



Demographic Transition, Population Expansion, and Human Capital Formation in Pakistan: A Comparative Ecological Analysis

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Key Words

Pakistan; demographic transition; population growth; human capital; demographic dividend; fertility; public health; population ageing; migration

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Received: 25 July 2026

Accepted: 07 August 2026

Published: 21 September 2026

Citation: Dr. Hafiz Waqas Ahmed *et al.*, 2026. Demographic Transition, Population Expansion, and Human Capital Formation in Pakistan: A Comparative Ecological Analysis *Res. J. Med. Sci.*, 20:20-27, doi:10.59218/makrjms.2026.1.20.27

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ABSTRACT

Pakistan has experienced substantial demographic expansion since the mid-twentieth century. The population increased from 33,740,167 in the 1951 census to 241,499,431 in the 2023 census. Such expansion increases the absolute demand for healthcare, education, employment, housing, food, water, sanitation, transportation, and other infrastructure. Population size, however, is not synonymous with human capital. The developmental consequences of demographic change depend on survival, health, nutrition, education, skills, economic participation, reproductive autonomy, and institutional capacity. To quantify Pakistan's long-term population expansion and interpret its demographic position in comparison with India, China, Germany, and Italy within demographic-transition and human-capital frameworks. We conducted a descriptive comparative ecological study using longitudinal national demographic data. Pakistan's census population was examined from 1951 to 2023. India and China were selected as large-population comparators, while Germany and Italy represented advanced demographic-transition settings. Primary measures included population size, absolute and percentage population change, population multiplication factor, and compound annual growth rate (CAGR). Cross-national contextual indicators included total fertility rate, population growth, life expectancy, and the World Bank Human Capital Index. Pakistan-specific human-capital indicators included literacy and labor-force participation. All analyses were descriptive; no individual-level or causal inference was attempted. Pakistan's population increased by 207,759,264 inhabitants between 1951 and 2023, representing a 7.16-fold increase and cumulative growth of 615.76%. The corresponding CAGR over the 72-year interval was approximately 2.77%. Pakistan continues to experience above-replacement fertility, with a total fertility rate of 3.6 children per woman reported in the 2024–25 Household Integrated Economic Survey. Literacy among the population aged 10 years and older was 63%, while labor-force participation was 46.3%. India and China have progressed further through fertility transition, with China now experiencing population ageing and natural population decline. Germany recorded 654,241 births and 1,006,588 deaths in 2025, resulting in a natural decrease of 352,347; net migration of approximately 235,000 did not offset this deficit. Italy recorded approximately 355,000 births, 652,000 deaths, a total fertility rate of 1.14 children per woman, and net international migration of approximately 296,000 in 2025. Pakistan's demographic expansion represents substantial demographic scale and potential, but population size alone does not constitute human capital. The developmental implications of demographic change depend on the extent to which the population achieves good health, adequate nutrition, quality education, relevant skills, productive employment, and access to voluntary reproductive-health services. Population policy should therefore integrate voluntary fertility transition with sustained investment in human capability across the life course.

INTRODUCTION

Population growth is an important public-health and development issue in Pakistan. Rapid demographic expansion increases the absolute requirement for healthcare, education, housing, food, water, sanitation, transportation, employment, and other public services. Population size alone, however, provides an incomplete measure of demographic advantage or disadvantage.

Human-capital theory conceptualizes health, education, knowledge, and skills as forms of investment that can increase individual and societal productive capacity^[1,2]. Human development is also cumulative across the life course. Health and nutrition before and during pregnancy, childhood development, education, adolescent health, occupational opportunities, and healthy ageing all contribute to the capabilities of individuals and populations^[3,4].

The distinction between population size and human capital is particularly relevant to Pakistan. The 2023 Population and Housing Census recorded 241,499,431 inhabitants, compared with 33,740,167 inhabitants in the 1951 census for the territory represented by the historical West Pakistan population^[5,6]. This demographic expansion represents a major transformation in the country's population structure. Pakistan remains characterized by a comparatively young population and continuing population growth. The Household Integrated Economic Survey 2024–25 reported a total fertility rate of 3.6 children per woman, a literacy rate of 63% among persons aged 10 years and older, and 28% of children aged 5–16 years being out of school^[7]. The Labour Force Survey 2024–25 reported a labor-force participation rate of 46.3% and unemployment of 7.1%^[8].

International comparison provides additional demographic context. India has experienced substantial fertility decline while retaining a very large population. China has undergone a rapid fertility transition and subsequently entered a period of population ageing and natural population decline. Germany and Italy represent later stages of demographic transition characterized by very low fertility, ageing populations, and natural population decrease, with international migration playing an increasingly important role in population dynamics^[9,10,16,18]. The present study therefore examines demographic scale not simply as a numerical phenomenon but in relation to demographic transition and human-capital development.

Objectives

The objectives of this study were to:

- Quantify Pakistan's population expansion between the 1951 and 2023 censuses.
- Describe the trajectory of population growth across successive Pakistani censuses.

- Compare Pakistan's demographic position with India, China, Germany, and Italy.
- Compare selected demographic and human-capital indicators across the five countries.
- Interpret the findings within demographic-transition and human-capital frameworks.
- Identify public-health and development priorities relevant to Pakistan's demographic transition.

MATERIALS AND METHODS

Study Design: This was a descriptive comparative ecological study using longitudinal national demographic data.

The ecological unit of analysis was the country. Pakistan was the principal country of interest. India, China, Germany, and Italy were selected as comparator countries representing different demographic-transition contexts. Comparisons were descriptive and contextual and were not intended to establish causal relationships or provide counterfactual estimates.

Comparator Framework:

- India and China were selected because both are large-population countries that have undergone major demographic transitions since the mid-twentieth century.
- Germany and Italy were selected because they represent advanced demographic-transition settings characterized by very low fertility, population ageing, and negative natural population change.
- The comparator framework was designed to illustrate contrasting demographic trajectories rather than to rank countries according to a single measure of demographic performance.

Study Period and Data Sources: Pakistan's historical population analysis covered the national censuses conducted in 1951, 1961, 1972, 1981, 1998, 2017, and 2023^[5,6].

Cross-national demographic indicators were obtained from harmonized United Nations demographic series and World Bank World Development Indicators^[9,10]. Recent German demographic statistics were obtained from the Federal Statistical Office of Germany (Destatis), while recent Italian demographic statistics were obtained from the Italian National Institute of Statistics (ISTAT)^[16,18].

Pakistan-specific socioeconomic and human-capital indicators were obtained from the Pakistan Bureau of Statistics, including the Household Integrated Economic Survey 2024–25 and Labour Force Survey 2024–25^[7,8].

Variables and Operational Definitions: The principal demographic variable was total national population.

Historical demographic measures included:

- absolute population change;
- cumulative percentage population change;
- population multiplication factor;
- intercensal percentage change; and
- compound annual growth rate.

Cross-national contextual variables included:

- total fertility rate;
- annual population growth;
- life expectancy at birth;
- natural population change;
- net international migration;
- age structure; and
- human-capital indicators.

The World Bank Human Capital Index (HCI) was used as a standardized comparative indicator of expected human-capital formation ^[11]. The HCI represents the expected productivity of a child born today relative to a benchmark of complete education and full health.

Pakistan-specific indicators included literacy and labor-force participation. These indicators were interpreted separately because they measure different dimensions of human capital and are not interchangeable with the HCI.

Statistical Analysis:

- Absolute change = Final population – Initial population
- Percentage change = [(Final population – Initial population) / Initial population] × 100
- Multiplication factor = Final population / Initial population
- CAGR = [(Final population / Initial population)^{1/n} – 1] × 100

where n represents the number of years between the initial and final observations

All analyses were descriptive. No segmented regression, join point analysis, ecological regression, or individual-level causal analysis was performed.

Ethical Considerations: The study used publicly available aggregated national statistics and did not involve identifiable individual-level data or recruitment of human participants. Individual informed consent was therefore not applicable.

RESULTS

Pakistan's Long-Term Population Expansion
Pakistan's population increased from 33,740,167 in 1951 to 241,499,431 in 2023 ^[5,6].

Source:

- Pakistan Bureau of Statistics, Population and Housing Census 2023 ^[5,6].
- Between 1951 and 2023, Pakistan's population increased by 207,759,264 people. The 2023 population was 7.16 times the 1951 population, corresponding to cumulative growth of 615.76%. The CAGR over the full 72-year period was approximately 2.77%.
- The highest intercensal CAGR occurred during 1961–1972 at approximately 3.90%, followed by 1972–1981 at 2.87%. The rate subsequently declined during 1981–1998 and 1998–2017, before increasing modestly during 2017–2023.

Fertility and Human-Capital Context in Pakistan:

Pakistan remains in an earlier stage of fertility transition than the advanced-transition comparator countries. The 2024–25 HIES reported a total fertility rate of 3.6 children per woman ^[7].

The same survey reported literacy of 63% among persons aged 10 years and older and an out-of-school rate of 28% among children aged 5–16 years [7]. The Labour Force Survey 2024–25 reported a labor-force participation rate of 46.3% and unemployment of 7.1% ^[8].

These indicators demonstrate that demographic scale alone is insufficient for evaluating demographic opportunity. A large population can provide a substantial potential workforce and domestic market, but the developmental return from population growth depends on health, education, skills, and productive economic participation.

Comparative Human-Capital Indicators: The World Bank Human Capital Index provides a standardized cross-national measure of expected human-capital formation.

Source: World Bank Human Capital Index 2020 ^[11].

The HCI values indicate substantial differences in expected human-capital formation across the five countries. The index should not be interpreted as a measure of current national productivity or as evidence of a causal relationship between demographic size and human capital. Comparative Demographic Context

Sources: Pakistan Bureau of Statistics; United Nations Department of Economic and Social Affairs, Population Division; World Bank; Destatis; ISTAT ^[7,9,10,16,18].

The table illustrates the broad contrast between Pakistan's continuing population growth and the

Table 1: Population of Pakistan by Census Year, 1951–2023

Census Year	Population	Intercensal Increase (%)	CAGR for Intercensal Period (%)
1951	33,740,167		—
1961	42,880,378	27.09	2.43
1972	65,309,340	52.31	3.90
1981	84,253,644	29.01	2.87
1998	132,352,279	57.09	2.69
2017	207,684,626	56.92	2.40
2023	241,499,431	16.28	2.55

Table 2: World Bank Human Capital Index for Pakistan and Comparator Countries

Country	Human Capital Index, 2020
Pakistan	0.41
India	0.49
China	0.65
Italy	0.73
Germany	0.75

demographic conditions of countries that have progressed further through the fertility transition.

India and China: India provides a structurally relevant comparison because it combines a very large population with substantial fertility decline and a large working-age population. Its demographic trajectory demonstrates that large population size can coexist with significant progression through fertility transition [9,10].

China represents a later stage of demographic transition. After decades of rapid population expansion, fertility declined substantially and the country entered a period characterized by population ageing and natural population decline [9,10]. These trajectories demonstrate that demographic challenges change as countries move through the demographic transition.

Germany: Germany represents an advanced demographic-transition setting.

- In 2025, Germany recorded 654,241 live births and 1,006,588 deaths, producing a natural decrease of 352,347 people [16].
- Net international migration was approximately 235,000 people in 2025. This migration balance was insufficient to offset the natural decrease, and Germany's population declined by approximately 110,000 people during the year [16].

Italy: Italy represents a similar advanced-transition environment.

- According to ISTAT's 2025 demographic indicators, Italy recorded approximately 355,000 births and 652,000 deaths. The resulting natural balance was approximately –296,000 people [18].
- The total fertility rate declined to 1.14 children per woman. International immigration was approximately 440,000 and emigration approximately 144,000, resulting in net international migration of approximately

+296,000, which almost completely offset the negative natural balance [18].

DISCUSSION

Principal Findings

This study identified three principal findings:

- First, Pakistan experienced substantial demographic expansion between 1951 and 2023, increasing from 33.74 million to 241.50 million inhabitants. The population increased 7.16-fold, with cumulative growth of approximately 615.76%.
- Second, international comparison demonstrates that demographic challenges vary across stages of demographic transition. Pakistan continues to manage population growth and above-replacement fertility, whereas China, Germany, and Italy face demographic environments characterized by very low fertility, ageing, and natural population decrease.
- Third, population size and human capital are conceptually distinct. Population represents the demographic base from which human capability may be developed, whereas human capital depends on health, nutrition, education, skills, and opportunities for productive participation.

Population Size Does Not Equal Human Capital: A population of several hundred million people does not automatically represent an equivalent level of productive capacity.

The developmental consequences of demographic expansion depend on whether successive generations experience adequate health, nutrition, education, skills development, and access to productive employment. The World Bank Human Capital Index provides one standardized illustration of this distinction. The 2020 HCI was 0.41 for Pakistan, compared with 0.49 for India, 0.65 for China, 0.73 for Italy, and 0.75 for Germany [11].

These differences should not be interpreted as evidence that population size causes human-capital outcomes. The countries differ substantially in economic structure, institutions, education systems, healthcare systems, historical development, and social conditions.

Nevertheless, the comparison supports the broader proposition that demographic scale must be accompanied by investment in human capability.

Table 3: Selected Demographic Indicators for Pakistan and Comparator Countries

Indicator	Pakistan	India	China	Germany	Italy
Demographic-transition position	Earlier transition	Intermediate transition	Advanced transition	Advanced transition	Advanced transition
Recent total fertility rate	3.6	Near replacement	Below replacement	Very low	1.14
Recent population trajectory	Growth	Slow growth	Decline	Near-stable /declining	Near-stable /declining
Natural population change	Positive	Positive	Negative	-352,347 (2025)	Approximately -296,000 (2025)
Net international migration, 2025	—	—	—	Approximately +235,000+	Approximately 296,000
population ageing	Relatively limited	Increasing	Advanced	Advanced	Advanced

Pakistan's Demographic Opportunity Is Conditional:

A demographic dividend may emerge when declining fertility changes the age structure so that the proportion of people in working ages becomes relatively large compared with dependent age groups. However, a large young population does not automatically produce a demographic dividend. The potential benefit depends on:

- high childhood survival;
- adequate nutrition;
- voluntary fertility transition;
- quality education;
- relevant workforce skills;
- employment creation;
- women's participation in education and employment;
- effective healthcare;
- economic investment;
- institutions capable of translating human capability into productive activity.

Pakistan therefore possesses a demographic opportunity, rather than an automatic demographic dividend.

Fertility Transition and Reproductive Autonomy:

Pakistan's total fertility rate of 3.6 children per woman in 2024–25 indicates that fertility remains above replacement level ^[7].

Fertility transition is influenced by multiple factors, including education, age at marriage, desired family size, contraceptive access and utilization, child survival, socioeconomic circumstances, gender norms, and reproductive-health services.

Population policy should therefore support voluntary and informed reproductive decision-making. Accessible family-planning services, maternal healthcare, birth spacing, and reproductive-health education can enable individuals and couples to make informed decisions regarding fertility.

Education as Human-Capital Investment: Education is a principal mechanism through which demographic scale can be transformed into human capital.

Pakistan's literacy rate of 63% among persons aged 10 years and older and the reported 28% proportion of children aged 5–16 years who were out of school in 2024–25 demonstrate continuing educational challenges ^[7].

Improving enrollment alone is insufficient. Educational quality, foundational literacy and numeracy, completion rates, technical skills, digital competencies, and alignment between education and labor-market requirements are also important.

Women's Education and Economic Participation:

Women's education has implications for maternal and child health, reproductive decision-making, family size, household welfare, and children's educational opportunities.

Women's participation in productive employment is also important because it increases utilization of human capability already present in the population.

Policies that improve access to education, safe mobility, skills training, and equitable employment opportunities can therefore contribute to both human-capital development and demographic transition.

Lessons From China: China illustrates the long-term evolution of demographic transition. The country moved from rapid population growth to very low fertility, population ageing, and population decline.

The implication for Pakistan is not to reproduce China's historical population policies. Rather, China's experience demonstrates that demographic conditions evolve over time. Policies designed for a period of rapid population growth may become inappropriate when fertility falls substantially and population ageing accelerates.

Lessons From Germany and Italy: Germany and Italy demonstrate that the end of population growth does not eliminate demographic pressures. Germany's natural population decrease of 352,347 in 2025 exceeded its net international migration of approximately 235,000 ^[16].

Italy experienced a natural decrease of approximately 296,000 in 2025, which was almost completely offset by net international migration of approximately 296,000 ^[18].

These examples demonstrate the increasing importance of migration in ageing societies. They also illustrate the demographic importance of workforce replacement, population ageing, long-term care, social protection, and labor-market participation.

Public Health and Human-Capital Preservation: Public health contributes to human-capital development by preventing avoidable illness, disability, and premature mortality.

Preventable disease can result in losses in:

- educational participation;
- cognitive and physical development;
- household income;
- labor-force participation;
- workplace productivity;
- functional independence; and
- healthy life expectancy.

Public-health investment therefore contributes not only to population health but also to preservation of human capability across the life course.

Oral Health and Injury Prevention as Illustrative Applications: Oral health and injury prevention provide practical examples of the relationship between public health and productive life, but they were not independent empirical outcomes of this study.

Advanced oral disease, including oral cancer, can affect nutrition, speech, swallowing, psychological well-being, social participation, and employment. Similarly, road-traffic injuries can affect adolescents and working-age adults and may result in disability, prolonged absence from work, or premature mortality.

These conditions are therefore best understood within the broader human-capital framework as examples of potentially preventable losses of productive years rather than as findings directly generated by the present ecological analysis. From Population Control to Population Development The findings support a broader population-development approach.

Population development should combine:

- voluntary fertility transition
- maternal and child health
- adequate nutrition
- universal quality education
- women's education and economic participation
- preventive healthcare
- workforce skills

- productive employment
- social protection
- preparation for population ageing.

This approach recognizes the pressures associated with rapid population growth while maintaining a focus on improving health, capability, and opportunity.

Policy Implications for Pakistan:

Strengthen Maternal, Newborn, and Child Health: Investment in maternal nutrition, antenatal care, skilled childbirth, neonatal services, vaccination, and childhood survival should be treated as long-term human-capital investment.

Improve Nutrition: Prevention and treatment of childhood malnutrition and micronutrient deficiencies are important for physical growth, cognitive development, educational attainment, and future productivity.

Expand Quality Education and Skills: Pakistan should pursue both increased school participation and improved learning outcomes. Technical education, vocational training, digital skills, and workforce-oriented education should complement conventional academic pathways.

Support Voluntary Reproductive Health and Family Planning: Accessible, high-quality reproductive-health and contraceptive services should enable informed and voluntary decisions regarding family size and birth spacing.

Increase Productive Economic Participation: The demographic dividend requires employment opportunities as well as a large working-age population. Employment creation, entrepreneurship, industrial development, research, digital-sector development, and women's economic participation should therefore accompany demographic transition.

Prepare for Future Population Ageing: Pakistan's current young population should not be regarded as a permanent demographic condition. As fertility declines and survival improves, the age structure will eventually change. Health, social-protection, pension, and long-term-care systems should therefore incorporate future population ageing into long-term planning.

Strengths of the Study: This study has several strengths.

- First, the historical Pakistan analysis uses national census observations rather than convenience samples or single-year estimates.

- Second, the analysis incorporates the complete sequence of national census observations from 1951 through 2023.
- Third, the comparative framework includes both large-population transition countries and advanced-transition countries.
- Fourth, recent German and Italian demographic statistics were verified against official national statistical releases.
- Fifth, the study explicitly distinguishes demographic scale from realized human capital.
- Finally, the study integrates demographic-transition theory with human-capital and life-course public-health perspectives.

Limitations

Several limitations should be considered:

- First, the ecological design prevents individual-level causal inference and creates the possibility of ecological fallacy.
- Second, national averages may conceal substantial socioeconomic, geographic, gender, and rural–urban inequalities.
- Third, historical census methodologies and demographic definitions may have changed over time.
- Fourth, the 1951 population figure used for Pakistan represents the historical West Pakistan territory rather than the entire Dominion of Pakistan. East Pakistan, which is now Bangladesh, was part of the Dominion of Pakistan in 1951. Consequently, the 33.74 million figure should not be described simply as the population of the entire 1951 Dominion of Pakistan ^[5,6].
- Fifth, the comparator countries differ substantially in political, economic, institutional, cultural, and historical circumstances.
- Sixth, no comparator country constitutes a true counterfactual for Pakistan.
- Seventh, human capital is multidimensional and cannot be fully represented by a single index. The World Bank HCI is useful for standardized comparison but does not capture every dimension of health, education, skills, social inclusion, or labor-market participation.
- Eighth, the indicators used in cross-national comparison are not necessarily available for exactly the same years. Recent country-specific demographic statistics therefore serve primarily as contextual evidence rather than as perfectly synchronized measurements.

Finally, recent demographic estimates may be revised by national statistical agencies. The German and Italian

2025 statistics reported in this manuscript correspond to the official releases available at the time of revision.

Future Research: Future research should extend the present descriptive framework using harmonized longitudinal country-level datasets.

Potential variables include:

- population growth;
- total fertility rate;
- working-age population;
- dependency ratios;
- life expectancy;
- healthy life expectancy;
- maternal mortality;
- child mortality;
- health expenditure;
- education expenditure;
- years of schooling;
- literacy;
- labor-force participation;
- female labor-force participation;
- unemployment;
- GDP per capita;
- labor productivity;
- Human Capital Index; and
- net international migration.

Formal panel-data approaches, including fixed-effects or random-effects models, could subsequently examine associations among demographic structure, health, education, labor-market participation, and economic performance.

Such analyses would represent a distinct analytical stage from the descriptive ecological analysis presented in this study.

CONCLUSION

Pakistan experienced substantial demographic expansion between 1951 and 2023, with its population increasing from 33.74 million to 241.50 million. This represents a 7.16-fold increase and cumulative growth of approximately 615.76%.

Population growth of this magnitude creates substantial requirements for healthcare, education, employment, infrastructure, housing, food, water, sanitation, and other public services. At the same time, a large population provides a substantial base of human capability and potential productive capacity.

International comparisons demonstrate that demographic challenges evolve across the demographic transition. India has progressed through substantial fertility decline while retaining a very large population. China has moved from rapid demographic

expansion toward very low fertility, population ageing, and natural population decline. Germany and Italy face low fertility, natural population decrease, population ageing, and increasing demographic importance of international migration.

For Pakistan, the central policy challenge is therefore not simply the numerical management of population size. It is the development and effective utilization of human capability while supporting a voluntary and rights-based fertility transition.

The developmental significance of Pakistan's demographic scale will ultimately depend on the health, nutrition, education, skills, economic opportunities, reproductive autonomy, and productive participation of the people who constitute that population.

Pakistan's demographic future should consequently be approached through an integrated framework linking demographic transition with human-capital development and life-course public health.

Declarations:

- Ethics Approval and Consent to Participate
- Not applicable. The study used publicly available, aggregated secondary data and did not involve identifiable human participants.
- Consent for Publication
- Not applicable.
- Availability of Data and Materials
- All data analyzed in this study are publicly available through the Pakistan Bureau of Statistics, United Nations Department of Economic and Social Affairs Population Division, World Bank, Federal Statistical Office of Germany, and Italian National Institute of Statistics.
- Competing Interests
- The authors declare no competing interests.
- Funding
- No external funding was received for this study.

Author Contributions:

Hafiz Waqas Ahmed: Conceptualization; methodology; investigation; formal analysis; data curation; interpretation of demographic and public-health findings; writing—original draft; writing—review and editing; supervision.

Munazza Kafait: Conceptualization; investigation; literature review; interpretation of oral-health and preventive-health implications; writing—review and editing; critical revision of the manuscript.

Alice Marie Quirk: Conceptualization; interdisciplinary interpretation; literature review; writing—original

draft; writing—review and editing; critical revision of the manuscript.

Arduizur “Carli” Richie-Zavaleta: Conceptualization; methodology; public-health and health-equity interpretation; policy analysis; writing—review and editing; critical revision of the manuscript.

Huma Sadaqat: Conceptualization; investigation; literature review; interpretation of population-health and mental-health implications; writing—review and editing; critical revision of the manuscript.

All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

Author confirmation: The CRediT roles assigned to Munazza Kafait and Huma Sadaqat should be confirmed by those authors before submission to ensure that they accurately represent their actual contributions

Acknowledgements: The authors acknowledge the national statistical agencies and international organizations responsible for collecting, validating, and disseminating publicly accessible demographic, health, educational, and socioeconomic data.

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