

UNEQUAL BEGINNINGS: INTERPROVINCIAL INEQUALITIES AND SOCIOECONOMIC AND DEMOGRAPHIC DETERMINANTS OF INFANT MORTALITY IN PAKISTAN

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Abstract

Infant mortality remains a critical indicator of population health and reflects the combined influence of maternal health conditions, new-born care practices, socioeconomic inequalities, and health system performance. Although Pakistan has achieved gradual improvements in child survival over recent decades, substantial disparities persist across provinces and administrative regions. This study examines provincial inequalities and determinants of infant mortality rate (IMR) in Pakistan using data from the latest available Multiple Indicator Cluster Surveys (MICS6) conducted in Punjab, Sindh, Khyber Pakhtunkhwa (KP), Balochistan, Azad Jammu and Kashmir (AJ&K), and Gilgit-Baltistan (GB). A comparative descriptive research design is employed to analyze variations in IMR according to socioeconomic characteristics, including place of residence, maternal education, and household wealth status, and demographic factors including child sex, maternal age at birth, birth order, and previous birth interval. The findings reveal considerable regional variation in infant survival outcomes, with Punjab reporting the highest IMR (60 deaths per 1,000 live births), followed by AJ&K (51), Balochistan (48), GB (43), Sindh (39), and KP (35). The analysis demonstrates strong socioeconomic gradients, where infants from poorer households and those born to mothers with lower educational attainment experience higher mortality risks. Demographic characteristics also play an important role, with adolescent motherhood, high birth order, and short birth intervals associated with increased infant mortality. The findings indicate that infant mortality in Pakistan is shaped by the interaction of regional inequality, socioeconomic disadvantage, reproductive behaviour, and health system effectiveness. The study argues that reducing infant mortality requires a region-specific strategy rather than a uniform national approach. Policy interventions should prioritize maternal education, poverty reduction, improved reproductive health services, skilled birth attendance, neonatal care, and equitable access to healthcare facilities, particularly in geographically disadvantaged and underserved regions.

1. INTRODUCTION

Infant mortality rate (IMR) is widely recognized as one of the most sensitive indicators of population health, reflecting the combined effects of maternal health conditions, pregnancy outcomes, newborn care practices, socioeconomic development, and healthcare system performance. Unlike broader childhood mortality indicators, IMR specifically captures vulnerabilities during pregnancy, delivery, and the first year of life, making it an important measure of maternal and neonatal healthcare effectiveness. High infant mortality often indicates deficiencies in antenatal care, skilled birth attendance, newborn management, nutrition, infection prevention, and timely access to healthcare services. Therefore, reducing IMR remains a major indicator of progress in public health and social development (World Health Organization [WHO], 2023). It is also a global priority under Sustainable Development Goal (SDG) 3.2, emphasizing on preventing avoidable newborn and child deaths by improving healthcare access and reducing inequalities (United Nations, 2023).

Globally, significant progress has been achieved in reducing infant mortality through improvements in maternal healthcare, institutional deliveries, immunization programs, neonatal care, breastfeeding promotion, and prevention of childhood infections (UNICEF, 2023). However, the progress remains uneven across regions and population groups. Infants living in poor households, remote communities, and socially disadvantaged populations continue to experience higher mortality risks because of inadequate healthcare access, poor nutrition, unsafe living conditions, and delayed treatment-seeking behavior. These inequalities demonstrate that infant mortality is not only a medical outcome but also a reflection of broader social, economic, and institutional conditions (Hashmi, 1979; WHO/UN, 1979; Hobcraft et al, 1984; Jinabhai, et al., 1986; UN, 1986; Nage, 1985; Kutly, et al., 1993; Kazmi 2009; Agha, 2000; Black et al., 2017; Memon, et al. 2023 Kazmi et al., 2026a,b-f)

In developing countries, including Pakistan, infant survival is strongly influenced by socioeconomic and demographic factors. Maternal

education, household economic status, healthcare utilization, and reproductive behaviour are among the most important determinants of infant mortality. Educated mothers are more likely to seek antenatal care, utilize skilled delivery services, adopt appropriate new-born care practices, enjoys better say in family, ensure vaccination, and recognize early signs of illness, thereby improving infant survival. Similarly, household wealth like education affects infant survival through pathways related to nutrition, sanitation, healthcare affordability, and access to preventive services (Pollani, 1979; Caldwell, 1980; Hashmi, 1979; Mosley & Chen, 1984; Irfan, 1986; Kazmi, 1995 & 2009; Memon, et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). These factors indicate that reducing infant mortality requires interventions addressing both healthcare systems and underlying social inequalities.

Pakistan continues to face significant challenges in reducing infant mortality despite improvements in health services and development indicators even with trivial budget provision (mostly < 1% of GDP). Although national statistics indicate gradual improvement, provincial averages often conceal substantial variations in infant survival outcomes. Differences across provinces and administrative regions are influenced by unequal healthcare infrastructure, poverty, maternal education disparities, fertility patterns, geographic barriers, and variations in availability of skilled healthcare providers (Knowles, 1979; Khan and Sirajeldin, 1979; Sathar, 1984 & 1992; Kazmi, 1995 & 1998; Agha 2000; Khan and Raza, 2014; Memon et al., 2023; Zaidi, 2024; Kazmi et al., e-f). Regions such as Balochistan, Gilgit-Baltistan (GB), and Azad Jammu and Kashmir (AJ&K) face additional challenges due to difficult terrain, dispersed populations, transportation constraints, and limited access to specialized maternal and neonatal healthcare services. At the same time, relatively developed provinces such as Punjab and Sindh continue to experience internal inequalities between urban and rural populations (Agha, 2000; Khan and Raza, 2014; Memon, et al., 2023; Kazmi et al., 2026a-f).

Previous research in Pakistan has demonstrated that socioeconomic and demographic

characteristics significantly influence infant survival. Maternal education, household income, healthcare utilization, maternal age, birth order, and birth spacing have been identified as important determinants of infant mortality. Young maternal age also increases risks associated with premature birth, low birth weight, and pregnancy complications, while short birth intervals may increase mortality through maternal nutritional depletion and inadequate recovery between pregnancies. Similarly, high birth order may increase mortality risk because of maternal exhaustion, reduced parental attention, and competition for household resources (Sathar, 1984; Kazmi 1995 & 2005; Kazmi, S.1995; Agha, 2000; Zaidi, 2024; Kazmi et al., 2026a&b).

The relationship between infant mortality and broader development conditions is also important in understanding regional differences in Pakistan. Kazmi (1995) study *Foreign Aid and Health in Pakistan* provides a wider development perspective by emphasizing that health outcomes depend not only on medical interventions but also on economic resources, infrastructure development, education, institutional capacity, and effective allocation of development assistance. Sustainable improvements in health require investment in healthcare systems, human resources, and social development sectors to ensure that vulnerable populations receive essential services.

Despite valuable contributions from previous studies, important research gaps remain. Much of existing research has examined child mortality at the national level or focused on individual determinants, providing limited understanding of how infant mortality varies across provinces with different socioeconomic, geographic, and healthcare contexts. Furthermore, many studies have combined infant and under-five mortality, although infant mortality represents a distinct period of vulnerability associated with pregnancy, childbirth, and neonatal care. The first year of life requires specific attention because maternal health, skilled birth attendance, newborn care quality, and health system responsiveness directly influence survival outcomes (Preston, 1980; Sathar 1984, 1987 & 1992; Rutstein, 2005; Black

et al., 2017; Agha, 2000; Memon et al., 2023; Zaidi 2024; Kazmi et al., 2026e-f).

Although socioeconomic and demographic determinants of infant mortality have been extensively studied internationally, limited evidence exists regarding how these factors interact with provincial inequalities in Pakistan using recent standardized datasets. National averages may conceal important disparities, particularly in geographically disadvantaged regions such as Balochistan, AJ&K, and GB, while also masking inequalities within larger provinces such as Punjab and Sindh. Moreover, previous studies have rarely integrated demographic factors, including maternal age, child sex, birth order, and birth spacing, with socioeconomic characteristics such as education, wealth, and residence within a comparative provincial framework (Hasmi, 1975; Kazmi 1995 & 2009; Sathar 1987 & 1992; Agha, 2000; Khan and Raza; 2014; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2006e-f).

This study addresses these gaps by conducting a comparative analysis of infant mortality across six provinces and administrative regions of Pakistan—Punjab, Sindh, Khyber Pakhtunkhwa (KP), Balochistan, AJ&K, and GB—using the latest available Multiple Indicator Cluster Survey (MICS6) datasets. The study contributes to existing literature by focusing exclusively on infant mortality, identifying provincial inequalities through standardized data, and integrating socioeconomic, demographic, and health development perspectives. The findings aim to generate evidence-based recommendations for reducing preventable infant deaths and supporting province-specific policies that promote equitable access to maternal and newborn healthcare services across Pakistan.

2. LITERATURE REVIEW

2.1 Global Trends in Infant Mortality

Infant mortality rate (IMR), defined as the probability of dying before completing the first year of life, is a key indicator of population health, maternal well-being, and healthcare system performance. It reflects conditions during pregnancy, delivery, and the neonatal period,

including maternal health, antenatal care, skilled birth attendance, newborn care, nutrition, and access to healthcare services (WHO, 2023). Moreover, reducing infant mortality remains a global priority under Sustainable Development Goal (SDG) 3.2, which emphasizes preventing avoidable newborn and child deaths through improved healthcare access and reduced inequalities (UN, 2023).

Globally, IMR has declined substantially due to improvements in maternal healthcare, institutional deliveries, immunization, breastfeeding promotion, neonatal care, and infection prevention programs (UNICEF, 2023). However, progress remains uneven, particularly in low- and middle-income countries where poverty, weak healthcare systems, malnutrition, and geographic barriers continue to increase mortality risks. While prematurity, low birth weight, birth asphyxia, and neonatal infections also remain major causes of infant deaths (Rusicka and Hansliwks 1982; Black et al., 2017; Agha, 2000, Memon., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). The Mosley and Chen (1984) framework explains that infant mortality is influenced not only by medical factors but also by socioeconomic conditions operating through pathways such as maternal behavior, nutrition, environment, and healthcare utilization.

2.2 Infant Mortality in Pakistan

Pakistan has achieved gradual improvements in infant survival; however, mortality levels remain high compared with several South Asian countries. Progress has been constrained by challenges related to maternal healthcare utilization, neonatal care quality, lacking female education, poverty, malnutrition, and unequal access to health services (Rusicka and Hansliwks, 1982; Sathar, 1991; Kazmi, 1995 & 1998; Jinabhai et al., 1996; Cleland & Jejeebhoy, 1996; Rutstein, 2005; Kah and Raza, 2014; Black et al., 2017; UNICEF, 2023; Rana et al., 2024; Kazmi et al., 2024, 2025, 2026e&f). WHO (2023) underlines that Neonatal conditions, including premature birth, low birth weight, and birth complications, remain major contributors to infant mortality, highlighting the importance of antenatal care,

skilled delivery services, and effective newborn healthcare.

Research indicates that infant mortality in Pakistan is closely linked with broader socioeconomic development. Kazmi (1995), in *Foreign Aid and Health in Pakistan*, emphasized that improvements in health outcomes depend not only on medical interventions but also on education, income growth, infrastructure development, institutional capacity, and effective allocation of development resources. The study identifies female education as a major determinant of health improvement in Pakistan and therefore, argued that sustainable health gains require investment beyond the health sector. Similarly, development assistance can contribute to better health outcomes when directed toward healthcare infrastructure, social development, and institutional strengthening. However, study found GDP per capita a significant and negative associate while fertility ratio is positive associate of IMR in Pakistan.

Regional inequalities remain a major challenge in Pakistan's infant mortality profile. Provinces and administrative regions differ significantly in healthcare infrastructure, health outlays, poverty levels, maternal education, geographic accessibility, and availability of skilled healthcare providers. Balochistan faces challenges due to its large geographical area and dispersed population, while AJ&K and Gilgit-Baltistan experience barriers due to mountainous terrain and transportation limitations. Punjab and Sindh, despite comparatively better infrastructure, continue to experience rural-urban inequalities, whereas KP faces challenges in remote and underserved areas (Kazmi et al., 2024 & 2025a&b, 2026e-f). These differences indicate that national averages may conceal important variations in infant survival outcomes.

2.3 Socioeconomic Determinants of Infant Mortality

Socioeconomic conditions are among the strongest determinants of infant survival because these influence maternal behavior, healthcare utilization, nutrition, and living conditions. Maternal education is consistently identified as a

protective factor because educated mothers are more likely to seek antenatal care, utilize skilled delivery services, ensure vaccination, practice appropriate breastfeeding, and recognize early signs of illness (WHO/UN 1979; Caldwell, 1980; Cleland & Jejeebhoy, 1996; Kazmi et al., 2026e-f). Kazmi (1995 & 2009) identified female education as a major determinant of health improvement in Pakistan, while Desai and Alva (1998) demonstrated that maternal education improves child health through enhanced knowledge and healthcare decision-making. Kazmi et al., (et al., 2026e-f) also discover mother education as an important determinant of IMR in Pakistan' provinces and areas. Household wealth also plays an important role in infant survival. Poor households frequently experience inadequate nutrition, poor sanitation, unsafe environments, delayed healthcare seeking, and limited ability to afford medical treatment. According to Mosley and Chen (1984), economic status influences infant mortality through intermediate mechanisms such as maternal care practices, nutritional status, environmental conditions, and healthcare access. GDP per capita is also found critical factor in averting the infant loss. Moreover, poverty reduction and social development remain essential components of infant mortality reduction strategies (Kazmi, 1995).

2.4 Demographic Determinants of Infant Mortality

Demographic characteristics influence infant mortality through biological vulnerability, maternal health conditions, and household care practices. Male infants generally experience slightly higher mortality risks because of biological vulnerability, increased susceptibility to prematurity, and neonatal complications (Sathar, 1987; Black et al., 2017; Zaidi, 2024). However, gender differences may also reflect social and healthcare related factors affecting healthcare utilization and resource allocation (Kazmi, 1995, 2009). Maternal age is another important determinant of infant survival. Adolescent mothers face increased risks due to biological immaturity, pregnancy complications, inadequate antenatal care, premature delivery, and low birth

weight (WHO, 2022; Kazmi et al., 2026 d-e). Advanced maternal age may also increase risks associated with pregnancy complications and adverse birth outcomes. Birth order and birth spacing influence infant survival through maternal health and household resource pathways. Kazmi (1995) study *Foreign aid and Health in Pakistan* found positive association between fertility ratio and IMR in Pakistan. Therefore, high birth order could increase mortality in provinces /areas of Pakistan as well due to maternal depletion, reduced parental attention, and competition for resources. Beside short birth intervals also increases risks because mothers may not fully recover physically and nutritionally between pregnancies (Cleland and Sathar, 1984 & 1992; Sathar, 1992; Kazmi, 1995; Rutstein, 2005; Kazmi et al., 2026 d-f).

2.5 Research Gap and Contribution of the Present Study

Despite extensive research on child mortality in Pakistan, limited evidence exists on provincial disparities in infant mortality using recent standardized datasets while integrating socioeconomic, demographic, and regional factors. Previous studies have mainly focused on national trends or individual determinants, providing limited understanding of how these factors interact across diverse provincial contexts (Sathar, 1984 & 1992; Kazmi 1995, 2005, 2010; Agha 2000, Khan and Raza 2014; Black et al., 2017; Rashid, 2023; Zaidi, 2024; Kazmi et al., 2023a-b, 2025a-b, 2026c-f). This study addresses prevailing gap by conducting a comparative analysis of infant mortality across six provinces and administrative regions using MICS6 provincial/regional data. It contributes to existing literature by focusing exclusively on IMR, integrating socioeconomic and demographic determinants, and interpreting mortality differences within broader health system and development perspectives. The findings provide evidence for targeted provincial policies aimed at reducing preventable infant deaths in Pakistan.

2.6 Limitations in Existing Literature and Data Comparability

Although previous studies have contributed to understanding infant mortality determinants in Pakistan, several limitations remain. Many studies rely on national-level analyses, which may overlook provincial and sub-provincial variations caused by differences in geography, healthcare accessibility, socioeconomic conditions, and infrastructure (Kazmi et al., 2026e-f). Furthermore, comparative analysis may be affected by differences in MICS6 survey periods conducted between 2017–18 and 2024–25. These variations reflect changes in regional development (Kazmi, 1995&2009; Kahn and Raza, 2014; Black et al 2017; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). Therefore, a comprehensive provincial analysis is required to understand the structural factors influencing infant survival in Pakistan.

3. METHODOLOGY

This study employs a comparative descriptive research design to examine variations in infant mortality rate (IMR) across provinces and administrative regions of Pakistan. It also explores socioeconomic and demographic factors associated with infant survival outcomes. A comparative descriptive approach is appropriate because the study aims at identifying regional disparities, vulnerable population groups, and mortality patterns rather than establish direct causal relationships. Such designs are widely used in education and population health research to examine inequalities and inform evidence-based policy interventions (Mosley & Chen, 1984; Kazmi 1995; Kazmi et al., 20023a&b; 2004, 2025a-b and 2026a-e). The study utilizes secondary data from the latest available Multiple Indicator Cluster Surveys (MICS6) conducted across six administrative regions of Pakistan: Punjab (2017–18), Sindh (2018), Khyber Pakhtunkhwa (KP) (2022), Balochistan (2022), Azad Jammu and Kashmir (AJ&K) (2020–21), and Gilgit-Baltistan (GB) (2024–25). MICS, supported by UNICEF, provides internationally standardized household survey data, gender parity, maternal and child health, demographic characteristics, education, nutrition, and socioeconomic conditions, water

economic conditions, health policies, and service availability over time though standardized MICS methodology provides a reliable basis for comparison (UNICEF, 2022). Previous research has also examined socioeconomic and demographic determinants separately rather than integrating them within a broader health development framework. Infant mortality is shaped by interconnected factors, including maternal education, poverty, fertility ratio, reproductive behavior, healthcare accessibility, institutional capacity, and

and sanitation, etc., (UNICEF, 2020 & 2022; Kazmi et al., 2023a&b, 2024, 2025; 2026 a-f). The use of MICS6 data is justified because of its standardized indicators, internationally recognized methodology, and rigorous data collection procedures, allowing meaningful comparison of health outcomes across diverse populations and regions (UNICEF, 2022 & 2023). The dependent variable in this study is Infant Mortality Rate (IMR), defined as the probability of dying before completing one year of age, expressed as deaths per 1,000 live births. IMR is selected as the primary outcome indicator because it reflects conditions related to pregnancy, delivery, neonatal care, maternal health status, nutrition, and accessibility of essential healthcare services (Kazmi, 1995; Memon et al; 2023; WHO, 2023; Kazmi, et al 2026 e-f).

The study examines two groups of determinants: socioeconomic and demographic factors. Socioeconomic variables include place of residence, maternal education, and household wealth quintile. Residence is considered important because rural and geographically isolated populations often face barriers in accessing skilled birth attendance, emergency healthcare, and specialized newborn services. While Maternal Education is included because educated mothers are more likely to seek antenatal care, utilize skilled delivery services, practice appropriate infant feeding, ensure vaccination, and recognize early signs of illness (Caldwell, 1980; Kazmi, 1995; Desai & Alva, 1998 Kazmi, 2009; Memon et al., 2023; Kazmi et al., 2026 e-f) Household wealth is analyzed because economic

status influences nutrition, sanitation, healthcare affordability, and timely access to treatment. According to the Mosley and Chen (1984) framework, socioeconomic conditions affect infant survival through intermediate pathways involving maternal practices, environmental conditions, and healthcare utilization. Similarly Kazmi study (1995, 2005 & 2009) finds socioeconomic factors have implications for infant and child survival through alternative routes. Most recent research efforts also substantiate the role on socioeconomic determinants of IMR & UFR (Kazmi et al, 2026e-f). Demographic determinants include child sex, maternal age at birth, birth order, and previous birth interval. Child sex is examined because male infants generally have greater biological vulnerability due to higher risks of prematurity and neonatal complications (Sathar, 1867; Black et al., 2017; Memon et al, 2023; Zaidi, 2024; Kazmi et al., 2026d-e)). Maternal age is considered because adolescent pregnancies are associated with premature birth, low birth weight, and pregnancy complications, whereas advanced maternal age may increase delivery-related risks (WHO, 2022). Birth order and birth interval are included because high birth order and short birth intervals may increase mortality risks through maternal depletion, reduced parental attention, competition for household resources, and inadequate maternal recovery (Sathar, 1992; Rutstein, 2005; Kazmi 199 & 2005; Memon et la., 2023; Zaidi, 2024; Kazmi et al., 2026e-f).

The analysis involves comparative assessment of IMR across provinces and administrative regions, followed by examination of mortality differences according to socioeconomic and demographic

characteristics. Since the study uses secondary cross-sectional survey data, findings are interpreted as associations and population-level patterns rather than causal relationships. The study however, has methodological limitations. The use of MICS6 datasets from different survey periods may reflect variations in socioeconomic conditions, health policies, and service availability over time. Furthermore, geographic differences, population characteristics, and healthcare accessibility may influence provincial comparisons. However, the standardized MICS methodology and indicators provide a reliable basis for comparative assessment despite these limitations (UNICEF, 2020 & 2022).

4. RESULTS AND DISCUSSION

The results of this study provide evidence of substantial variations in infant mortality rate (IMR) across provinces and administrative regions of Pakistan. The data in Table 4.1 & 4.2 demonstrate inequalities in healthcare accessibility in urban rural areas, skilled birth attendance, referral services, maternal education, socioeconomic conditions and numerous demographic determinants (WHO, 2023). These data in the tables also reveal that infant survival is shaped by a combination of regional, socioeconomic, and demographic factors. Unlike broader childhood mortality indicators, IMR is particularly sensitive to conditions during pregnancy, childbirth, and neonatal period. Therefore, variations in IMR reflect differences in maternal health status, new-born care practices, healthcare accessibility, socioeconomic progress, and demographic characteristics (Kami 1995, 2010; Kazmi et al 2026e-f).

Table 4.1: Provincial/Area Infant Mortality Rates by Socioeconomic Characteristics						
Areas/Region	Punjab	Sindh	KP	Balochistan	AJ&K	GB
Total	60	39	35	48	51	43
Rural	66	47	34	51	53	44
Urban	49	29	39	39	41	36
Education						
Pre-primary or none	75	44	35	50	70	55
Primary	65	32	39	44	47	40
Middle	50	31	43	37	56	43
Secondary	26	33	29	34	43	27

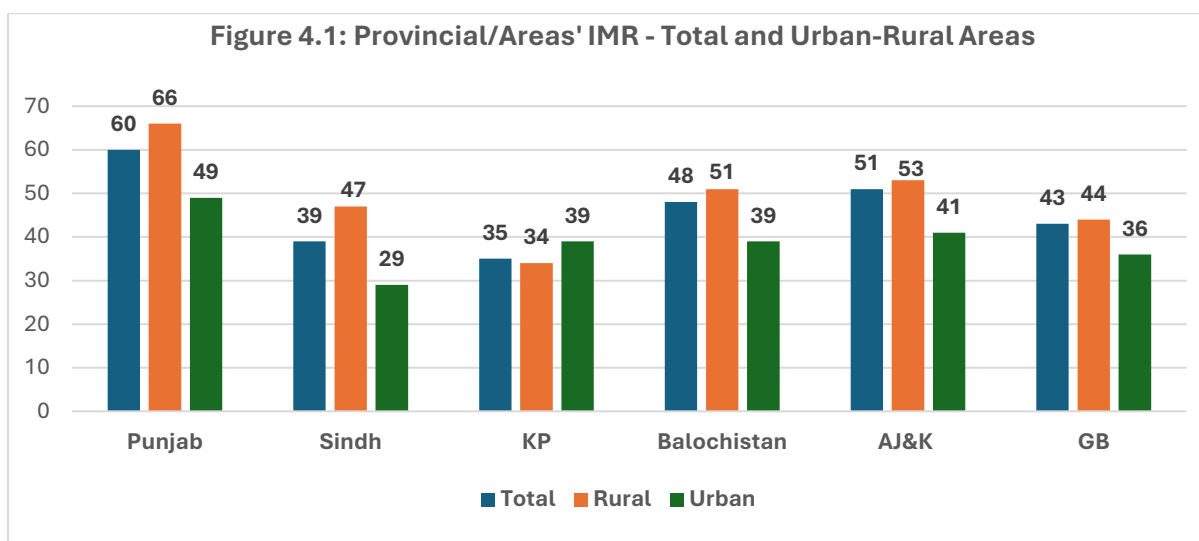
Higher Secondary	16	16	27	39	37	28
Wealth index quintile						
Poorest	83	46	37	66	65	51
Second	74	54	35	58	62	48
Middle	60	37	36	38	46	45
Fourth	49	16	33	39	36	33
Richest	27	16	32	35	38	36
Sources: MICS6 (Punjab 2017-18; Sindh 2018 ; KP 2022,; Baluchistan 2022; AJ&K 2020-21; and GB 2024-25)						

The result analysis is based on MICS6 data from Punjab (2017-18), Sindh (2018), Khyber Pakhtunkhwa [KP] (2022), Balochistan (2022), Azad Jammu and Kashmir [AJ&K] (2020-21), and Gilgit-Baltistan [GB] (2024-25). Table 4.1 also contains information on Provincial/Areas' variation in IMR by Socioeconomic factors and huge disparities across Pakistan. Punjab noticed the highest overall IMR with 60 deaths per 1,000 live births. Next to Punjab is AJ&K with IMR 5, followed by Balochistan (IMR 48), GB (IMR 43), Sindh (IMR 39) and KP (IMR 35) having the lowest IMR among the all. The segregated results of IMR and its socioeconomic determinants - Rural-urban, Maternal Education and Wealth Index Quintile are deliberated the next subsections.

4.1.1 Rural-Urban Differences in Infant Mortality

Residence remains an important determinant of infant survival. In areas rural populations generally experience higher IMR compared with urban populations in several regions. In Pakistan's provinces/areas rural IMR exceeds urban IMR except in KP, signifying persistent geographical disparities in the child survival. The results referred in Table 4.1 and portrayed in Figure 4.1 intimate inequalities in healthcare accessibility in urban rural areas. Punjab shows a substantial rural disadvantage, with rural IMR reaching 66 compared with 49 in urban areas. Similarly, AJ&K reports higher rural mortality 53 compared with urban areas 41, reflecting challenges related to healthcare accessibility and mountainous geography. Balochistan (rural 51 versus urban 39), Sindh (Rural 47 versus urban 29), and GB (rural 44 versus urban 36), demonstrating rural disadvantages in IMR due to dispersed settlements

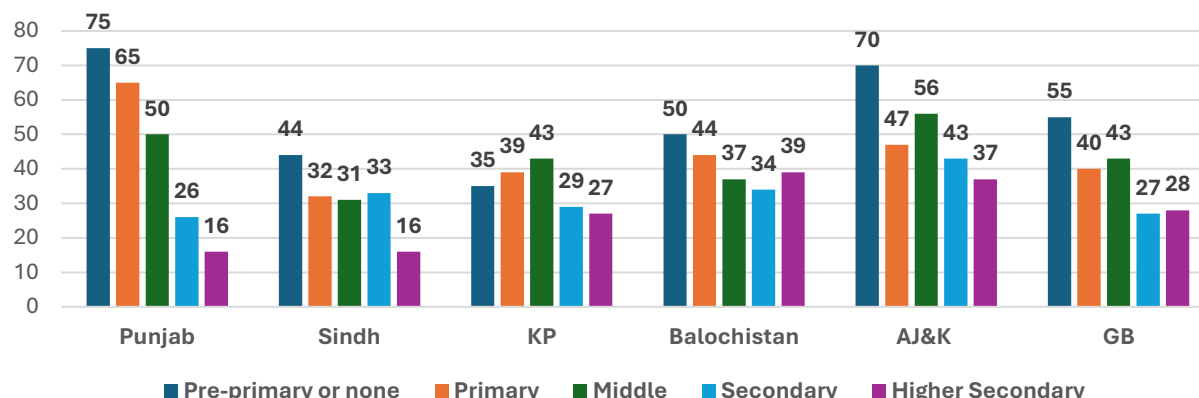
and limited availability of skilled healthcare providers. These findings indicate that rural populations persistently suffer from disparities related to inadequate health infrastructural set up, transportation difficulties, low service use, and socio-economic deprivation in most regions/areas. These results mainly, support previous evidence that geographical accessibility and availability of maternal and neonatal healthcare services are critical determinants of infant survival (WHO, 2023, Memon et al., 2023). These findings also suggest that rural populations continue to face disadvantages associated with limited health infrastructure, transportation barriers, lower service utilization, and socioeconomic deprivation. However, an important exception is observed in Khyber Pakhtunkhwa (KP), where urban IMR (39) is higher than rural IMR (34), despite KP having the lowest overall IMR (35). Kazmi (et al., 2026c) observed a similar trend in Out of School Children (OOSC) in urban areas of Islamabad Capital Territory (ICT). This unusual pattern may be associated with the socioeconomic characteristics of urban populations, including peri-urban poverty, overcrowding, and unequal access to quality healthcare services. It may also reflect differences in healthcare utilization patterns, community-based interventions, or survey characteristics. The KP finding highlights that urban residence does not automatically ensure better infant survival outcomes. Therefore, policies should focus on vulnerable populations in both rural and urban settings rather than relying solely on geographic classification. Overall, the results demonstrate that place of residence remains an important determinant of infant mortality in Pakistan but its influence varies according to regional socioeconomic and healthcare contexts.



4.1.2 Maternal Education and Infant Mortality

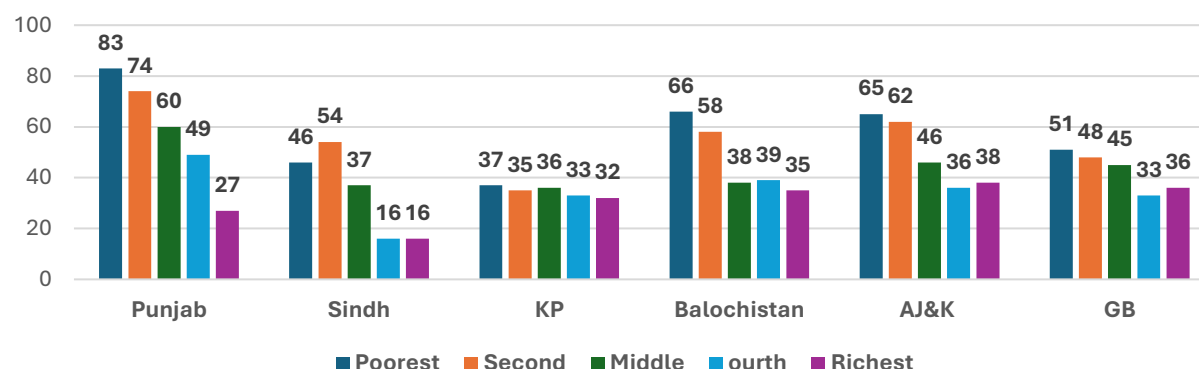
Maternal education holds a strong inverse relationship with Infant Mortality Rates (IMR) and demonstrates a clear protective relationship with infant survival. In Pakistan, it [Maternal education] is also found one of the strongest socioeconomic factor articulating the IMR (Sathar, 1987; Kazmi, 1995&2009; Kazmi et al., 2023a&b, 2024, 2025a-b, 2026e-f). Across Pakistan's provinces/areas, infants born to mothers with lower educational attainment generally experience higher mortality compared with those whose mothers have higher education. Punjab shows a strong educational gradient, where IMR declines from 75 among mothers with pre-primary or no education to 16 among mothers with higher secondary education. Similarly, AJ&K shows a reduction from 70 among mothers with no education to 37 among mothers with higher secondary education. GB demonstrates a reduction from 55 among mothers with no

education to 28 among mothers with higher secondary education. Balochistan observes a reduction from 50 among mothers with no education to 34 mothers with secondary education. Sindh shows a reduction from 44 among mothers with no education to 16 among mothers with higher secondary education while KP confirms a reduction from 35 among mothers with no education to 27 among mothers with higher secondary education. The pattern reflected in Table 4.1 and Figure 4.2. confirms that maternal education improves infant survival through multiple pathways, including better healthcare utilization, improved hygiene practices, increased awareness of danger signs, better financial autonomy, and greater decision-making capacity (Khan and Sirajeldin, 1979; Caldwell, 1980; Sathar, 1987 & 1992; Kazmi, 1995&1998; Desai & Alva, 1998, Memon. et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f).

Figure 4.2: Provincial/Areas' IMR by Mother Education

4.1.3 Household Wealth Inequality and Infant Mortality

Household economic status remains a major determinant of infant survival. The results in Table 4.1 reveal a consistent wealth gradient, with poorer households experiencing substantially higher infant mortality than wealthier households. Figure 4.3 exhibits that Punjab demonstrates the strongest inequality, with IMR declining from 83 among the poorest households to 27 among the richest. Balochistan witness significant disparity, with IMR declining from 66 among the poorest households to 35 among the richest. Similarly, AJ&K also shows considerable disparity, with IMR diminishing from 65 among the poorest households to 38 among the richest. GB suffers from disparity, with IMR deteriorating from 51 among the poorest households to 36 among the richest.

Figure 4.3 Provincial/Areas' IMR by Wealth Index Quintile

Sindh also observe wide disparity, decreasing from 46 among the poorest households to 16 among the richest. However, KP finds smallest richest-poorest gap (5) and lowest disparity, which deteriorates from 37 among the poorest households to 32 among the richest. Poverty affects infant survival through inadequate nutrition, poor sanitation, delayed healthcare seeking, and inability to afford medical services (Rusicka and Hansliwks, 1982; Mosley & Chen, 1984; Kazmi, 1995 & 2009; Kazmi et al., 2026d-f). These findings highlight that reducing IM requires interventions beyond healthcare provision, including poverty reduction and social protection measures.

4.2 Demographic Determinants of Infant Mortality

Demographic determinants of Infant Mortality including gender difference or child sex, Mother's age at birth, Birth order and previous birth interval play key role in determining IMR contour of Provinces/Areas in Pakistan (Sathar, 1987; Kazmi S., 1995; Kazmi, 1995; Agha, 2000' Memon, et al., 2003; Zaidi, 2004; Kazmi et al., 2026f). Table 4.2 provides an account of Provincial/Areas' IMR by Demographic Characteristics while Figure 4.4 to 4.7 portrayed the extent of Demographic Determinants of Infant Mortality in Provincial/Areas including Gender, Mother's Age at Birth, Birth Order and Previous Birth Interval deliberating in next sub-sections.

4.2.1 Gender Difference or Child Sex

Gender differences indicate slightly higher mortality among male infants in several regions. Biological vulnerability, including greater susceptibility to prematurity and neonatal

complications, may contribute to higher male mortality risks (Cleland & Sathar, 1984; Sathar, 1989; Khan & Raza, 2014; Black et al., 2017; Zaidi, 2024; Kazmi et al., 2026e-f). This higher mortality among male infants may reflect biological vulnerability although socioeconomic and healthcare-related factors may also contribute. Table 4.2 and Figure 4.4 show that AJ&K exhibits the largest gender disparity in infant mortality, with an IMR of 58 deaths per 1,000 live births among male infants compared with 43 among female infants, showing the highest 15 points difference and indicating higher mortality risk among male infants. Similarly, KP also demonstrates considerable gender disparity IMR hurting boys having IMR boys 40 and girls 29, with 11 points gap. GB witnesses male 45 female 41 having 4 points gap. Punjab though has highest IMR for male (61) and female (59) exhibits only 2 points gap. Baluchistan with IMR male 48 and female 47, gets the smallest 01 point gap.

Table 4.4: Demographic Determinants of Infant Mortality in Provincial/Areas

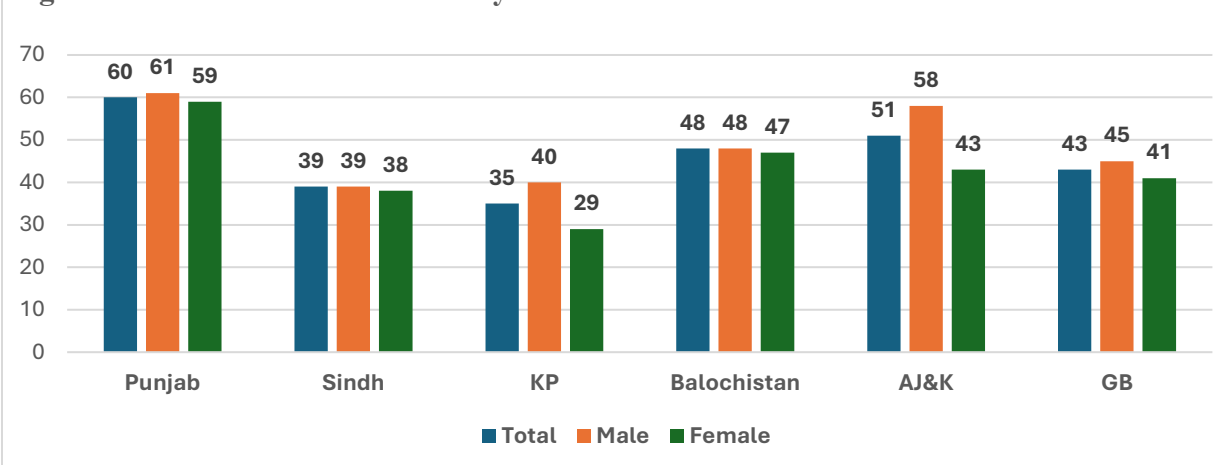
Gender	Punjab	Sindh	KP	Balochistan	AJ&K	GB
Total	60	39	35	48	51	43
Male	61	39	40	48	58	45
Female	59	38	29	47	43	41
Mother's age at birth						
Less than 20	85	50	40	36	83	63
20-34	58	37	34	47	45	38
35-49	61	39	35	56	70	60
Birth order						
1 child birth	58	39	40	32	54	47
2-3 children birth	52	35	32	39*	48	34
4-6 children birth	67	35	32	56	42	45
7+ children Birth	95	67	45	85	102	58
Previous birth interval						
First Birth	60	30	43	33	54	NI*
< 2 years	89	61	49	73	69	67
2 years	45	33	27	42	36	33
3 years	40	19	28	26	38	28
4+ years	39	21	19	32	49	24

Note: *NI refers to No Information

Sources: MICS6 (Punjab 2017-18; Sindh 2018 ; KP 2022,; Baluchistan 2022; AJ&K 2020-21; GB 2024-25)

Sindh also enjoys the lowest IMR for male (39) and female (38) and the smallest 01 point gap like Balochistan. The variations across the provinces/areas suggest that social and healthcare related factors also influence gender differences.

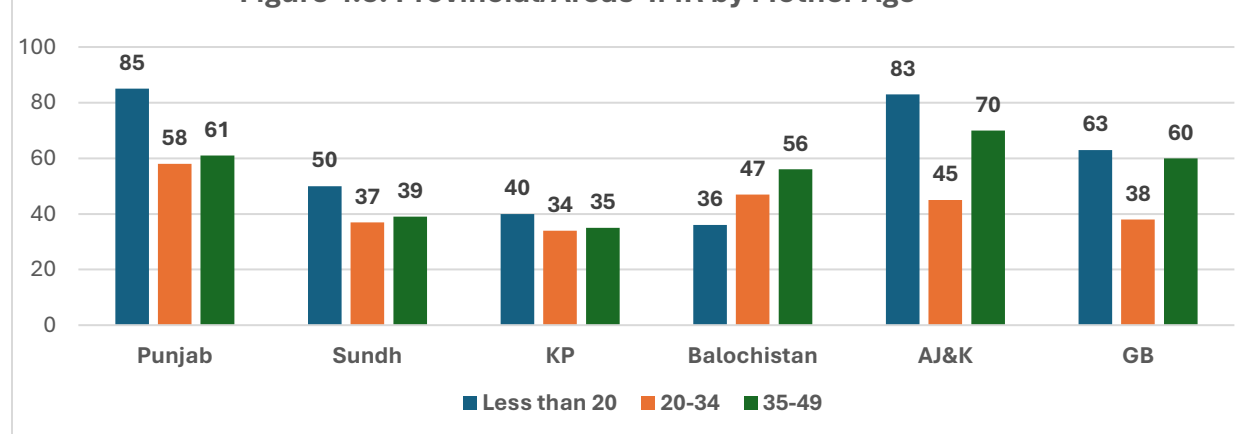
Figure 4.4 Provincial/Areas' IMR by Gender



4.2.2 Maternal Age at Birth

Maternal age demonstrates a significant relationship with infant survival. Adolescent mothers experience elevated mortality risks, particularly in Punjab (IMR 85), AJ&K (IMR 83), and GB (IMR 63). Sindh, KP and Balochistan observe IMR 30, 40 and 38 respectively for mother aged less than 20 years. Young maternal age is associated with biological immaturity, premature delivery, low birth weight, and inadequate antenatal care utilization (WHO, 2022). Older maternal age also increases risks, particularly in AJ&K where mothers aged 35–49 years show higher mortality (IMR 70) followed by Punjab, GB and Balochistan with IMR 61, 60 and 56 respectively. Sindh and KP in turn have IMR 39 and 35 as portrayed in Figure 4.5. These findings confirm the importance of reproductive health services targeting both adolescent and older mothers.

Figure 4.5: Provincial/Areas' IMR by Mother Age



4

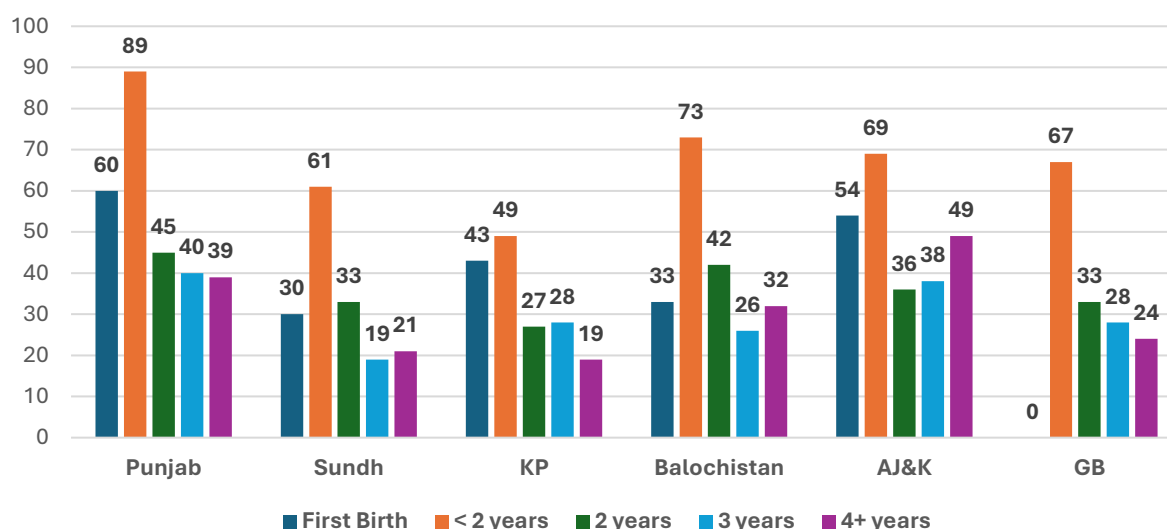
2.3 Birth Order

Higher birth order is strongly associated with increased infant mortality. The highest risk is observed among children with seven or more births, particularly in AJ&K with IMR (102), Punjab (95), and Balochistan (85). Sindh comes next to Balochistan with IMR 67 followed by GB having IMR 58. As previous research by Kazmi (1995) found fertility ratio as positive associate of IMR in Pakistan so high fertility prevailing in provinces also increases mortality through maternal depletion, reduced childcare attention, and competition for household resources (Rutstein, 2005; Kazmi, 2009; Memon et al. 2023; Memon, et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). However, KP on the other hand enjoys the lowest score (45) with highest children birth (+7), indication some better health facilities with judicious distribution and enhanced access at various levels. Seeking insight from KP may also help to mitigate the problem in areas having high Children Birth Order including AJ&K, Punjab, Balochistan, Sindh and GB. Moreover, strengthening of family planning programs and reproductive health services is therefore essential.

4.2.4. Previous Birth Interval

Birth spacing emerges as one of the strongest demographic predictors of infant survival. Short birth intervals increase mortality risks, particularly intervals of less than two years (Cleland & Sathar, 1984; Rutstein, 2005; Kazmi 1995; Kazmi et al., 202e&d). Punjab reports an IMR of 89 among children born after intervals shorter than two years, compared with 39 among children with four or more years spacing. Similar patterns are observed in Balochistan with IMR 73, AJ&K 69, GB 67, Sindh 61 and KP 49 among children born after intervals shorter than two years in comparison with IMR 32, 49, 24, 21 and 19 respectively in children with four or more years spacing. Table 4.2 and Figure4.6 demonstrate a clear picture of wider discrepancies in IMR occurring due to spacing or birth interval. Adequate birth spacing improves maternal recovery, reduces premature births, and enhances childcare capacity (Cleland, & Sathar, 1984;

Sathar, 1988 &1992; Kazmi, 1995 & 2009; Rutstein, 2005; Khan & Raza, 2014; Memon, et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f).

Figure 4.6 Provincial/Areas' IMR by Previous Birth Interval

5. Key Findings

The findings of this study reveal substantial provincial and regional variations in infant mortality rates (IMR) across Pakistan, indicating that infant survival opportunities remain unequal among different geographic areas. The comparative analysis demonstrates that regions such as Punjab and Azad Jammu and Kashmir (AJ&K) experience greater infant mortality challenges, reflecting the combined influence of population pressure, manmade and natural disasters, geographical barriers, healthcare accessibility, and variations in maternal and newborn care services. In contrast, Khyber Pakhtunkhwa (KP) demonstrates comparatively lower infant mortality levels, suggesting improvements in maternal and child health interventions and healthcare utilization, although continued efforts are required to ensure equitable access among remote and vulnerable populations. Regional differences in infant mortality highlight that healthcare availability alone is insufficient; effective service delivery, institutional capacity, and fair distribution of resources are equally important determinants of health outcomes (Mosley & Chen, 1984; Kazmi, 1995&2009, Khan & Raza, 2014; WHO, 2023; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). The study further identifies socioeconomic inequalities as major determinants of infant survival. Maternal education emerges as one of the strongest protective factors because educated mothers are more likely to utilize

antenatal care, seek skilled birth attendance, adopt appropriate breastfeeding practices, ensure timely vaccination, and recognize early signs of infant illness (Caldwell, 1980; Sathar, 1984; Desai & Alva, 1998; Kazmi, 1995; Kazmi S. 1995; Kazmi et al., 2026e-f). Conversely, poverty also remains a significant contributor to infant mortality because economically disadvantaged households often experience inadequate nutrition, poor sanitation, delayed healthcare seeking, and limited access to quality maternal and newborn services. The relationship between household wealth and infant survival reflects the broader influence of social and economic conditions on health outcomes (United Nations, 1979; Mosley & Chen, 1984; Nag, 1985; Kazmi, 1995; UNICEF, 2023; Kazmi et al., 2026e-f).

The analysis also highlights the importance of demographic determinants in shaping infant mortality patterns. Adolescent motherhood is associated with increased mortality risks due to pregnancy complications, premature delivery, low birth weight, and limited access to appropriate maternal healthcare (WHO, 2022). Similarly, advanced maternal age may increase risks associated with pregnancy and delivery complications. High birth order is linked with increased infant mortality because of maternal nutritional depletion, reduced parental attention, and competition for household resources. Short birth intervals further increase mortality risks by limiting maternal physical recovery and increasing

the likelihood of adverse birth outcomes, including prematurity and low birth weight (Rutstein, 2005; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f). Overall, the findings demonstrate that reducing infant mortality in Pakistan requires integrated strategies addressing provincial inequalities, female education, poverty reduction, reproductive health services, fertility control, optimal birth spacing, and equitable access to quality maternal and neonatal healthcare.

6. CONCLUSION AND POLICY RECOMMENDATIONS

The findings of this study demonstrate that infant mortality in Pakistan is not merely a healthcare challenge but a complex outcome of interconnected social, economic, demographic, and institutional factors (Kazmi 1995, 2009; Kazmi et al., 2026d-e). The comparative analysis of Punjab, Sindh, Khyber Pakhtunkhwa (KP), Balochistan, Azad Jammu and Kashmir (AJ&K), and Gilgit-Baltistan (GB) reveals significant regional differences in infant survival outcomes. These variations indicate that provincial disparities in infant mortality are shaped by differences in healthcare accessibility, socioeconomic development, maternal education, geographic conditions, and the capacity of health systems to provide timely and quality maternal and newborn services. Therefore, reducing infant mortality requires a broader development approach that extends beyond medical interventions and addresses the structural determinants of health (Kazmi, 1995; Mosley & Chen, 1984; UNICEF, 2023; Kazmi et al., 2026a&b, Kazmi et al., 2026e-f).

The study highlights that social inequality remains a major contributor to differences in infant survival. Infants born into poor/poverty ridden households and disadvantaged communities often experience limited access to healthcare, inadequate nutrition, poor sanitation, and delays in receiving medical treatment. Similarly, maternal empowerment, particularly through education, plays a crucial role in improving infant survival because educated mothers are more likely to adopt healthy behaviors, utilize healthcare services, hold greater autonomy and make informed decisions regarding pregnancy and newborn care (Caldwell, 1980; Mosley & Chen, 1984; Kazmi, 1995; Desai & Alva, 1998; UNICEF, 2023; WHO, 2023; Memon et al., 2023; Zaidi, 2024; Kazmi et al.,

2026e-f). The findings also demonstrate that reproductive behavior, including maternal age, birth order, and birth spacing, significantly influences infant mortality risks. Adolescent pregnancies, high birth order, and short birth intervals increase vulnerability through biological and socioeconomic pathways, including premature birth, low birth weight, maternal depletion, and limited household resources (Kazmi, 1995; Rutstein, 2005; Khan and Raza, 2014; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f).

The regional variations observed in infant mortality further emphasize the importance of health system effectiveness and equitable resource distribution. While some regions such as KP demonstrate comparatively better infant survival outcomes, others including Punjab, AJ&K, and Balochistan require targeted interventions to address persistent challenges. The broader development perspective discussed in the literature on foreign aid and health in Pakistan also suggests that improvements in health outcomes depend on effective investment in healthcare infrastructure, education, institutional capacity, immunization spread and social development rather than healthcare spending alone (Sathar, 1984; Kazmi, 1995 & 2009). Sustainable reductions in infant mortality require coordinated efforts involving health, education, poverty reduction, and social protection sectors (Caldwell, 1980; Kazmi, 2009; Agha, 2000; WHO, 2023, Memon, et al., 2023; Kazmi et al., 2026e-f).

At the national level, Pakistan should prioritize strengthening neonatal healthcare services, expanding skilled birth attendance, improving antenatal and postnatal care coverage, and ensuring timely access to emergency obstetric and newborn services. Since a significant proportion of infant deaths occur during the neonatal period, investments in newborn care units, trained healthcare workers, and referral systems are essential for improving survival outcomes (WHO, 2023). Improving maternal education should also remain a central policy priority because female education has long-term effects on reproductive behavior, healthcare utilization, and child health outcomes (Khan and Sirajeldin, 1979; Flege, 1982; Frenzen and Hogan, 1982; Sathar, 1984; Kazmi, 1995; Desai & Alva, 1998; Rutstein, 2005; Black et al 2017; Memon et al., 2023; Kazmi et al., 2026a-f).

At the provincial level, interventions should be designed according to regional needs. In Punjab, where infant mortality remains relatively high despite better healthcare infrastructure, policy efforts should focus on improving rural newborn services, reducing inequalities between urban and rural populations, and strengthening the quality of maternal healthcare delivery (Memon, et al., 2023). In AJ&K and GB, geographical barriers require innovative solutions, including mobile health services, outreach programs, telemedicine support, and improved emergency transportation systems to ensure timely access to maternal and newborn care in remote communities. Balochistan requires substantial investment in healthcare infrastructure due to its large geographical area, dispersed population, and limited availability of skilled healthcare providers. Strengthening primary healthcare facilities, improving referral mechanisms, and expanding skilled birth attendance should be key priorities. In Sindh, policies should focus on addressing poverty-related health inequalities, improving nutrition interventions, and strengthening maternal

healthcare utilization, particularly in rural and underserved communities. For KP, where comparatively better infant survival outcomes are observed, the priority should be maintaining successful maternal and child health programs while addressing remaining inequalities among remote and marginalized populations (Kazmi et al., 2026a&b).

Overall, the reduction of infant mortality in Pakistan (including provinces and areas) requires a comprehensive and region-specific strategy that combines healthcare improvement with broader social development. Policies should integrate maternal empowerment, poverty reduction, reproductive health services, improved birth spacing, female education, mother age, and equitable healthcare access (Caldwell, 1980; Kazmi, 1995; Desai & Alva, 1998; Black et al., 2017; Memon et al., 2023; Zaidi, 2024; Kazmi et al., 2026e-f)). A coordinated approach involving federal and provincial governments, healthcare institutions, and development partners is essential to achieve sustainable improvements in infant survival and reduce preventable infant deaths (Kazmi et al., 2026a&b).

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