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ORIGINAL ARTICLE

Antenatal Care Coverage in Tropical and Non-Tropical Countries: The Role of Economic and Health System Indicators

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Abstract

Background: Antenatal care (ANC) coverage is a key indicator of maternal health system performance. Geographic and socioeconomic factors are often hypothesized to influence ANC utilization, yet evidence remains inconsistent. **Objective**: to examine the association between geographic classification (tropical and non-tropical countries), socioeconomic indicators, and health system characteristics with ANC coverage at the global level. **Method**: Global health data from countries with complete records were analyzed. Countries were classified by geographic zone (fully tropical, partially tropical, non-tropical) and health system indicators, including GDP per capita, health expenditure, medical doctors (physicians) density, nurse and midwife density, and hospital facility density. Descriptive statistics and comparative analysis were conducted, with mean differences, 95% CI, and p-value reported. **Results**: More than half (52.20%) of the countries analyzed were fully tropical, with lower ANC coverage (M = 72.95%, SD = 19.70%), though geographic classification was not significantly correlated (p = 0.588). GDP per capita was significantly associated with ANC coverage, with high-income countries showing a mean difference of 23.16 (95% CI = 6.98–39.33; p = 0.022) compared to the lowest-income countries. Physician density demonstrated a significant inverse association: countries with fewer than 23 doctors per 10,000 population had a mean difference of ANC coverage 16.84 higher (95% CI = 1.99–31.69; p < 0.001) than those with ≥44.5 doctors per 10,000 population. By contrast, nurse and midwife density (p = 0.255), health expenditure (p = 0.066), and hospital facility density (p = 0.112) were not significantly associated with ANC coverage. **Conclusion**: Economic capacity, rather than geographic classification or resource availability, is a significant determinant of ANC coverage. The inverse association with physician density highlights the role of workforce distribution and reliance on non-physician providers.

Keywords: ANC, GDP, health system, hospital facility, UHC

INTRODUCTION

Antenatal care (ANC) is defined as the care provided by skilled health-care professionals to pregnant women and adolescent girls to ensure the best health conditions for both mother and baby during pregnancy, and the World Health Organization (WHO) emphasizes that comprehensive ANC, including timely visits and essential interventions, significantly reduces maternal and neonatal morbidity and mortality [1]. Despite global progress, disparities in ANC coverage and quality remain a pressing challenge, particularly in low- and middle-income countries [2]. Besides, the Sustainable Development Goals (SDGs), especially Goal 3 on ensuring healthy lives and promoting well-being for all at all ages [3], will benefit from valuable insight provided by the study on disparities in ANC.

Most existing studies on ANC disparities focus on socio-economic, educational, or urban–rural divides [4]. However, geographic and climatic contexts—such as tropical versus non-tropical regions—may also play a critical role in shaping maternal health outcomes [5] [6]. The tropical region is located between the Tropic of Cancer (23.5^0N) and the Tropic of Capricorn (23.5^0S), including the equator, such as Small Island Oceanic States, South East Asia, South Asia, Northern Africa, Middle East, Central and South Africa, South America, Caribbean, and Central America [7, 8]. Tropical countries often face unique challenges, including a higher burden of infectious diseases (e.g., malaria, dengue), limited health infrastructure, and socio-cultural barriers that affect women's access to care [9]. In contrast, non-tropical countries generally benefit from stronger health systems, higher health expenditure, and more consistent policy enforcement, which contribute to better ANC coverage and outcomes [10].

Health expenditure is defined as the allocation of funds to health systems, encompassing government, household, and external donor contributions [11]. Healthcare expenditures as a share of Gross Domestic Product (GDP) provide a measure of the relative importance of health spending in the overall economy, and represent the financial resources allocated to health services, reflecting both public and private spending [12]. There is no single figure that can be regarded as "ideal" for health expenditure as a percentage of GDP. However, academic literature and international institutions (WHO, OECD, World Bank) indicate that a range of 5–10% of GDP is generally considered adequate to ensure sustainable health services. High-income countries on average allocate between 8–17% of GDP, whereas many low- and middle-income countries remain below 5% of GDP, a level frequently associated with limited access to and quality of health care services [13, 14]. Accordingly, health expenditure expressed as a share of GDP is deemed more suitable than GDP alone, given that GDP is commonly defined as the principal summary statistic of economic activity and the most important variable in economic growth assessments [15].

GDP per capita is an economic indicator derived by dividing a country's total Gross Domestic Product (GDP) by its population [16]. For analytical purposes, GDP per capita can be categorized into the following ranges (in USD): the lowest (less than 1000), low-middle (1000 to less than 3000), middle (3000 to less than 8000), upper-middle (8000 to less than 30,000) and high (30,000 and more) [17]. It is widely utilized to assess average living standards and economic

capacity [17], although it has notable limitations as it does not capture income distribution or broader aspects of social welfare [18]. Previous studies have only revealed a health paradox in which countries with higher GDP per capita tend to exhibit a greater prevalence of chronic diseases, whereas increased health expenditure has been shown to reduce such prevalence [19]. However, no scientific articles have yet examined the influence of macroeconomic factors on the coverage of ANC within a country.

Furthermore, workforce density—defined as the number of health workers (including physicians, nurses, and midwives) per 1,000 population—serves as a benchmark for monitoring health system capacity and progress towards universal health coverage, and it also influences antenatal care (ANC) coverage [20]. Besides, WHO has established a minimum threshold for the density of health workers (including physicians, midwives, and nurses) at 4.45 per 1,000 population (equivalent to 44.5 per 10,000 population) [20]. However, WHO is advised to reconsider the consistency between the standard number of ANC contacts and the threshold for health workforce density [21]. According to prior research, the WHO identified that a threshold of 2.3 health workers per 1,000 population (equivalent to 23 per 10,000 population) is considered the minimum density required to ensure the provision of essential healthcare services[22].

In addition to the ratio of health workers, facility density may also influence ANC coverage. Facility density is defined as the number of health facilities (such as hospital, primary health centers, clinics, or health posts) per 10,000 or 100,000 population, which is used to measure the availability of health services within a given area [23]. Unfortunately, not all countries have facility density (hospital) data available on the WHO website, where the most recent records date back to 2013.

A comparative analysis of ANC between tropical and non-tropical countries offers a novel perspective on global health disparities, after adjusting for health expenditures, GDP per capita, medical doctors per 10,000 population, nurses and midwives per 10,000 population, and facility density (hospital) per 10,000 population. Such an approach highlights the intersection environmental, epidemiological, and systemic factors in shaping maternal health services. Understanding these differences is essential for designing context-specific interventions that strengthen ANC delivery in tropical regions, while also identifying best practices from non-tropical countries that can be adapted to diverse settings.

This study aims to examine the association between geographic classification (tropical and non-tropical countries), socioeconomic indicators, and health system characteristics with ANC coverage at the global level. By analyzing global health data and synthesizing evidence from multiple sources, the research aims to provide policymakers and health professionals with actionable recommendations. Ultimately, the findings contribute to advancing maternal health equity and achieving the SDGs, particularly Goal 3: ensuring healthy lives and promoting well-being for all at all ages.

METHOD

This study employed a comparative cross-sectional design using secondary data from international health databases. Data were obtained from multiple authoritative services: **United Nations:** United Nations Member States

[24]; **World Population Review:** Tropical Countries 2026 [25]; **World Bank:** current health expenditure (% of GDP) [14] and GDP per capita (USD) [26]; **World Health Organization (WHO) Global Health Observatory:** Medical Doctors [27], and Nursing and Midwifery Personnel [27], facility density (hospital) [23], and Antenatal Care Coverage-at least four visits (%) [28]. These sources provide standardized, internationally comparable datasets suitable for cross-country analysis.

The unit of analysis in this study is the member countries of the United Nations. The dependent variable of this study is ANC coverage (% of women with at least four visits). The independent variables are geographic classification (fully tropical, partially tropical, non-tropical), GDP per capita 2022 (USD), health expenditure (% of GDP 2022), medical doctors per 10,000 population, nurse and midwives per 10,000 populations, and data availability of hospital facility density per 100,000 population.

According to data reported by the United Nations, the total number of member states was initially recorded as 243 countries. However, following the removal of those whose memberships had lapsed, the figure was subsequently reduced to 188 countries. Those countries were classified into fully tropical, partially tropical, and non-tropical countries based on the data of World Population Review.

Data selection was guided by the availability of ANC at least four visits, health expenditure, GDP per capita, ratios of medical doctors, nurses, and midwives within the preceding decade, as well as data availability of hospital facility density. Only datasets meeting these criteria were deemed eligible for inclusion. Furthermore, records with incomplete or missing information were systematically excluded to preserve the integrity and reliability of the analysis. This rigorous approach ensured that the study was grounded in comprehensive and consistent data, thereby minimizing potential biases associated with gaps in reporting. In total, 159 countries were retained for analysis.

Descriptive statistics were employed to summarize factors associated with ANC coverage. Categorical variables were presented as frequencies and percentages, while continuous variables were summarized using the mean, standard deviation, median, minimum, and maximum values. Bivariate associations were examined using simple linear regression. Subsequently, multivariable linear regression was performed to estimate adjusted mean differences, 95% confidence interval, and p-value after controlling for relevant covariates.

This study used publicly available secondary data from United Nations, World Population Review, World Bank, and WHO-databases. No individual-level identifiers were included, and ethical approval was not required.

RESULTS

More than half (52.20%) of the countries with complete data analyzed in this study are classified as fully tropical. The mean GDP per capita was USD 13,552 (SD= 19,845), with nearly one-third (31.45%) of the countries falling into the middle-income category. In terms of health financing, more than half (52.20%) of the countries examined reported health expenditures categorized as middle level, with a mean of 6.66% of GDP (SD= 3.35%). Regarding health workforce indicators, the majority (62.89%) of the countries analyzed exhibited a medical doctor density of fewer than 23 per 10,000 population, compared to the global mean

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of 18.46 per 10,000 population (SD= 16.43). Furthermore, 39.62% of the countries included in the analysis reported nurse and midwife densities below 23 per 10,000 population, in contrast to the global average of 41.72 per 10,000 population (SD= 33.69). Hospital facility density was also limited, with 68.55% of the countries demonstrating an average of 1.56 hospitals per 100,000 population (SD= 4.70) (Table 1).

An analysis of antenatal care (ANC) coverage revealed that fully tropical countries had comparatively lower coverage (M= 72.95%, SD= 19.70%) than partially tropical and non-tropical countries. However, statistical testing indicated that this geographic classification was not significantly correlated with ANC coverage (p= 0.588). In contrast, GDP per capita was significantly associated with ANC coverage, with countries in the high-income category demonstrating a mean difference of 23.16 (95% CI= 6.98–39.33; p= 0.022) compared to those with the lowest GDP per capita. Notably, the ratio of medical doctors was also found to be significantly and inversely associated with antenatal care (ANC) coverage.

Countries with fewer than 23 medical doctors per 10,000 population demonstrated average ANC coverage that was 16.84 percentages points higher (95% CI= 1.99–31.69; p< 0.001) compared to countries with a medical doctor density greater than or equal to 44.5 per 10,000 population. Nevertheless, the ratios of nurses and midwives per 10,000 population (p= 0.255), health expenditure (p= 0.066), and data availabily data of hospital facility density per 100,000 population (p=0.112) were not significantly associated with ANC coverage (Table 2).

Table 1. Characteristic of the countries (n= 159)

Factors	Frequency (f)	Percentage (%)
Geographic classification		
Fully Tropical	83	52.20
Partially Tropical	25	15.72
Non-tropical	51	32.08
GDP per capita (USD)		
The lowest (<1000)	18	11.32
Low-middle (1000 to less than 3000)	31	19.50
Middle (3000 to less than 8000)	50	31.45
Upper-middle (8000 to less than 30,000)	37	23.27
High (30,000 and more	23	14.47
Mean (SD)	13,552 (19,845)	
Median (Min:Max)	5,911 (303 to 123,720)	
Health expenditure (% of GDP)		
Low (<5)	60	37.74
Middle (5-10)	83	52.20
High (≥10)	16	10.06
Mean (SD)	6.66 (3.35)	
Median (Min:Max)	6.19 (1.82 to 23.09)	
Medical Doctors (per 10,000 population)		
<23	100	62.89
23 – 44.5	48	30.19
≥44.5	11	6.92
Mean (SD)	18.46 (16.43)	
Median (Min:Max)	13.55 (0.38 to 65.98)	
Nurses and Midwives (per 10,000 population)		
<23	63	39.62
23 – 44.5	36	22.64
≥44.5	60	37.74
Mean (SD)	41.72 (33.69)	
Median (Min:Max)	34.83 (1.67 to 158.6)	
Data Availability of Hospital Facility Density (per 100,000 population)		
No	50	31.45
Yes	109	68.55
Mean (SD)	1.56 (4.70)	
Median (Min:Max)	0.56 (0 to 56.45)	

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Table 2. Crude and adjusted mean different of ANC coverage at least 4 visits controlled for all factors

Factors	n	Mean (SD)	Crude Mean Different	Adjusted Mean Different	95% Confidence Interval	p-value
Overall	159	75.64 (22.43)	N/A	N/A	N/A	N/A
Geographic classification						0.588
Fully Tropical	83	72.95 (19.70)	0	0	0	
Partially Tropical	25	75.95 (16.38)	3.00	-3.42	-12.47 to 5.63	
Non-tropical	51	79.85 (28.18)	6.90	-4.12	-12.78 to 4.54	
GDP per capita (USD)						0.022*
the lowest (<1000)	18	53.56 (20.63)	0	0	0	
low-middle (1000 to less than 3000)	31	67.77 (14.74)	14.21	13.82	2.23 to 25.42	
middle (3000 to less than 8000)	50	79.28 (16.65)	25.72	19.77	8.13 to 31.42	
upper-middle (8000 to less than 30,000)	37	83.42 (18.99)	29.86	19.52	5.00 to 34.04	
high (30,000 and more	23	83.07 (33.21)	29.51	23.16	6.98 to 39.33	
Health expenditure (% of GDP)						0.066
Low (<5)	60	70.53 (22.64)	0	0	0	
Middle (5-10)	83	81.23 (18.87)	10.70	5.04	-2.27 to 12.36	
High (≥10)	16	65.78 (30.88)	-4.75	-7.42	-18.67 to 3.84	
Medical Doctors (per 10,000 population)						<0.001*
≥44.5	11	63.74 (43.02)	0	0	0	
23 – 44.5	48	89.23 (15.57)	25.49	24.58	11.72 to 37.44	
<23	100	70.42 (19.18)	6.68	16.84	1.99 to 31.69	
Nursing and Midwifery (per 10,000 population)						0.255
<23	63	65.31 (19.25)	0	0	0	
23 – 44.5	36	80.91 (20.51)	15.60	6.86	-2.80 to 16.51	
≥44.5	60	83.32 (22.74)	18.01	9.35	-2.55 to 21.24	
Data Availability of Facility density (hospital per 100,000 population)						0.112
No	50	70.06 (29.77)	0	0	0	
Yes	109	78.19 (17.69)	8.13	5.45	-1.29 to 12.18	

DISCUSSION

This study provides important insights into the determinants of ANC coverage across countries with varying geographic and socioeconomic characteristics. Although fully tropical countries demonstrated comparatively lower ANC coverage than partially tropical and non-tropical countries, statistical testing indicated that geographic classification was not significantly

correlated with ANC coverage. This finding suggests that climatic or geographic factors alone do not adequately explain disparities in maternal health service utilization. Consistent with the previous study, climatic or geographic disparities in maternal health service utilization are largely mediated by socioeconomic and health system factors rather than geography alone [29]. While climate change may indirectly affect maternal health, systemic inequities remain the dominant drivers of ANC coverage disparities[30].

In contrast, GDP per capita emerged as a significant predictor of ANC coverage. Countries with higher GDP per capita demonstrated substantially greater ANC coverage compared to those with the lowest GDP per capita. This result underscores the critical role of economic capacity in shaping health system performance. Higher national income levels are typically associated with stronger health financing, improved infrastructure, and greater availability of skilled health professionals, all of which contribute to enhanced maternal health service utilization [31]. Higher GDP per capita is often linked to stronger infrastructure, and greater availability of skilled health professionals, all of which contribute to improved access to maternal health services [32]. Conversely, countries with lower GDP per capita may face systemic barriers, including limited health financing, shortages of trained personnel, and inequitable distribution of facilities, which constrain the ability of pregnant women to receive adequate ANC [33].

Interestingly, medical doctor density was found to be significantly and inversely associated with ANC coverage. Countries with fewer than 23 medical doctors per 10,000 population demonstrated a higher ANC coverage compared to countries with physician densities greater than or equal to 44.5 per 10,000 population. This counterintuitive finding suggests that higher physician density does not necessarily translate into improved ANC coverage. Possible explanations include reliance on non-physician providers such as nurses and midwives in delivering ANC services, inequitable distribution of medical doctors (physicians) concentrated in urban centers [34], or systemic inefficiencies in health service delivery [35].

By contrast, other health system indicators such as nurse and midwife density per 10,000 population, health expenditure, and data availability of hospital facility density were not significantly associated with ANC coverage. These results highlight that the mere presence of resources does not guarantee improved service utilization, and that the effectiveness of resource allocation, workforce distribution, and service delivery models may be more critical determinants.

Health expenditure related to the financial input alone is insufficient because equitable distribution and quality of care are critical for improved ANC coverage [2]. Health expenditure does not automatically lead to increased antenatal care (ANC) coverage when service quality is low or the distribution of health workers is inequitable, as many countries with relatively high levels of spending continue to report low ANC coverage due to systemic inefficiencies [36]. Structural barriers such as distance, inequitable distribution, and poor quality often prevent women from accessing services even when resources exist [35]. Simply having facilities or staff is insufficient without supportive policies and effective implementation [37].

Taken together, these findings emphasize the importance of economic development as a driver of maternal health outcomes, while also pointing to the need for more nuanced health system strategies. This large-scale analysis emphasized that economic capacity, health financing, and workforce distribution are stronger predictors of maternal health outcomes than climatic or geographic factors [38].

CONCLUSION

This study, encompassing data from 159 countries over the past decade, provides new insights into the determinants of ANC coverage. Descriptive analysis revealed substantial variation in ANC utilization across regions, underscoring persistent inequities in maternal health services. Interestingly, the ratio of medical doctors was significantly and inversely associated with ANC coverage, with countries reporting fewer than 23 physicians per 10,000 population demonstrating an average ANC coverage 16.84 percentage points higher (95% CI: 1.99–31.69; $p < 0.001$) compared to those with physician densities greater than or equal to 44.5 per 10,000 population. In contrast, the ratios of nurses and midwives ($p = 0.255$), national health expenditure ($p = 0.066$), and hospital facility density ($p = 0.112$) were not significantly associated with ANC coverage.

RECOMMENDATIONS

The findings highlight the importance of integrating economic development strategies with health system strengthening to achieve universal health coverage and meet global targets for maternal and child health. Policymakers should prioritize investments in health financing, workforce density, and equitable distribution of facilities, particularly in low-income settings. By aligning national health strategies with the Sustainable Development Goals (SDGs), countries can accelerate progress toward reducing maternal health disparities and ensuring that all women have access to essential antenatal care services.

Future research should aim to address the limitations of this cross-sectional study by incorporating longitudinal data to better capture causal relationships between economic development and maternal health service utilization. Comparative case studies across regions could provide deeper insights into how contextual factors—such as governance, health financing mechanisms, and workforce distribution—mediate the relationship between GDP per capita and ANC coverage. Additionally, expanding the analysis to include other maternal and child health indicators, such as skilled birth attendance, maternal mortality ratios, and neonatal outcomes, would provide a more comprehensive understanding of health system performance. Finally, integrating qualitative approaches, such as policy analysis and stakeholder interviews, could enrich the quantitative findings and inform more targeted interventions to strengthen maternal health systems in low- and middle-income countries.

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REFERENCES

[1] World Health Organization, *WHO Recommendations on Antenatal Care for a Positive Pregnancy Experience*. 2016, Genewa: World Health Organization.

[2] Arroyave, L., et al., Inequalities in antenatal care coverage and quality: an analysis from 63 low and middle-income countries using the ANCq content-qualified coverage indicator. *International Journal for Equity in Health*, 2021; 20(1): p. 102.

[3] UNDP. *The SDGs in Action*. 2023 [cited 2023 August, 27]; Available from: https://www.undp.org/sustainable-development-goals?utm_source=EN&utm_medium=GSR&utm_content=US_UNDP_PaidSearch_Brand_English&utm_campaign=CENTRAL&c_src=CENTRAL&c_src2=GSR&gclid=EAIaIQobChMI1s742OaR-wIV6Z1LBR1wSATHEAAYAyAAEgLhX_D_BwE.

[4] Aboagye, R.G., et al., Utilisation of eight or more antenatal care visits and its associated socio-economic-related inequalities in sub-Saharan Africa: A decomposition analysis. *PLOS ONE*, 2025. 20(3): p. e0312412.

[5] Osborne, P.L., *Tropical Ecosystems and Ecological Concepts*. 2012, Cambridge University Press.

[6] Henry, J., *Tropical And Equatorial Climates*, in *Encyclopedia of World Climatology*, J.E. Oliver, Editor. 2005, Springer Netherlands: Dordrecht. p. 742-750.

[7] Ahmad, R., *Tropical Environments*, in *Encyclopedia of Engineering Geology*, P.T. Bobrowsky and B. Marker, Editors. 2018, Springer International Publishing: Cham. p. 905-910.

[8] Sutter, P.S., *The Tropics: A Brief History of an Environmental Imaginary*, in *The Oxford Handbook of Environmental History*. 2014, Oxford University Press. p. 0.

[9] UNICEF. *Antenatal Care*. 2024 November 2024; https://data.unicef.org/topic/maternal-health/antenatal-care/.

[10] The Commonwealth Fund. *Mirror, Mirror 2024: A Potrait of the Failing U.S. Health System Comparing Performance in 10 Nations*. 2024 September 19, 2024; https://www.commonwealthfund.org/publications/fund-reports/2024/sep/mirror-mirror-2024.

[11] Vărzaru, A.A. Assessing the Relationships of Expenditure and Health Outcomes in Healthcare Systems: A System Design Approach. *Healthcare*, 2025. 13, 352. https://doi.org/10.3390/healthcare13040352

[12] Ginn, W., Healthcare expenditures and economic growth: evidence via panel local projections. *The European Journal of Health Economics*, 2025. 26(6): p. 877-892.

[13] Organisation for Economic Co-operation and Development (OECD), *Health at a Glance 2023: OECD Indicators*. 2023, Organisation for Economic Co-operation and Development (OECD): Paris.

[14] The World Bank. *Current Health Expenditure (% of GDP)*. 2021; https://data.worldbank.org/indicator/SH.XPD.CHEX.GD.ZS.

[15] Gupta, Y. and S. Aggarwal, *Global Gross Domestic Product and Sustainable Development*, in *Decent Work and Economic Growth*, W. Leal Filho, et al., Editors. 2020, Springer International Publishing: Cham. p. 1-14.

[16] United Nations, *Methodology Sheets: Gross Domestic Product per capita*. 2007.

[17] United Nations Conference on Trade and Development (UNCTAD), *Fact Sheet #7: Gross Domestic Product*, in *United Nations Conference on Trade and Development (UNCTAD)*. 2022.

[18] Cohen Kaminitz, S., *The significance of GDP: a new take on a century-old question*. Journal of Economic Methodology, 2023. 30(1): p. 1-14.

[19] Iuga, I.C., R.A. Nerişanu, and H. Iuga, How a nation's well-being influences its health profile: an analysis of critical indicators. *The European Journal of Health Economics*, 2025. 26(8): p. 1439-1457.

[20] World Health Organization, *Health Workforce Requirements for Universal Health Coverage and The Sustainable Development Goals*. 2016: Geneva. p. 10.

[21] Aiga, H., Adapting workforce density threshold to WHO's new antenatal care recommendations. *The Lancet*, 2020. 395(10217): p. 27.

[22] World Health Organization, *The World Health Report 2006: Working Together for Health*. 2006.

[23] WHO. *Health Infrastructure: Hospitals, Density per 100,000 Population*. 2013; Available from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/total-density-per-100-000-population-hospitals.

[24] United Nations. *United Nations Member States*. 2025 December 2025; Available from: https://digitallibrary.un.org/record/4082085?utm_source=copilot.com.

[25] World Population Review. *Tropical Countries 2026*. 2026; Available from: https://worldpopulationreview.com/country-rankings/tropical-countries?utm_source=copilot.com.

[26] world Bank. *GDP per capita (current USD)*. 2025; Available from: https://data.worldbank.org/indicator/NY.GDP.PCAP.CD.

[27] World Health Organization. *The Global Health Workforce Statistics Database*. 2025; Available from: https://www.who.int/data/gho/data/themes/topics/health-workforce?utm_source=copilot.com.

[28] World Health Organization. *Antenatal Care Coverage-At Least Four Visits (%0*. 2026; Available from: https://www.who.int/data/gho/data/indicators/indicator-details/GHO/antenatal-care-coverage-at-least-four-visits.

[29] Tripathi, P., et al., Geographic disparities and determinants of full utilization of the continuum of maternal and newborn healthcare services in rural India. *BMC Public Health*, 2024. 24(1): p. 3378.

[30] Meherali, S., et al., Impact of climate change on maternal health outcomes: An evidence gap map review. *PLOS Global Public Health*, 2024. 4(8): p. e0003540.

[31] Baten, A., et al., Utilization of maternal healthcare services in low- and middle-income countries: a systematic review and meta-analysis. *Systematic Reviews*, 2025. 14(1): p. 88.

[32] Belay, D.G., et al., Preferences of women for maternal healthcare services in low-income and middle-income countries: a systematic review of discrete choice experiments. *BMJ Global Health*, 2025. 10(8): p. e017410.

[33] Gube, A.A., et al., Inequity in uptake of maternal health care services in developing countries: a systematic review and meta-analysis. *Frontiers in Public Health*, 2024; 12.

[34] Rosser, J.I., et al., The Effect of Healthcare Worker Density on Maternal Health Service Utilization in Sub-Saharan Africa. *The American Journal of Tropical Medicine and Hygiene*, 2022; 106(3): p. 939-944.

[35] Sarikhani, Y., S.M. Najibi, and Z. Razavi, Key barriers to the provision and utilization of maternal health services in low-and lower-middle-income countries; a scoping review. *BMC Women's Health*, 2024; 24(1): p. 325.

[36] Sheffel, A., et al., Effective Coverage for Maternal Health: Operationalising Effective Coverage Cascades for Antenatal Care and Nutrition Interventions for Pregnant Women in Seven Low- and Middle- Income Countries. *Journal of Global Health*, 2025. 15(04041).

[37] Creanga, A.A., et al., Maternal Health Policy Environment and the Relationship with Service Utilization in Low- and Middle- Income Countries. *Journal of Global Health*, 2023; 13(04025).

[38] Souza, J.P., et al., A global analysis of the determinants of maternal health and transitions in maternal mortality. *The Lancet Global Health*, 2024; 12(2): p. e306-e316.