)	MMR	SDG (3.1.1 & 3.1.2): To reduce the global maternal mortality ratio to less than 70 per 100,000 live births by 2030.	WDI, 2022
	6. Births attended by skilled health staff (% of total)	BASS		
Empowerment	1. Proportion of seats held by women in national parliaments (%)	WSP	SDG (5.5) To ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic and public life.	WDI, 2022
	2. School enrollment, tertiary, female (% gross)	FTES	1. SDG (4.1) ensures that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes 2. As higher education delays FLFP and opens new opportunities in other sectors 3. U-Shape hypothesis (Kalsen & Pieters, 2012)	WDI, 2022

Source: Authors' construct; WDI represents the World Development Indicator

enrolment (FTES). By taking the natural logarithm of the variables, Eq. (1) can be expressed by the following functional form:

$$\begin{aligned}
 LnFLFP_{it} = & \beta_0 + \beta_1 LnTFR_{it} \\
 & + \beta_2 LnMMR_{it} + \beta_3 LnAFR_{it} \\
 & + \beta_4 LnBASS_{it} \\
 & + \beta_5 LnPWRPC_{it} + \beta_6 LnCP_{it} \\
 & + \beta_7 LnWSP_{it} \\
 & + \beta_8 LnFTES_{it} + u_{it}
 \end{aligned} \quad (2)$$

In Eq. (2) β_0 is the constant term and β_i ($i = 1, 2 \dots .8$) are the long-run elasticities of the parameters to be estimated and u_{it} is the independent and identically distributed error term. The subscripts "i" and "t" denote country and year, respectively.

To check the time series properties of the variable, the study applied the Cross-Sectional Augmented Im-Pesaran Shim second-generation unit root test (CIPS). The stationarity of the variables is an important property of time-series data, and it is crucial to check cross-sectional dependence among the countries, along with integration of the variables. Hence, CIPS is used to address this. Further, the study applies the Kao cointegration test to check the possible presence of a long-term stable relationship between the independent and dependent variables. After this, the PARDL model, which was proposed by Pesaran (2007), was employed. It is applicable irrespective

of the order of integration of the variables, i.e. when the variables are I(0) and I(1) [but not I(2)]. Following Pesaran et al. (1999), the PARDL model for this study can be expressed as follows:

$$\begin{aligned}
 \Delta LnFLFP_{it} = & \beta_0 + \alpha_i LnFLFP_{it-1} + \beta_1 LnTFR_{it-1} \\
 & + \beta_2 LnMMR_{it-1} \\
 & + \beta_3 LnAFR_{it-1} \\
 & + \beta_4 LnBASS_{it-1} \\
 & + \beta_5 LnPWRPC_{it-1} \\
 & + \beta_6 LnCP_{it-1} + \beta_7 LnWSP_{it-1} \\
 & + \beta_8 LnFTES_{it-1} \\
 & + \phi_{ij} \sum_{i=1}^{p-1} \Delta LnFLFP_{it-j} \\
 & + \omega_{1ij} \sum_{j=0}^{q-1} \Delta LnTRF_{it-j} \\
 & + \omega_{2ij} \sum_{j=0}^{q-1} \Delta LnMMR_{it-j} \\
 & + \omega_{3ij} \sum_{j=0}^{q-1} \Delta LnAFR_{it-j} \\
 & + \omega_{4ij} \sum_{j=0}^{q-1} \Delta LnBASS_{it-j} \\
 & + \omega_{5ij} \sum_{j=0}^{q-1} \Delta LnPWRPC_{it-j} \\
 & + \omega_{6ij} \sum_{j=0}^{q-1} \Delta LnCP_{it-j} \\
 & + \omega_{7ij} \sum_{j=0}^{q-1} \Delta LnWSP_{it-j} \\
 & + \omega_{8ij} \sum_{j=0}^{q-1} \Delta LnFTES_{it-j} + u_{it}
 \end{aligned} \quad (3)$$

Equation (3) can be expressed in the error correction form as follows:

Table 2 Summary statistics

Variable	Mean	Std. Deviation	Min	Max	Skewness	Kurtosis
FLFP	30.91	13.11	10.98	64.57	1.05	3.53
AFR	73.42	44.89	7.29	162.84	0.29	1.91
MMR	359.83	371.25	28	1784	2.17	8.28
TFR	3.52	1.60	1.41	7.70	1.02	3.17
BASS	53.09	33.06	4.35	100.8	0.09	1.52
CP	37.01	18.49	3.6	93.16	0.62	3.96
PWRPC	64.26	26.42	15.4	102.1	-0.124	1.69
WSP	12.72	9.04	1.47	33.16	0.74	2.14
FTES	9.24	9.96	0.30	52.51	2.19	9.21

Source: Authors' construct

$$\begin{aligned}
 \Delta \text{LnFLFP}_{it} &= \beta_0 + \alpha_i \text{ECM}_{it-1} \\
 &+ \phi_{ij} \sum_{j=1}^{p-1} \Delta \text{LnFLFP}_{it-j} \\
 &+ \omega_{1ij} \sum_{j=0}^{q-1} \Delta \text{LnTFR}_{it-j} \\
 &+ \omega_{2ij} \sum_{j=0}^{q-1} \Delta \text{LnMMR}_{it-j} \\
 &+ \omega_{3ij} \sum_{j=0}^{q-1} \Delta \text{LnAFR}_{it-j} \\
 &+ \omega_{4ij} \sum_{j=0}^{q-1} \Delta \text{LnBASS}_{it-j} \\
 &+ \omega_{5ij} \sum_{j=0}^{q-1} \Delta \text{LnPWRPC}_{it-j} \\
 &+ \omega_{6ij} \sum_{j=0}^{q-1} \Delta \text{LnCP}_{it-j} \\
 &+ \omega_{7ij} \sum_{j=0}^{q-1} \Delta \text{LnWSP}_{it-j} \\
 &+ \omega_{8ij} \sum_{j=0}^{q-1} \Delta \text{LnFTES}_{it-j} + u_{it}
 \end{aligned} \tag{4}$$

Where $\text{ECM}_{it-1} = \text{LnFLFP}_{it-1} + \theta_1 \text{LnTFR}_{it-1} + \theta_2 \text{LnMMR}_{it-1} + \theta_3 \text{LnAFR}_{it-1} + \theta_4 \text{LnBASS}_{it-1} + \theta_5 \text{LnPWRPC}_{it-1} + \theta_6 \text{LnCP}_{it-1} + \theta_7 \text{LnWSP}_{it-1} + \theta_8 \text{LnFTES}_{it-1}$. Here 'p and q' represent the maximum lag length that captures the short-run dynamics of the dependent and independent variables respectively and 'j' is the lag index for short-run dynamics. Further, α_i is the coefficient of error correction term which measures the speed with which short-run equilibrium converges to long-run after any shock applied to the regressors. Statistical significance of α_i ensures the existence of non-linear cointegration between the studied variables.

Moreover, $\theta_1 (= -\frac{\beta_1}{\alpha})$, $\theta_2 (= -\frac{\beta_2}{\alpha})$, $\theta_3 (= -\frac{\beta_3}{\alpha})$, $\theta_4 (= -\frac{\beta_4}{\alpha})$, $\theta_5 (= -\frac{\beta_5}{\alpha})$, $\theta_6 (= -\frac{\beta_6}{\alpha})$, $\theta_7 (= -\frac{\beta_7}{\alpha})$ and $\theta_8 (= -\frac{\beta_8}{\alpha})$ are the long-run coefficients of, *LnTFR*, *LnMMR*, *LnAFR*, *LnBASS*, *LnPWRPC*, *LnCP*, *LnWSP* and *LnFTES* respectively and $\omega_{1i}, \omega_{2i}, \omega_{3i}, \omega_{4i}, \omega_{5i}, \omega_{6i}, \omega_{7i}$ and ω_{8i} are their short-run coefficients.

Table 3 Variance inflation factor (VIF)

Variable	VIF	1/VIF
LnMMR	14.98	0.06
LnAFR	10.37	0.09
LnTFR	9.96	0.10
LnBASS	7.62	0.13
LnPWRPC	7.45	0.13
LnCP	4.45	0.22
LnFTES	3.98	0.25
LnWSP	1.76	0.56

Source: Authors' construct

7 Result

Before analysing the results, it is essential to understand the characteristics of the variables as shown in Table 2. Among them, MMR has the highest mean and standard deviation, indicating MMR is high on average in the region, with considerable disparities across countries. All variables, except PWRPC, are positively skewed, suggesting most countries have values clustered at the lower end of the distribution, with a few countries exhibiting exceptionally high levels. In terms of kurtosis, AFR, BASS, PWRPC and WSP are platykurtic, indicating uniform distribution with fewer extreme values. While FLFP, MMR, TFR, CP and FTES are leptokurtic, exhibiting extreme variations in the variables across the dataset.

Table 3 presents the Variance Inflating Factor (VIF) analysis to test for multicollinearity. The VIF shows the speed with which variance and covariance increase due to the presence of multicollinearity in the data. As per the rule of thumb, VIFs exceeding 10 are signs of serious multicollinearity. The result shows, LnMMR and LnAFR exceeded the limit. The existing literature established a negative relationship between these variables and FLFP; hence, multicollinearity is expected. Nevertheless, these variables are retained in the model due to their theoretical and empirical relevance, particularly as key indicators of women's reproductive health recommended by the WHO and SDGs.

The study employs PARDL to examine the relationship between women's reproductive health, women's

Table 4 Cross-sectional augmented Im-Pesaran-Shin (CIPS) unit root test

Variables	CIPS	
	Level	1st difference
LnAFR	4.03	-5.83***
LnBASS	2.14	-3.16***
LnCP	1.26	-4.36***
LnFLFP	0.74*	-4.25***
LnTFR	-2.73***	-6.49***
LnMMR	4.35	-4.33***
LnPWRPC	1.37*	-5.63***
LnFTES	0.53	-3.70***
LnWSP	-1.06	-7.44***

Source: Authors' construct; ***Denotes 1% level of significance. **Denotes a 5% level of significance. *Denotes a 10% level of significance

Table 5 Kao residual cointegration test

ADF	t-Statistic	Prob
	-2.04***	0.02
Residual variance	0.002	
HAC variance	0.002	

Source: Authors' construct; ***Denotes 1% level of significance

empowerment, and economic opportunities. The model is applicable in the case of mixed orders of integration, i.e. $I(0)$ and $I(1)$, but not in $I(2)$. Therefore, to check the integration order, the study applied the CIPS unit root test (Pesaran 2007). Table 4 presents the results of CIPS, which show the mixed order of integration.

Before moving to the PADRL results to check the existence of long-run relationships among the variables, the study used the Kao cointegration test. The null hypothesis of the test is no cointegration. The result of Table 5 shows the presence of long-term cointegration among the variables. In a dynamic model, PARDL variables often depend on past values. Hence, selecting an appropriate lag length is crucial; avoiding this might lead to model misspecification. To address this, the study employed statistical criteria and tests to select the optimal lag length in time series. Table 6 presents the criterion of optimal lag length selected for the study. The majority of the criteria indicate two as the maximum lag length.

Table 7 shows the result of the PARDL test. The coefficient of the error correction $ECM(-1)$ is negative and significant, which supports a weak long-run cointegrating relationship between selected indicators of women's

Table 7 Result of PARDL

Variable	Coefficient	Std. Error
Long Run Equation		
LnAFR	0.01	0.09
LnTFR	-0.32	0.50
LnMMR	0.58**	0.20
LnBASS	-0.21	0.15
LnCP	1.06***	0.32
LnPWRPC	0.26*	0.15
LnFTES	0.11***	0.04
LnWSP	0.07	0.05
Short Run Equation		
ECM(-1)	-0.16*	0.08
D(LnFLFP(-1))	0.01	0.17
D(LnAFR)	0.0002	0.19
D(LnAFR(-1))	0.10	0.12
D(LnTFR)	-0.55	0.66
D(LnTFR(-1))	-0.39	1.29
D(LnMMR)	-0.02	0.03
D(LnMMR(-1))	-0.10	0.12
D(LnBASS)	3.05	3.08
D(LnBASS(-1))	-3.28	3.26
D(LnCP)	-2.53	1.64
D(LnCP(-1))	1.31**	0.67
D(LnPWRPC)	1.15***	0.52
D(LnPWRPC(-1))	0.74	0.41
D(LnFTES)	0.01	0.01
D(LnFTES(-1))	0.01	0.02
D(LnWSP)	1.10	1.05
D(LnWSP(-1))	0.23	0.23
C	-0.63*	0.35

Source: Authors' construct; ***Denotes 1% level of significance. **Denotes a 5% level of significance. *Denotes a 10% level of significance

reproductive health and FLFP. Further, it represents the speed of adjustment, which indicates that in the case of any shock in the explanatory variables, the system converges to equilibrium by 0.16% annually.

The findings indicate that CP is positively associated with FLFP in both the long and short run. A 1% increase in CP results in a 1.31% increase in FLFP in the short run and a 1.06% increase in the long run. Similarly, PWRPC has a positive long and short-run relationship with FLFP. A 1% increase in PWRPC leads to an increase of 1.15% in FLFP in the short run and a 0.26% increase in the long run. The model also identifies a positive long-run

Table 6 Optimal lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-712.73	NA	0.00	6.68	6.82	6.74
1	2317.75	5780.35	0.00	-20.63	-19.22*	-20.06
2	2512.05	354.41	0.00*	-21.67*	-19.00	-20.59*
3	2565.84	93.64	0.00	-21.42	-17.49	-19.83

Source: Authors' construct; * indicates lag order selected by the criterion. LR: sequential modified LR test statistic (each test at 5% level). FPE: Final prediction error. AIC: Akaike information criterion. SC: Schwarz information criterion. HQ: Hannan-Quinn information criterion

relationship between FTES and FLFP. A 1% increase in FTES leads to a 0.11% increase in FLFP in the long run. The results suggest that countries with higher female enrollment in higher education tend to exhibit higher levels of labour market participation among women over time. Contrary to the existing literature, the results show that MMR is positively associated with FLFP in the long run. A 1% increase in the MMR leads to a 0.58% increase in FLFP. While the result seems counterintuitive to the existing literature, it might still be true in South Asia due to several interconnected factors.

7.1 D-H causality test

There is a potential reverse causality between FLFP and the independent variable. The estimated PARDL model does not provide information regarding the direction of temporal relationships among the variables. Therefore, to investigate further, the study performed a D-H Granger causality test. The test allows for heterogeneity across countries and assesses whether past values of one variable can predict changes in another over time. Table 8 presents the result, which shows that bidirectional Granger causality exists between CP and FLFP. On the other hand, a unidirectional Granger causality runs from MMR to FLFP, and FTES to FLFP. These findings suggest that past values of these variables help predict changes in female labour force participation.

8 Discussion

The results reinforce findings from prior studies (Ajakaiye & Mwabu, 2010; Canning and Schultz 2012), suggesting that South Asian countries with better access to reproductive healthcare and education increase women's labour market participation.

The positive association between contraceptive prevalence and FLFP may reflect country-level patterns in which broader access to family planning services contributes to changes in fertility behaviour, potentially facilitating greater workforce engagement among women over time. Similarly, the positive association between prenatal care (PWRPC) and FLFP aligns with previous evidence from Bangladesh, where improved maternal health services have been linked to better economic outcomes for women (Canning and Schultz 2012). Although the analysis is conducted at the macro-level, the result is consistent with the argument that investment in reproductive health may reduce pregnancy-related complications and enable women to actively participate in economic activity at a national scale.

The positive long-run relationship between female tertiary education enrollment and FLFP also corresponds with the literature on the feminisation U-shape hypothesis (Goldin 1994; Mammen and Paxson 2000), which posits that economic development initially reduces but

Table 8 Result of the D-H causality (null hypotheses) test concerning FLFP

	W-Stat.	Zbar-Stat.	Direction
<i>CP, BASS (bidirectional)</i>			
LnCP ≠ LnFLFP	4.003***	2.155***	LnCP ↔ LnFLFP
LnFLFP ≠ LnCP	7.356***	6.123***	
LnBASS ≠ LnFLFP	5.017***	3.356***	LnBASS ↔ LnFLFP
LnFLFP ≠ LnBASS	4.115***	2.287***	
<i>AFR, MMR, TFR (unidirectional)</i>			
LnAFR ≠ LnFLFP	6.003***	4.522***	LnAFR → LnFLFP
LnFLFP ≠ LnAFR	2.383	0.238	
LnMMR ≠ LnFLFP	4.499***	2.743***	LnMMR → LnFLFP
LnFLFP ≠ LnMMR	3.203	1.208	
LnTFR ≠ LnFLFP	4.326***	2.538***	LnTFR → LnFLFP
LnFLFP ≠ LnTFR	2.583	0.474	
LnFTES ≠ LnFLFP	5.541***	3.975***	LnFTES → LnFLFP
LnFLFP ≠ LnFTES	1.169	-1.198	
<i>PWRPC, WSP (No causality)</i>			

Source: Authors' construct; ***Denotes 1% level of significance. **Denotes a 5% level of significance. *Denotes a 1% level of significance. ≠ Denotes no causality, whereas → and ↔ denote unidirectional and bidirectional causality.

later increases women's participation in the labour force, particularly as educational investments accumulate. While the study does not directly test this hypothesis at the micro level, the long-run trend observed is consistent with this broader structural dynamic in South Asia.

Interestingly, MMR shows a counterintuitive positive association with FLFP. This may be due to unique socio-economic conditions in South Asia. With 64.18% of the population living in rural areas (WDI, 2022), high maternal mortality is often linked to poverty, inadequate healthcare, and early marriages. Despite such conditions, women engage in subsistence work for household survival, increasing FLFP. Therefore, countries' wealth¹ and development is correlated with female health and labour force participation. This might explain how higher MMR leads to higher FLFP. Secondly, the positive impact of MMR on FLFP can be analysed from a theory of the "time allocation" (Becker 1965) and "risk-sharing models in the household". These works highlight the household coping mechanism against a shock, particularly for low-income economies, which is also applicable to South Asia, where the death of women due to maternity complications leads to a household shock that creates a loss of care work, labour supply and household income. Therefore, to compensate for the loss, the other female members of the family take paid work, which increases FLFP.

¹ The positive correlation between female mortality rates and labor market participation may also be influenced by a country's gross domestic product per capita (GDPPC). In nations with lower GDPPC, maternal mortality rates (MMR) tend to be higher, and female labor force participation (FLFP) is also elevated. To explore this relationship, the paper attempted to include GDPPC as a variable, but it led to a higher R² but insignificant t values suggesting the presence of multicollinearity (Gujarati, (Gujarati 2003)). As a result, the paper preferred to drop the variable.

Another logical reason could be that an increase in MMR can shock the female labour force supply, which may raise the wage level for such work. The labour market segmentation and gender role theory argues that the labour market is not perfectly competitive and is divided into segments based on various attributes such as gender, skill, class and cast. Hence, an increase in MMR could create a labour supply shortage that men cannot fill. This leads to an increase in wages, which might lure other women to join the workforce. Though the increased wage rate for women cannot exclusively be due to the shock to FLFP due to higher MMR, the effect of such a shock on the wage rate cannot be ruled out. Therefore, assuming that the wage hike might lure the surviving women to participate in the labour market is not illogical.

9 Conclusion and policy implications

This study investigates the impact of women's reproductive health and women's empowerment on economic opportunities in the South Asian region using panel data from 1991 to 2021. The findings of the model provide evidence that both contraceptive prevalence and pregnant women receiving prenatal care have positive long and short-term impacts on female labour force participation (FLFP). This suggests that family planning, the use of modern contraceptives and better health facilities in terms of prenatal care support females to enter the labour market. Further, the result shows that female tertiary school enrolment has a long-run positive impact on FLFP. Empowering females through education empowers them to make strategic decisions in life and provides the required knowledge and skills to enter the labour market. The result of the estimate shows that the maternal mortality rate is positively associated with FLFP in the long run, and the paper tries to provide adequate justification. However, further investigation is still required. Additionally, the D-H causality test result indicates bidirectional Granger causality exists between CP and FLFP and BASS and FLFP. On the other hand, a unidirectional causality runs from AFR to FLFP, MMR to FLFP, and FTES to FLFP.

The study proposes that policymakers should increase funding for women's reproductive health programmes and expand access and awareness on using modern contraceptives. The government should also ensure cost-efficient prenatal and maternal health care. Further, females can be given special incentives to study beyond secondary school. Investment should be made in women's vocational and technical education tailored to market needs.

This study has several limitations. First, although the World Health Organization (WHO) has identified 17 indicators to comprehensively assess women's reproductive health—ranging from access to healthcare services and obstetric care needs to the prevalence of low birth

weight and infertility—comprehensive data for all these indicators are not consistently available across South Asian countries. Consequently, this study incorporates only six indicators based on data availability. Second, the results are based on macro data; hence, it does not capture individual behaviours or decision-making. Third, the findings are regionally aggregated and reflect South Asian trends. While this offers a broad understanding, country-specific analyses using micro-level data could yield more nuanced insights and effectively inform targeted and context-specific policy interventions.

Appendix

Table A.1: Information about extrapolated and interpolated data

Variables	Time Period (Method)	Country	
Contraceptive prevalence	1991-99 ^a , 2001-02 ^c , 2005-06 ^c , 2013 ^c , 2019 ^f , and 2021 ^c	Afghanistan	
	1992-94 ^c , 1998-99 ^f , 2008-09 ^c , 2012 ^c , 2017 ^c	Bangladesh	
	1991-99 ^a , 2001-2009 ^c , 212-2021 ^c	Bhutan	
	1991-92 ^a , 1994-98 ^c , 2001-22 ^c , 2009-2015 ^c , 2017-2021 ^a	India	
	1992-98 ^c , 20004-2006 ^c , 2010-16 ^c , 2018-2021 ^a	Maldives	
	1992-98 ^c , 2004-2006 ^c , 2010-16 ^c , 2018-2021 ^a	Nepal	
	1992-93 ^c , 1997-98 ^c , 2006-07 ^c , 2010-16 ^c , 2018-2021 ^a	Pakistan	
	1994-99 ^c , 2004-15 ^c , 2019-2021 ^a	Sri Lanka	
	Pregnant women receiving prenatal care and Births attended by skilled health staff	1991-99 ^a , 2001-02 ^c , 2005-06 ^c , 2013 ^c , 2019 ^f , and 2021 ^c	Afghanistan
		1991-93 ^b , 1995-96 ^c , 1998-99 ^c , 2008 ^c , 2015 ^c , and 2021 ^a	Bangladesh
1991-93 ^b , 1995-1999 ^c , and 2020-21 ^c		Bhutan	
1991-99 ^a , 2020-21 ^c		India	
1991-99 ^a , 2020-21 ^c		Maldives	
1991-99 ^a , 2020-21 ^c		Nepal	
1991-99 ^a , 2020-21 ^c		Pakistan	
1991-99 ^a , 2020-21 ^c		Sri Lanka	
Maternal mortality ratio	1991-1999 ^a	All countries	
Proportion of seats held by women in national parliaments	1991-04 ^a	Afghanistan	
	1991-95 ^a	Bangladesh,	
	1991-96 ^a	India, Maldives, Pakistan, Sri Lanka, Bhutan	
Female tertiary school enrolment	1992-2002 ^c	Maldives	

Source: Authors' construct; a, b, and c denote linear extrapolation, three-year moving average extrapolation, and linear interpolation, respectively

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Author contributions

(a) Surbhi Mishra: Data collection, data interpretation, and manuscript writing.
(b) Dukhabandhu Sahoo: Supervision and conceptualization.

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Data availability

The datasets generated and/or analysed during the current study are available in the World Development Indicator repository, <https://databank.worldbank.org/source/world-development-indicators>.

Declarations

Competing interests

The authors declare that they have no competing interests.

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