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Demographic transition and opportunities for development in Bangladesh from 1971 to 2100

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Abstract

There is significant variation in estimates and assumptions about Bangladesh's demographic trajectory, highlighting the need for reassessment. This study primarily utilizes data from the 2022 Revision of the World Population Prospects to examine the demographic transition in Bangladesh and highlight a key window of opportunity. It provides a comprehensive examination of population structure, fertility, mortality, and labor force participation to contextualize the transition stages. The analysis underscores that the theory of demographic transition cannot be applied universally as a "one-size-fits-all" model. The study demonstrates that, by analyzing the common features associated with the demographic transition, including birth rates, death rates, and population trends, a country can determine its specific stage in the transition process. In the case of Bangladesh, while categorized as a lower-middle-income nation, it has reached the fourth stage of demographic transition as of 2020. This is a notable development, as many lower-middle-income countries remain in earlier stages of transition. The study emphasizes that the period from 2020 to 2037 is critical for Bangladesh to realize the maximum demographic dividend. This opportunity hinges on ensuring that the working-age population has access to quality healthcare, education, and employment opportunities. The study also underscores the importance of creating employment opportunities, with a particular emphasis on increasing female labor force participation and skill development, as well as integrating socioeconomic, cultural, and gender considerations into demographic analyses. In addition, proactive planning for an aging population post-2037 is crucial to maintaining the demographic dividend and addressing economic and social challenges. Harnessing this window wisely will determine Bangladesh's long-term socioeconomic resilience and sustainable development trajectory.

Keywords: Bangladesh; Demographic transition; Demographic window of opportunity; Demographic dividend; Population pyramid

1. Introduction

Births, deaths, and migration are fundamental drivers of population size and age–sex distribution. Long-term shifts in these components shape population growth or decline. Historical and contemporary data indicate that, in most countries, mortality declines typically precede fertility declines. Consequently, countries experience a phase of population growth followed by a phase of population shrinkage, a phenomenon known as the "demographic transition" (Notestein, 1945; Thompson, 1929). The demographic transition essentially describes the evolution of a population from a pre-modern agricultural society marked by high birth and death rates to a post-modern urban industrial society characterized by low and stable birth and death rates (Bloom & Williamson, 1998; Kirk, 1996). While the five stages of the classical demographic transition model are well-documented (Cilliers, 2018), they are summarized as follows: an initial phase of high birth and death rates; a phase of declining mortality with sustained high fertility; a phase of rapid fertility decline; a phase of slow fertility decline and sustained low mortality; and finally, a phase of low, stabilized fertility and mortality. Some countries experience a fifth stage of very low stabilized fertility and mortality.

While the classical model serves as a useful heuristic, it assumes a linear and universal pathway. In this study, we adopt a more expansive conceptual framework that incorporates demographic dividend theory and the interplay between development and demography. This approach enables us to analyze Bangladesh's trajectory as a dynamic and policy-sensitive process rather than a predetermined route. By doing so, we transcend a merely descriptive presentation of indicators and contribute a unique conceptual perspective to the existing literature. We present empirical evidence from Bangladesh's post-independence period and critically assess how the country's experience challenges conventional applications of the model.

1.1. Literature review

Demographic transition presents various demographic, social, and economic opportunities and challenges (Bloom & Williamson, 1998; Kalemli-Ozcan, 2003; Mason & Lee, 2006; M. M. Islam, 2020; Navaneetham & Dharmalingam, 2012; Spoorenberg, 2008). The opportunities are time-sensitive and depend on policies targeting health, education, and employment. Importantly, the demographic changes can also yield significant social and economic advantages, commonly referred to as the "demographic dividend" or "demographic bonus" (Chalise, 2018). However, the demographic dividend is not automatic; its realization depends on socioeconomic, cultural, and policy contexts that shape health, education, gender equality, and labor market participation (United Nations Population Fund [UNFPA], 2022). The timeframe during which a country can capitalize on this demographic dividend is known as the "demographic window of opportunity" (Chalise, 2018). During this window, a nation typically has a large proportion of its population in the working-age group, characterized by good health, quality education, and decent employment opportunities, alongside a lower ratio of young and elderly dependents. With fewer children per household, families can often invest more in each child's development, provide greater opportunities for women to participate in the formal workforce, allocate additional resources to previously unaffordable needs, and enhance savings for retirement. Furthermore, with fewer older adults in households, healthcare and living costs tend to be lower for this demographic. When these elements align, the country's economic benefits can be substantial, enabling it to fully harness its demographic dividend (UNFPA, 2016).

This singular opportunity may not necessarily guarantee positive outcomes (UNFPA, 2022). The yield of the demographic dividend largely depends on how effectively a country prepares and organizes support for its population, particularly concerning good health, quality education, and decent employment for its working-age population (UNFPA, 2016). The literature suggests that countries that fail to align these factors often experience "demographic traps," in which the potential dividend does not translate into economic gains (Bairagi & Datta, 2001). To secure the demographic dividend, investing in infrastructure and human resource development is vital before the demographic window of opportunity (Haider, 2019). Thus, the demographic dividend should be viewed as both a theoretical and a practical construct reflecting the intersection of population dynamics with social policy, governance, and economic planning rather than as an automatic by-product of demographic change.

Numerous nations have previously undergone demographic transition and experienced low birth and death rates (Bongaarts, 2008). Bangladesh has also undergone several stages of demographic transition and may have opened the demographic window of opportunity. However, recent studies show considerable variation in estimates and assumptions about Bangladesh's demographic trajectory, underscoring the need for a critical reassessment (Karim *et al.*, 2025; S. Farid & Mostari, 2022). For instance, one study indicated that Bangladesh began reaping its demographic dividend in 1980, with the window remaining open until 2020 (Navaneetham &

Dharmalingam, 2012). Conversely, another study suggested that the demographic window of opportunity emerged in 1980 and would continue for 60 years until 2040 (Matin, 2012). A third study reported that this window began in the 1990s, peaked during the 2020s, and would remain open until the 2030s (M. M. Islam, 2016). More recently, a study asserted that the potential window of opportunity in Bangladesh opened in 1984 and is projected to last until 2037 (S. Farid & Mostari, 2022). Esha & Farid (2021) emphasized the challenges of sustaining the demographic dividend, particularly in the context of urbanization, migration, and gender disparities, while Streatfield & Karar (2008) documented the evolving policy landscape. These differences highlight the importance of addressing data uncertainties, considering regional and gender differences, and situating Bangladesh's demographic transition within both policy and international contexts.

1.2. Objectives

Against this backdrop, this study reassesses both the timing of the demographic transition and the window of opportunity in Bangladesh from 1950 to 2100. It does so not only by evaluating whether the five stages of demographic transition are evident in historical data but also by applying an expanded conceptual framework that links age–structure change to policy variables, such as female labor-force participation, education and skill development, migration flows, and health policy. By situating Bangladesh's experience alongside international evidence, we identify the conditions under which the demographic dividend can be maximized or lost. This integrated approach underscores the study's unique contribution beyond existing literature. Specifically, we investigate the timing of the demographic window of opportunity to identify the optimal period for maximizing the demographic dividend. Finally, by analyzing population pyramids at both the beginning and the end of the demographic window, we examine the distribution of the economically active and inactive population by age and sex, which has significant implications for harnessing the demographic dividend in Bangladesh.

2. Data and methods

2.1. Data

This study utilized de-identified population-level data sourced from three key secondary sources: the 2022 Revision of the World Population Prospects (United Nations [UN], 2022a), the World Bank (WB) (WB, 2020a), and the International Labor Organization (ILO) (International Labor Organization, Department of Statistics [ILOSTAT], 2020). The data include single-year population estimates and medium-variant projections, along with metrics, including the crude birth rate (CBR), crude death rate (CDR), rate of natural increase (RNI), net reproduction rate (NRR), total fertility rate (TFR), infant mortality rate (IMR), and life expectancy at birth (LE_0) in Bangladesh from 1950 to 2100, all sourced from the 2022 Revision of the World Population Prospects. These specific metrics were emphasized because they directly capture generational replacement (e.g., NRR), population momentum (e.g., RNI), and key health and fertility dynamics (e.g., TFR, IMR, and LE_0). The 2022 Revision of the World Population Prospects employs the cohort–component method and future survival probabilities to project total population figures (UN, 2022a). In addition, the labor force participation rate (LFPR)—defined as the proportion of the total population aged 15–64 years who are economically active—was obtained from the WB for the period 1990–2019. Due to the unavailability of post-2019 data, we carried the 2019 age-specific rates forward until 2100. We acknowledge that these model-based estimates may not fully capture regional or informal-sector employment, seasonal migration, or gender disparities, and therefore may not precisely quantify the working-age economic potential. Furthermore, data on the LFPR by 5-year age groups for individuals aged 15–59 in 2019, used to create the population pyramid, were sourced from modeled estimates by the ILO. To enhance robustness, we triangulated across multiple sources and explicitly discussed potential margins of error and assumptions in Section S1.

2.2. Measurements

This study used various standard demographic and economic indicators based on international definitions (ILOSTAT, 2020; UN, 2022a). The economically active population (EAP) comprises individuals aged 15 to 59 who participate in the labor market and produce goods and services during a specific period. In contrast, the economically inactive population (EIP) comprises individuals in the same age range who are not engaged in such activities.

The CBR and CDR represent the number of live births and deaths per 1000 people in the mid-year population, respectively. The RNI is the difference between the CBR and the CDR. The TFR indicates that the average number of children a woman would have over her reproductive years (ages 15–49), while the NRR estimates the average number of daughters a woman would have, accounting for mortality. The IMR reflects the probability of dying before age one per 1,000 live births. LE_0 indicates the average number of years a newborn is expected to live based on current mortality conditions.

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2.3. The outcome variable for the timing of the demographic window

Using a dependency-ratio-based approach, the demographic window is defined as the period during which the proportion of the working-age population (ages 15–59) outnumbers both dependent children (ages 0–14) and older adults (ages 60 and above), yielding the lowest total dependency ratio. This period represents a significant opportunity for a country to potentially maximize its demographic dividend. In this study, we identify the demographic window as the years when the working-age population comprises approximately 64–65% of the total population and when dependency ratios reach their minimum levels.

2.4. Analytical strategies

Bangladesh achieved its independence in 1971, and our main analysis focuses on the period from 1971 to 2100. However, to capture the full demographic trajectory, pre-independence trends (1950–1970) are also included for contextual understanding, particularly for the first stage of the demographic transition. To explore the demographic transition and window of opportunity in Bangladesh, we plotted CBR, CDR, and total population from 1950 to 2100. From 1971 to 2100, we categorized the total population into three broad age groups: (i) children aged 0–14 years, (ii) working-age individuals aged 15–59 years, and (iii) older adults aged 60 years and above. This categorization reflects national retirement and old-age conventions and aligns the analysis with international demographic research. In various sectors, Bangladesh defines old age as 60 and older, with a retirement age of 59 years (M. S. Islam *et al.*, 2022). The working-age population was further segmented into the EAP and the EIP. We then plotted the total population by these broad age groups from 1971 to 2100 to assess Bangladesh's demographic window of opportunity.

In addition, population pyramids were generated at the beginning and end of the demographic window of opportunity to visualize age–sex composition and the proportion of economically active versus inactive populations. Subsequently, we plotted RNI, NRR, TFR, IMR, and LE_0. Rather than treating these indicators as purely descriptive, we interpret them through an expanded theoretical lens that integrates demographic dividend theory and development–demography interactions. This enables us to critically examine the conventional model, highlight the policy sensitivity of Bangladesh's demographic trajectory, and explore potential deviations resulting from climate, migration, or labor-force shocks. We provide a detailed discussion of assumptions and methodological constraints—including data uncertainties, margins of error, and the possibility that global projections may mask national or regional variations—to ensure transparency and enhance the robustness of our conclusions in Section S1.

3. Results

3.1. Stages of the demographic transition in Bangladesh

Figure 1 presents the CBR, CDR, and total population trends, illustrating Bangladesh's various stages of demographic transition from 1950 to 2100. The conventional characteristics of demographic transition stages and their corresponding CBR and CDR trends (Cilliers, 2018) do not match exactly with Bangladesh's CBR and CDR trends. Therefore, based on the similarities observed between conventional transition characteristics and Bangladesh's trends, five stages of demographic transition are identified from 1950 to 2100.

From 1950 to 1970, Bangladesh (formerly East Pakistan) was in the first stage of demographic transition. This stage was characterized by high CBR, high but fluctuating CDR, and a slow but steady increase in population from 39.7 to 67.5 million. The second stage of transition began in 1971. It continued until 1985, characterized by high but decreasing CBR, rapidly declining CDR, and a rapid increase in population from 68.4 to 96.0 million. The Liberation War contributed to the high CDR of 41.0 in 1971, and the CDR was 17.1 in 1972. The third stage of the demographic transition began in 1986. It continued up to 2019, characterized by decreasing CBR, a slow decline in CDR, and a rapid increase in population from 98.3 to 165.5 million (for yearly data on CBR, CDR, and total population, Table S1). The increase in population slowed down at the end of this stage.

The fourth stage of the demographic transition started in 2020. It is estimated to continue until 2067 and may not resemble the conventional characteristics of the fourth stage of demographic transition. In the fourth stage of demographic transition, Bangladesh is estimated to experience a slow declining CBR, rising CDR, and increasing population from 167.4 million in 2020 to a peak of 206.9 million in 2060–62, then to 205.9 million in 2067. The fifth stage of demographic transition is projected to start in 2068 and continue until 2100. The characteristics of the fifth stage of demographic transition in Bangladesh may not follow the conventional characteristics. In the fifth stage, Bangladesh will experience a very slow decline in CBR, a slow rise in CDR, and a decline in population from 205.5 to 176.4 million. The five stages of demographic transition, along with their intrinsic characteristics for Bangladesh, are outlined in Table 1.

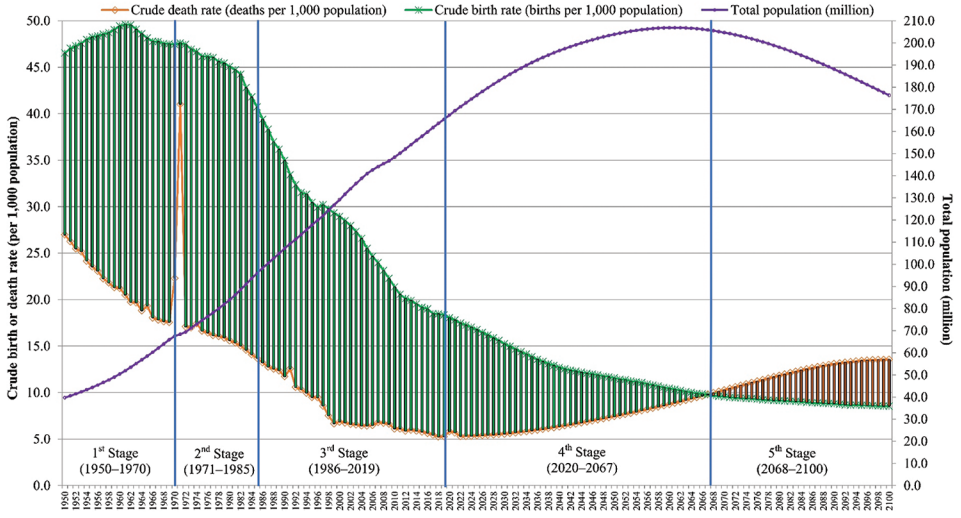

Figure 1. Stages of the demographic transition in Bangladesh from 1950 to 2100
Source: Authors' calculations based on data from the 2022 Revision of World Population Prospects (UN, 2022a).

Table 1. Conventional (and intrinsic for Bangladesh) characteristics of birth rate, death rate, and natural increase by stage of demographic transition

Stage of demographic transition	Characteristics	Birth rate	Death rate	Natural increase
First stage	Conventional	High	High	Stable or slow increase
	Intrinsic for Bangladesh	High	High but fluctuating	Slow but steady increase
Second stage	Conventional	High	Falls rapidly	Very rapid increase
	Intrinsic for Bangladesh	High but falling	Rapid declining	Rapid increase
Third stage	Conventional	Falling	Falls more slowly	Increase slows down
	Intrinsic for Bangladesh	Falling	Slow declining	Increase slows down at the end of the period
Fourth stage	Conventional	Low	Low	Falling and then stable
	Intrinsic for Bangladesh	Slow declining	Rising	Falling at the end of the period
Fifth stage	Conventional	Raising again	Low	Stable or slow increase
	Intrinsic for Bangladesh	Very slow declining	Slow rising	Falling

Source: Authors' calculations based on data from the 2022 Revision of World Population Prospects (UN, 2022a).

3.2. Fertility, mortality, and demographic window of opportunity in Bangladesh

After the 1971 Liberation War, Bangladesh experienced a high TFR of 6.8 births per woman and a high IMR of 151.3 deaths per 1,000 live births in 1972 (Figure S1 and Table S1). Since then, both the TFR and IMR have declined rapidly, reaching 2.0 and 24.0, respectively, in 2020. Demographic transition was dynamic over the period, resulting in longer LE_0 and a "demographic window of opportunity."

Due to high fertility and mortality, the age composition in Bangladesh was almost constant until 1990, with 42.9–45.5% of children aged 0–14 years, 49.4–51.8% working-age population aged 15–59 years (29.0–30.4% EAP and 20.4–21.4% EIP aged 15–59 years), and 5.1–5.5% older adults aged ≥60 years (Figure 2 and Table S2). The influence of successive fertility and mortality decline on the age composition is evident in 2012, with an increase in the older adults population aged ≥60 years by 1.5% percentage points, an increase in EAP aged 15–59 years by 5.2% percentage points, and EIP aged 15–59 years by 3.8% percentage points, and a decline in the children population. Apparently, the population is aging gradually over time. In 2020, the working-age population aged 15–59 years accounted for 64.3%, the older adults aged ≥60 years accounted for 8.8%, and children accounted for 27.0%. The percentage of the working-age population aged 15–59 years is estimated to reach its peak at 65.1% from 2024 to 2027 and to remain almost the same (64.0%)

from 2020 to 2037. This indicates that in the next 17 years, from 2020 to 2037, the country will add 26.1 million people to its total population, but there will be no change in the percentage of the working-age population and the dependents (sum of children and older adults; considering no unemployment among the working-age population) due to declining fertility and mortality. Consequently, the period from 2020 to 2037 appears to be the window of opportunity for reaping the highest demographic dividend in Bangladesh.

3.3. Population pyramid and proportion of working-age population during the demographic window of opportunity in Bangladesh

Figures 3 and 4 present the population pyramids of Bangladesh for 2020 and 2037, respectively, which illustrate

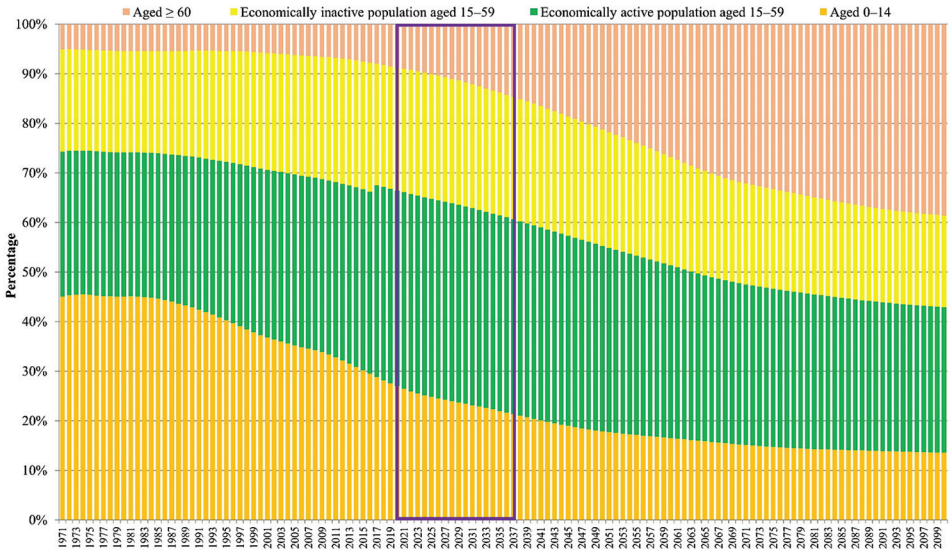

Figure 2. Percentage of total population by broad age groups (0–14, economically active population aged 15–59, economically inactive population aged 15–59, and ≥60) from 1971 to 2100, and the demographic window of opportunity from 2020 to 2037
Source: Authors' calculations based on data from the 2022 Revision of World Population Prospects (UN, 2022a), the World Bank (WB, 2020), and the International Labor Organization, Department of Statistics (ILOSTAT, 2020).

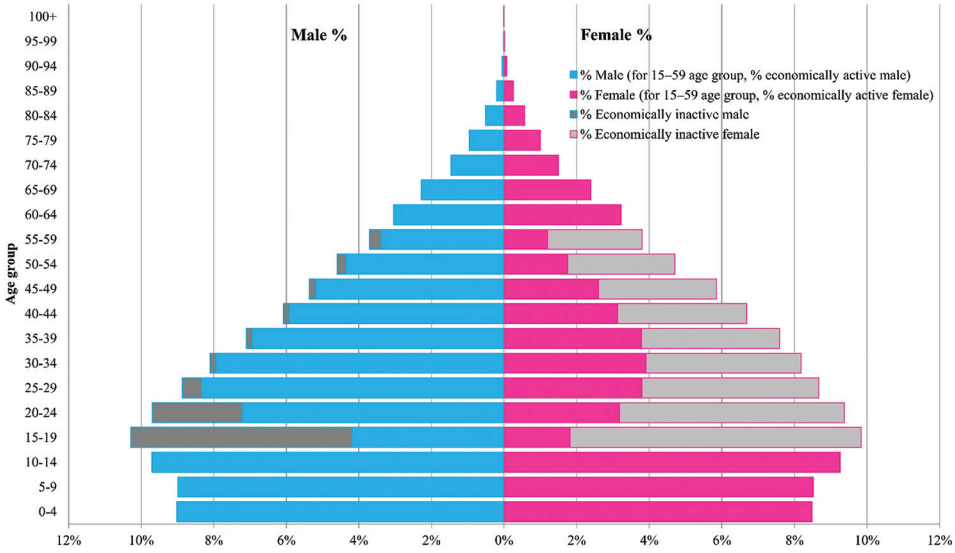

Figure 3. Population pyramid of Bangladesh in 2020
Note: The latest available sex-specific labor force participation rate for 2019 was used to generate the economically active and inactive population for 2020.
Source: Authors' calculations based on data from the 2022 Revision of World Population Prospects (UN, 2022a), the World Bank (WB, 2020), and the International Labor Organization, Department of Statistics (ILOSTAT, 2020).

the changes in population composition by age and sex at the beginning and end of the demographic window of opportunity (the corresponding values are provided in Table S3). With declining RNI and increasing LE_0 (Figure S1), the 2020 age–sex pyramid appeared to be an expansive but aging population pyramid (Figure 3). With 27% children, 64.3% working-age population, and 8.8% older adults, the highest percentage of the population (20.1%) stayed in the age group of 15–19 years. The proportion of the EIP decreased with increasing age. Among the working-age population, females have a larger share of the EIP than males. Moreover, females aged 15–59 years were disproportionately likely to be economically inactive.

With further declines in RNI and increasing LE_0 (Figure S1), the 2037 age–sex pyramid still appears to be an expansive but aged population pyramid (Figure 4). With 21.4% children, 64.0% working-age population, and 14.7% older adults, the highest percentage of the population (16.1%) would stay in the age group of 30–34 years. As the pyramids show males (100% in total) on the left side and females (100% in total) on the right side, despite using the latest available sex–specific LFPR of 2019 for 2020 to 2100, the proportions of the economically active and inactive population in 2037 appear to be only slightly different from what they were in 2020.

4. Discussion

This study employs comprehensive data, primarily sourced from the 2022 Revision of the World Population Prospects, to delineate the stages of demographic transition in Bangladesh. It also identifies a demographic window of opportunity between 2020 and 2037, offering significant potential for capitalizing on the demographic dividend. Furthermore, the study illustrates population pyramids that display EAP and EIP aged 15–59 at the beginning and end of this demographic window. By integrating empirical data and conventional demographic transition theory, this study provides a nuanced understanding of Bangladesh's population dynamics, extending prior work that focused largely on descriptive trends. In addition, this analysis places Bangladesh's demographic transition within the broader global context. For example, countries in East Asia, such as South Korea and Singapore, have successfully maximized their demographic dividends through early and large-scale investments in education, industrialization, and governance reforms. In contrast, many sub-Saharan African countries have faced challenges due to weak labor markets and institutional barriers (Mason & Kinugasa, 2008). Bangladesh represents an intermediate case—it has experienced a rapid decline in fertility (WB, 2020b); however, persistent structural constraints, such as limited job creation and gender differences in participation, may hinder the full realization of the dividend. The insights from this study are intended to assist the government and policymakers in crafting a strategic roadmap to effectively leverage the working-age population, particularly the inactive female population, to pursue Bangladesh's economic and sustainable development goals.

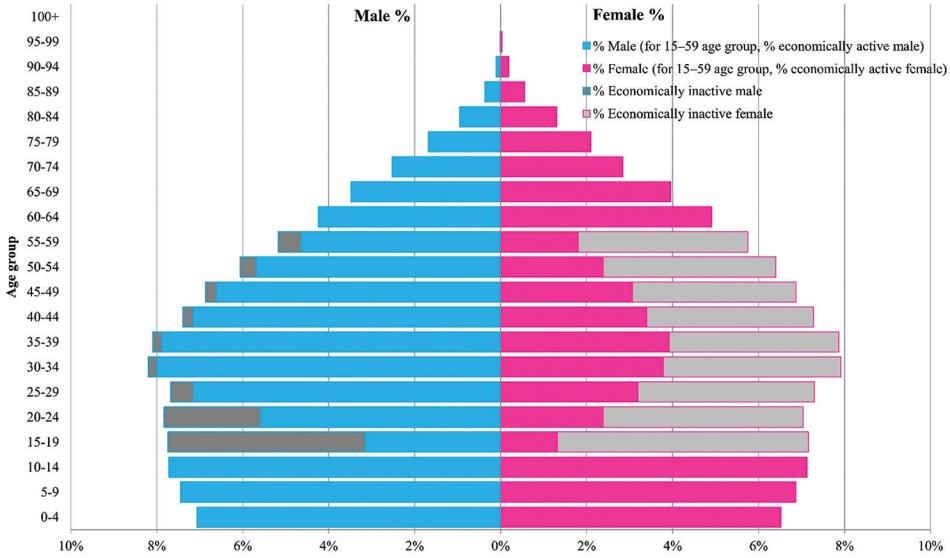

Figure 4. Projected population pyramid of Bangladesh in 2037
Note: The latest available sex-specific labor force participation rate for 2019 was used to generate the economically active and inactive population for 2037.
Source: Authors' calculations based on data from the 2022 Revision of World Population Prospects (UN, 2022a), the World Bank (WB, 2020), and the International Labor Organization, Department of Statistics (ILOSTAT, 2020).

The present study indicates that Bangladesh entered the second stage of the demographic transition in 1971 and completed it in 1985. Subsequently, it entered the third stage in 1986 and ended in 2019. Bangladesh began the fourth stage of demographic transition in 2020 and is expected to transition to the fifth stage in 2068, following its completion of the fourth stage in 2067. These timelines provide clarity in a context where prior studies have presented inconsistent stage durations (M. M. Islam, 2016; S. Farid & Mostari, 2022), highlighting the value of systematic, long-term empirical assessment. In analyzing Bangladesh's five stages of demographic transition, along with their characteristics and timelines, it is essential to consider both conventional characteristics (Table 1) and empirical data (Figure 1). However, these timelines should not be interpreted as fixed or deterministic; instead, they are contingent on socioeconomic transformation, policy effectiveness, and external shocks, such as migration, climate-related displacement, and public health crises. This recognition highlights the sensitivity of demographic projections and underscores the need for flexible, adaptive planning.

Theoretical understanding suggests that during the fourth stage of demographic transition, birth and death rates are low, resulting in stable population growth. Typically, most developed countries—characterized by stronger economies, higher levels of education, better healthcare systems, a greater proportion of working women, and a fertility rate of around two children per woman—are considered to be in this stage (Grover, 2014). The trends presented in Figure 1 do not align with the demographic transition theory. With a fertility rate of about two children per woman, Bangladesh is categorized as one of the lower-middle-income countries facing significant structural barriers to sustainable development (WB, 2024). Notably, the Bangladesh Demographic and Health Survey has consistently reported a TFR of 2.3 across four consecutive surveys conducted in 2011, 2014, 2017, and 2022 (National Institute of Population Research and Training & ICF, 2023). This highlights that while Bangladesh is progressing into the fourth stage of demographic transition, structural and socioeconomic constraints may limit the conventional demographic dividend typically observed in high-income countries. The decline in fertility rates in Bangladesh has been shaped not only by economic modernization but also by cultural transformations, women's education-driven empowerment, and the success of family planning initiatives since the 1980s (Bora *et al.*, 2022). Meanwhile, reductions in mortality rates have been facilitated by advances in immunization, maternal health programs, and rural primary healthcare initiatives. These social, cultural, and gender-related factors demonstrate that demographic transition is not merely a statistical process but one embedded in broader societal change.

The impact of successive declines in fertility on age composition is evident, leading to gradual population aging. This aging trend aligns with patterns observed in other lower-middle-income countries undergoing demographic transition (Bairagi & Datta, 2001; Streatfield & Karar, 2008). However, unlike East Asian nations that entered their aging phase after reaching high per capita incomes, Bangladesh confronts the challenge of "aging before affluence." If adequate health and pension systems are not developed in a timely manner, this situation could further exacerbate vulnerabilities within the population. As a result of the concurrent trends in CBR and CDR, Bangladesh is currently experiencing the fourth stage of demographic transition, creating a "demographic window of opportunity" from 2020 to 2037. During this period, the country's population will exhibit an age structure particularly advantageous for economic development, featuring a larger proportion of individuals in the working-age group and a smaller proportion of young and elderly dependents. Nonetheless, this opportunity should be viewed as contingent rather than guaranteed, as labor market absorption, external migration flows, and vulnerability to climate change may influence the extent to which the dividend is realized. However, existing literature showed inconsistent information on the duration of this demographic window in Bangladesh. For example, one study reported the window as "1980–2020" (Navaneetham & Dharmalingam, 2012), while others cited "1980–2040" (Matin, 2012), "1990s–2030s" (M. M. Islam, 2016), and "1984–2037" (S. Farid & Mostari, 2022). These discrepancies underline the need to standardize definitions of the working-age population and adopt consistent methodologies for estimating demographic windows. Utilizing the same criteria as the present study but drawing on data from the 2019 Revision of World Population Prospects, another study identified "2020–2040" as the demographic window of opportunity for Bangladesh (M. S. Islam *et al.*, 2022).

The period from 2020 to 2037 represents a significant demographic window of opportunity for Bangladesh to fully capitalize on its demographic dividend. However, this timeframe is not guaranteed; labor force participation variations, economic fluctuations, and external factors, such as climate events or migration, could all impact the potential outcomes. This potential can be realized if the working-age population benefits from good health, access to quality education, and decent employment opportunities. Effectively harnessing the demographic dividend requires substantial investment in the education and health sectors to cultivate high-quality human capital (Zulu, 2014). The

demographic dividend has the potential to enhance per capita income and to increase savings and investments in the Bangladeshi economy (Gómez & Hernández de Cos, 2008; Jafrin *et al.*, 2021). The manifold benefits of harvesting the demographic dividend were outlined in the Introduction section. This highlights the importance of policy coherence across education, health, and labor markets. Thus, ensuring decent employment for the entire working-age population will be crucial to maximizing the demographic dividend in Bangladesh during the 2020–2037 timeframe. In addition, future analyses could explore different methods, as described by Zou *et al.* (2024), to enhance the estimation of the demographic window.

The current LFPR stands at 61.4% of the total population as of 2019, highlighting the significant challenge of generating enough jobs to accommodate the growing working-age population in the country (Fan, 2017). While the increase in the female LFPR from 31.1% in 2010 to 38.5% in 2019 is a positive development, it remains insufficient to fully leverage the potential demographic dividend anticipated in Bangladesh between 2020 and 2037. This highlights the gendered dimension of labor market participation and underscores the need for targeted interventions to expand opportunities for women. At present, the country faces rising youth unemployment, human-capital constraints, a shortage of trained workers, low female labor-force participation, and a fluctuating savings rate. These factors may impede the realization of demographic dividends and economic growth (Jafrin *et al.*, 2021). Due to social barriers, women's participation in the job market is limited, and many provide unpaid care and services within their households. Future strategies must therefore emphasize vocational training, gender-inclusive employment policies, and greater integration of women into the formal sectors.

A significant yet often overlooked factor affecting the labor force in Bangladesh is the high proportion of economically inactive women of working age. This issue is largely due to cultural norms and religious conservatism in Muslim-majority contexts (Heath & Jayachandran, 2016; Klasen, 2019). While female labor force participation has increased, social expectations and household responsibilities continue to present substantial barriers. Future policy interventions should prioritize gender-inclusive employment strategies, childcare support, and incentives for integrating the female workforce. In the near future, factors such as gradual secularization, improved female education, and globalization—particularly the growth of the ready-made garment sector—may enhance participation rates. Furthermore, gender-inclusive hiring policies by international buyers could further promote this change. However, if socio-cultural barriers persist, the economic potential of many working-age women may remain underutilized, thereby limiting the demographic dividend.

By the end of the demographic window of opportunity in 2037, the demographic transition is estimated to yield an aged population pyramid, with approximately 14.7% (28.4 million) of the population aged 60 years or more. If effective planning for the issues and healthcare needs of older adults is not implemented by 2037, a significant portion of the demographic dividend achieved between 2020 and 2037 may have to be allocated post-2037 to address the needs of this aging population, turning the demographic dividend into a missed opportunity. By 2050, with approximately 21.3% (43.4 million) of the population comprised older adults, Bangladesh will face the challenges and demands of an aging society (UN, 2022a). This highlights the need for forward-looking policies that address retirement, healthcare systems, and long-term care. Although there have been observations of compression of morbidity and an increase in healthier older adults over time, policymakers and the government are urged to prioritize issues affecting older adults, particularly regarding disability, care needs, retirement age, and health systems (Tareque, 2022).

This study has a few limitations. Due to the unavailability of the LFPR for the 15–59 age group, we utilized the LFPR for the 15–64 age group to calculate the EAP and EIP. Given the mandatory retirement age of 59 in government services in Bangladesh, the LFPR for the 15–59 age group may be higher than that for the 15–64 age group. This may slightly underestimate the EAP, introducing potential bias in assessing labor force participation and the demographic dividend, but not the demographic window of opportunity. In addition, in the absence of LFPR data from 2020 onwards, we applied the 2019 LFPR for projections extending to 2100. Several factors, including industrial expansion, the creation of both informal and formal employment, labor market growth, and the rising female LFPR, are expected to increase the labor force volume in the coming decades (M. S. Islam *et al.*, 2022). Consequently, the proportions of EAP and EIP may differ from those shown in the 2037 population pyramid, as depicted in Figure 4. This limitation underscores that while long-term projections are useful, they should be interpreted with caution, and future research should update these analyses with updated LFPR data, revised retirement ages, and revised World Population Prospects. The age–sex distribution of the population is largely influenced by factors such as births, deaths, migration, economic conditions, warfare, political changes, social transformations, famine, and natural disasters (Tulchinsky & Varavikova, 2014). However, the traditional demographic transition model primarily focuses on birth, death, and natural increase, overlooking

other significant influences. In our demographic transition model illustrated in Figure 1, we considered total population figures rather than solely natural increase. Although all demographic indicators, including total population estimates from the 2022 Revision of World Population Prospects, accounted for migration, natural disasters, and the pandemic (e.g., COVID-19) (UN, 2022b), subsequent studies should incorporate new projections. The low- and high-variant projections from the 2022 World Population Prospects were not employed in this study. Due to the extensive data handling involved in our research, incorporating these projections fell outside the scope of our analysis. Future studies should consider using both the low- and high-variant projections, in addition to the medium-variant projections from the World Population Prospects, to better address uncertainties and enhance the accuracy of the estimates. Future analyses would also benefit from the explicit integration of population policies and health interventions in Bangladesh, including the national family planning program, community clinic initiatives, and rural health outreach efforts, all of which have shaped both fertility and mortality trends. In addition, migration—particularly labor migration to the Middle East and climate-induced internal migration—along with socioeconomic indicators, such as education, will play an increasingly critical role in shaping Bangladesh's demographic future.

5. Conclusions

Our study not only updates empirical evidence on Bangladesh's demographic transition but also advances understanding by integrating conventional demographic transition theory with country-specific data to delineate distinctive stages and timelines. It emphasizes that the theory of demographic transition cannot be universally applied as a "one-size-fits-all" model. By critically comparing conventional stage characteristics with actual CBR, CDR, and population trends, this study provides a methodological framework for identifying context-specific stages, which represents a novel contribution to demographic research in Bangladesh.

Our findings indicate that Bangladesh is currently in the fourth stage of demographic transition, with a demographic window of opportunity spanning from 2020 to 2037, providing a critical period to harness the potential demographic dividend. The study also underscores the importance of integrating socioeconomic, cultural, and gender considerations into demographic analyses. For example, highlighting the significant proportion of economically inactive women of working age and linking it directly to policy-relevant outcomes adds explanatory depth beyond descriptive statistics. Policymakers should therefore prioritize investments in quality education, healthcare, and employment generation, with a particular focus on enhancing female labor force participation and skill development to maximize the benefits of this demographic window. In addition, proactive planning for an aging population post-2037 is crucial to maintaining the demographic dividend and addressing economic and social challenges. Our study combines long-term projections with policy insights to provide a solid foundation for future research and practical interventions to promote rapid economic growth during the demographic window of opportunity.

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Conflict of interest

The authors declare that they have no competing interests.

Author contributions

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Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data

Data for this study were obtained from the 2022 Revision of World Population Prospects, the World Bank, and the International Labor Organization, which are publicly available at https://population.un.org/wpp/, https://data.worldbank.org/indicator/SL.TLF.ACTI.ZS, and https://www.ilo.org/shinyapps/bulkexplorer32/?lang=en&segment=indicator&id=EAP_2WAP_SEX_AGE_RT_A, respectively.

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