



Regular Article

True nature of brain drain and brain gain: A MM-QR analysis on migration, remittances and FDI

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ARTICLE INFO

Keywords:

Brain drain

Brain gain

FDI

Method of moments quantile regression

Migration

Remittances

ABSTRACT

With ever-changing global dynamics, understanding which factors promote or hinder economic growth is crucial for any country. Although many studies have examined the variables migration, remittances, and FDI, fewer have examined their collective impact on economic growth in an income-level analysis. A noticeable limitation of the few existing studies in the area is the inability of the mean-based models to address the heterogeneity in real-life distributions. The main objective of the study was to bridge the knowledge gap and address the heterogeneity concerns in mean-based models using MM-QR, meanwhile providing quantile-based evidence for economic theories such as endogenous growth theory, structural transformation theory and most importantly, brain drain theory. The study used a panel dataset of 118 countries from 1995 to 2023, categorized into 4 income levels. Results of the study supported the brain drain theory, where migration negatively affected poorer economies and hinted at the possible existence of brain gain in HICs. Continuous non-linear behavior of FDI, remittances explained the existence of developmental asymmetries and supported endogenous growth theory and structural transformation theory and reveals development threshold effects. Finally, the study underlines the importance of placing tailored policies to absorb migration, remittances and FDIs for economic growth and provides policy recommendations accordingly.

1. Introduction

The population movement, also known as human migration, has been part of human nature since the beginning of history. Migration could either be within a country (internal migration) or between countries (international migration). The reasons for migration have been changing constantly. These reasons could be voluntary, such as to seek better educational and economic opportunities or involuntary, such as natural disasters, armed conflicts, or political instability of nations (Esses, 2018). Currently, in the information age, most of the academic literature identifies the increased economic opportunities and the enhanced quality of living as major influencing factors for migration (Mackey & And Liang, 2013; Bhardwaj & Sharma, 2023; Hagen-Zanker et al., 2025).

Brain drain emerged as a significant concern for developing countries over the past several decades (Beine et al., 2001; Docquier et al.,

2007; Gibson & McKenzie, 2011; Hemmi, 2005). This often leads to adverse economic effects on the countries of origin or “sending countries”. Brain drain condemns a developing country's ability to progress. Moreover, when state-educated and trained professionals migrate to a foreign country in search of job opportunities, it results in considerable economic and knowledge losses for the source country. However, recent academic studies have explored the potential of reversing these negative effects into positive economic contributions, referred to in the literature as “beneficial brain drain (BBD)” and have analyzed the simultaneous coexistence of both brain drain and beneficial brain drain (Adow, 2025; Kangasniemi et al., 2007).

Studying and analyzing how cross-border migration flows, remittances, and FDI shape economic performance has regained urgency in an era of greater mobility and global capital integration. Theoretical and empirical literature indicates multiple channels through which these flows may influence a country's growth. FDI can transfer

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technology and raise productivity where absorptive capacity exists (Alfaro et al., 2004; Borensztein et al., 1998), remittances often relax liquidity constraints but frequently finance consumption rather than scalable investment (Clemens et al., 2018; Ruiz-Arranz & Giuliano, 2009). Migration can raise GDP per capita (PGDP) when skill complementarities and innovation spillovers occur, but can depress growth through brain drain when skilled emigration is large (Beine et al., 2008; Docquier et al., 2007; Ottaviano & Peri, 2012).

However, these findings gathered from mean-based analytical methods mask important distributional and country-specific heterogeneity; the same inflows that boost growth in one country may be neutral or even harmful depending on institutional quality, financial development and the skill composition of the countries (Alesina et al., 2016; Alfaro et al., 2004; Borensztein et al., 1998).

From the output above (Fig. 1), it is clear that PGDP is significantly higher in HICs, and the average PGDP declines as a country's income level decreases. A key aspect of the above result is the average PNM across different income groups. The only recorded positive value is recorded in HICs. This implies that, apart from those countries, all other countries experience a net loss of migrants, leading to brain drain. Remittances, on the other hand, indicate that the largest recipients are LICs; this suggests that LICs rely more on remittances. HIC implies a low dependence on external sources.

Upon all these insights, an underlying key factor which is often overlooked is that most studies and the public are heavily focused on the two extremes of economic levels because of their significant differences, but UMIC and LMIC, in the midst of it, without indicating extreme results is more reactive to migration and its consequences, making them a key focus group in this study. Detailed descriptive statistics are attached in Appendix 2. The classification of countries in each income group category is illustrated in Fig. 2.

Migration itself is driven by a mix of push and pull factors that also shape migrant selection and, in turn, the economic consequences of migration for both sending and receiving countries. Classic formulations emphasize that people move in response to net differentials across

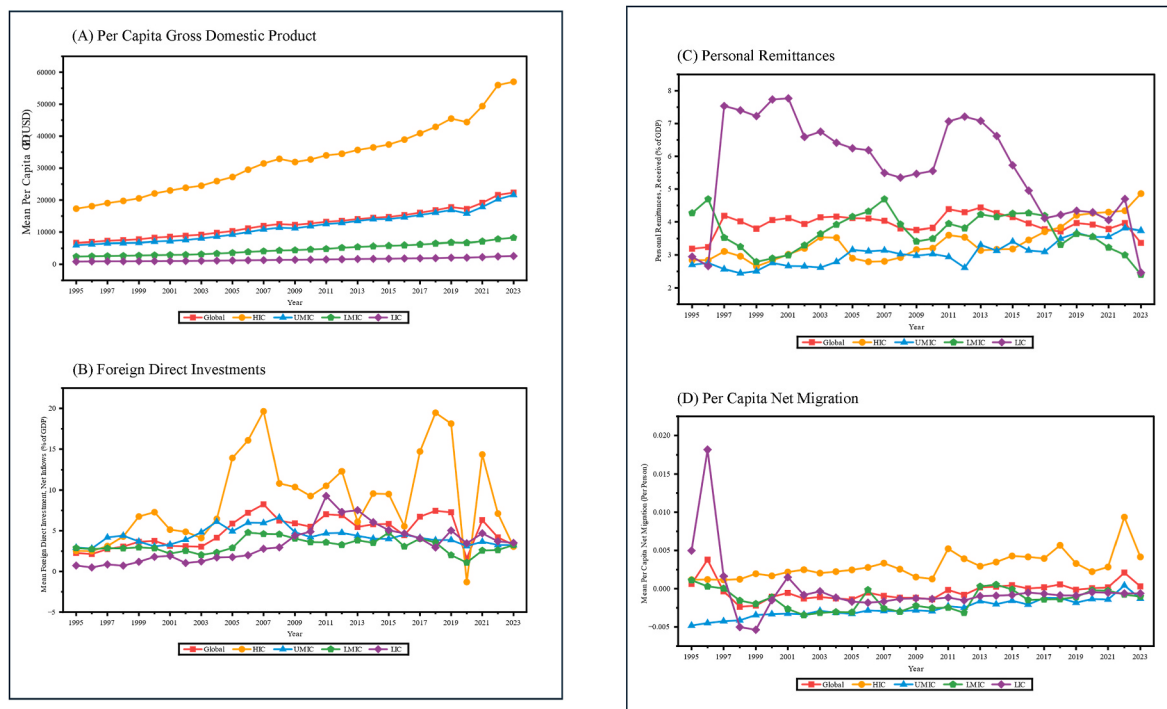
locations (Borensztein et al., 1998; Massey et al., 1993). The key push factors include low local wages, high unemployment rates, internal political instability, and low-level public services, which increase the reasons to emigrate (Clemens et al., 2018; Docquier & Rapoport, 2012). The pull factors in destination nations include things such as higher wages, better employment opportunities, stronger institutions, demand for specific skills, immigration policies that admit particular categories of workers and existing diaspora networks that offer low migration costs (Alesina et al., 2016; Ortega & Peri, 2014). Institutional and policy variables mediate how these pull factors translate into realized inflows (Jaumotte et al., 2016a).

This paper addresses two related gaps. First, it asks whether the effects of migration, remittances, and FDI on economic growth differ across the conditional distribution of country income, and how? Secondly, are the effects concentrated in high-performing countries, while absent or negative in low-performing ones?

This study contributes to the literature by providing insights in multiple ways. Firstly, this study aims to assess the impact of migration and its consequences on economic growth across the four established income groups. By using remittances and FDI as measures of the migration consequences, this allows for a more in-depth view of the benefits of brain drain. Secondly, by employing one of the latest quantile regression approaches, we capture distributional heterogeneity and uncover relationships that are often overlooked, beyond average effects methodologies. Thirdly, the study utilizes an updated global dataset including 118 countries from 1995 to 2023. Inclusion of the most recent data ensures that the findings of this study reflect current global trends and economic dynamics. Finally, the study offers policy implications for countries at different growth levels within each income group. This study aims not only for academic disclosure but also for practical policy formulations to enhance economic development.

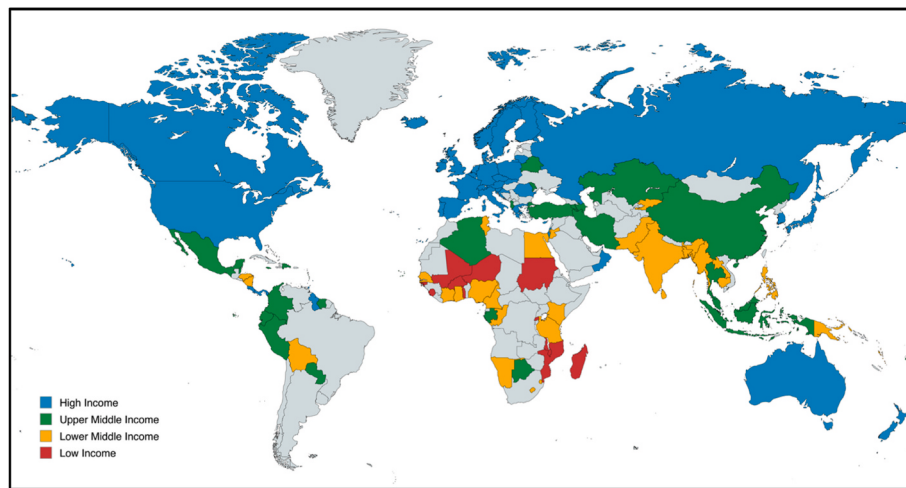
2. Critical literature review

The section below provides a critical literature review of migration,



Source: Authors' compilation based on World Bank data using Origin Pro software.

Fig. 1. Historical trends of mean values of PGDP, FDI, REM, and PNM
Source: Authors' compilation based on World Bank data using Origin Pro software.



Source: Authors' illustration

Fig. 2. Countries included in each income group.

Source: Authors' illustration

remittances, and FDI across income groups. A systematic literature search was conducted, and the search, screening, and selection process is detailed in Fig. 3.

2.1. High income countries (HICs)

A number of studies find that immigration of skilled individuals carries economic benefits such as an increase in labor productivity, improved innovation and research output, tendency of native's wage increases (Azmi et al., 2025; Beine et al., 2008; Hunt & Gauthier-Loiselle, 2010; Jaumotte et al., 2016b; Ortega & Peri, 2014; Ottaviano & Peri, 2012; Pal et al., 2022; Peck, 2023). Migration not only brings economic benefits but also social value as well by increasing cultural diversity (Alesina et al., 2016). This aligns with the Brain Gain phenomenon described by Beine et al. (2001) and Kangasniemi et al. (2007), in which rich countries benefit from accumulated networks of skilled foreigners. However, Ottaviano and Peri (2006), Morrison (2023), and Jennissen (2003) argue that a country's economic growth attracts skilled labor and that accumulated human capital does not drive the economy's growth. Contrary to these, some recent studies find short-run negative effects on economic growth, labour market disruptions, and fiscal policy adjustment costs caused by migration (Borjas, 2003; OECD, 2021; Öztürk & Özdi, 2020). These contrasting findings suggest that for HICs, the impact of migration highly depends on the skill composition of migrants.

Past literature states that rich nations relied less on remittance inflows due to the established domestic labor structures and self-sustaining capital markets (Haller et al., 2018; Ruiz-Arranz & Giuliano, 2009). However, contradicting the above statements, respectively Shah (2023) and Pal et al. (2022) find that as remittances increase, exports decrease within a threshold and unemployment rate increases for HICs.

FDI shows modest but positive effects in HICs according to various previous studies. Alfaro et al. (2004) discovered that FDI enhanced growth only when it was supported by high-level financial institutions, while Doytch and Eren (2012) emphasized that the service sector FDI, not manufacturing, yielded meaningful returns in developed economies. FDI can strengthen competitive advantages, but create decreasing incremental improvements in mature sectors (Haskel et al., 2007). However, interestingly, Hayat (2019) finds that FDI slows the economic growth of HICs. Further, it is mandatory to note that FDI inflows to HICs are not influenced by diaspora networks. And growth impact through FDI is not a consequence of migration for HICs.

While HICs gain many benefits from skill migration, remittances play an insignificant role. These benefits are limited and distributional, and some authors state otherwise. This mix of negative and positive factors creates a gap in existing literature.

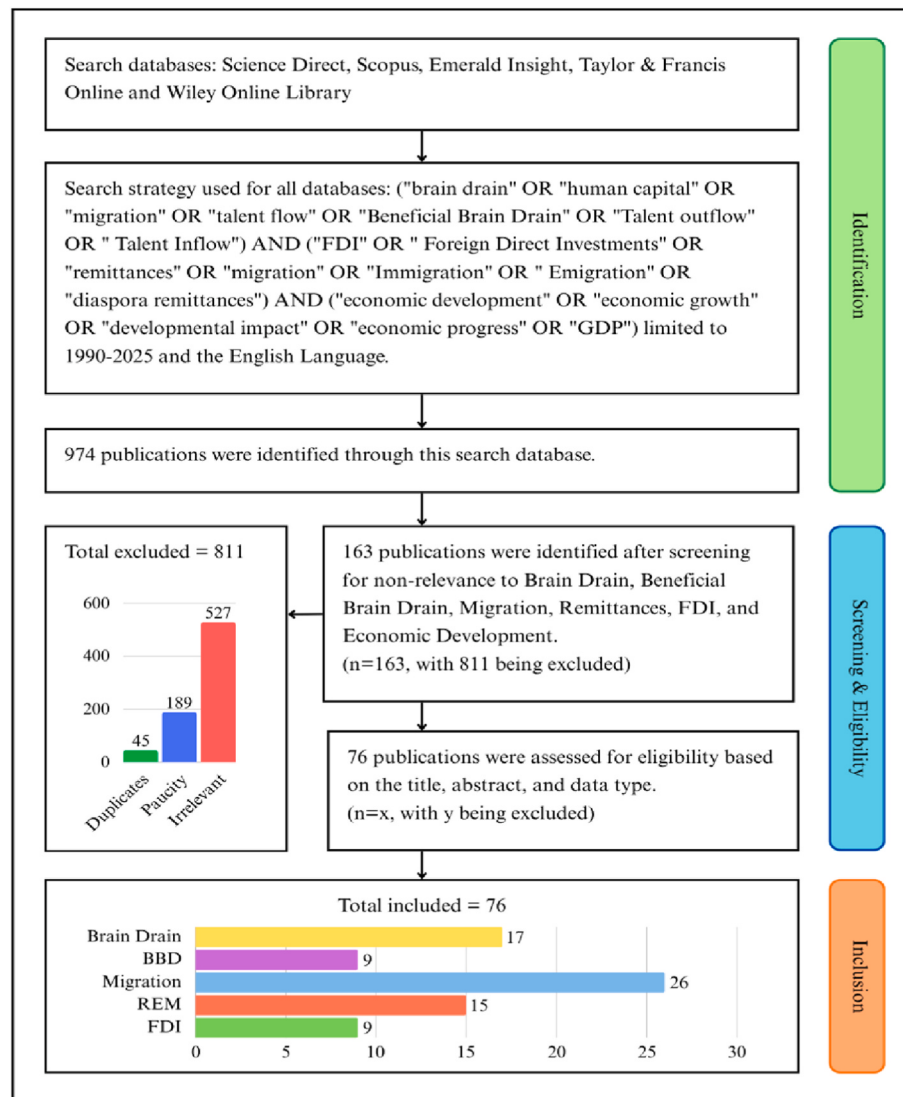
2.2. Upper middle-income countries (UMICs)

Recent literature on migration argues that it generates a “beneficial brain drain” effect for UMICs. Migration increases GDP per capita by improving the quality and quantity of labor and enhancing trade integration. Moreover, as investment in education increases to access foreign labour markets, migration prospects increase human capital accumulation in a nation (Beine et al., 2008, 2010). Interestingly, Rayevnyeva et al. (2023) stated that migration can have a negative impact on the country's population and a positive effect on GDP, while GDP growth can decrease migration. However, some authors argue that Beine et al. (2010), when institutional quality and skilled labor retention are weak, outbound migration leads to a persistent loss of human capital (Artuc et al., 2015; Beine et al., 2010). This further confirmed the presence of growth-hindering labor losses, similar to the dynamics highlighted by Kangasniemi et al. (2007), in which developing and semi-developed nations experienced skill shortages as migration intensified.

Remittances in UMICs had positive but insignificant economic effects. Moreover, a study by Chami et al. (2005) covering 113 countries finds that remittances act as a remunerative transfer, hindering growth and labour supply. However, Ruiz-Arranz and Giuliano (2009) argue that remittances are substantial for the growth of UMICs. Where banks fail to fund investments, remittances significantly support growth.

Unlike HICs, FDI showed mixed implications in UMICs. As Nguyen et al. (2024) noted, “FDI benefits depended strongly on absorptive capacity, which remained weak in many UMICs”. Furthermore, FDI creates stronger spillovers when there's human capital and supplier networks (Borensztein et al., 1998; Javorcik, 2004). These studies imply that UMICs faced structural limitations that prevented them from transforming migration, remittances, and FDI into sustained growth, reflecting both partial advantages and evidence of outward brain drain.

While the existing literature has studied the consequences of migration, these studies are limited to either selected countries and regions or to constructed economic models and may not capture the association among migration, remittances, FDI, and their impact on economic growth.



Source: Authors' compilation.

Fig. 3. Literature search flow diagram.

Source: Authors' compilation.

2.3. Lower middle-income countries (LMICs)

LMICs face much more severe consequences from migration outflow, as their economic systems lack the depth to keep skilled individuals locally. Previous literature have described this phenomenon as brain drain and stated that it was a "major constraint for emerging economies due to the weakening of domestic talent pools, increased labor scarcity, and slowed productivity growth" (Beine et al., 2008; Docquier et al., 2007; Docquier & Rapoport, 2012). Nevertheless, recent findings show that migration increases schooling investments and knowledge transfer through diaspora networks may offset losses (Bahar & Rapoport, 2018; Beine et al., 2001).

Similarly, in UMICs, remittances served as a partial compensatory mechanism. According to Cooray (2012), "remittances promoted financial development in intermediate economies by increasing savings and investment", although Ruiz-Arranz and Giuliano (2009) argued that "only countries with evolving financial systems efficiently channeled remittances into productive investment", which explained their limited role in less advanced LMICs. Furthermore, Chami et al. (2005) and Azmi et al. (2025) state that remittances primarily support consumption, and there is less evidence that they lead to long-term investment-driven

growth.

FDI demonstrated consistently positive effects in LMICs across regression techniques, stating that these countries heavily relied on foreign capital for growth (Hayat, 2019). This supported Borensztein et al. (1998), who established that "middle-income economies benefited from FDI-led technology spillovers when paired with basic human capital". The stable FDI impact in the study supported the dependency-driven development pathway described by Mottaleb (2008), in which LMICs relied heavily on foreign investment due to limited domestic capital formation. However, contrary to the above, Emako et al. (2022) find that FDI in the tertiary sector of developing countries negatively affects growth. Moreover, LMICs appeared to experience negative migration outcomes but benefited from remittances and FDI at a level of partial structural maturity, indicating the need for policy intervention to mitigate brain drain while strengthening productive investment mechanisms.

In various LMICs, FDI, remittances and PNM have different micro advantages and mixed macro benefits (Beine et al., 2008; Docquier & Rapoport, 2012; Doytch & Uctum, 2011; Javorcik, 2004). Previous studies find that FDI supports when it creates supplier relations and is unrestricted, and that migration can either provide skills or cause

harmful brain drain, depending on whether LMICs are net receivers or senders.

2.4. Low-income countries (LICs)

Previous literature has consistently claimed that LICs have borne the greatest economic consequences of migration. These consequences have reflected a structural inability to retain human capital, and have increased labour depletion without offsetting knowledge transfers (De Haas, 2006). Moreover, literature finds that skilled migration decomposes the economic growth of poorer countries, weakening institutional capacity and increasing dependency on already developed economies (Artuc et al., 2015; Rapoport & Docquier, 2006). However, an early study by Beine et al. (2008) suggests positive economic impacts, such as knowledge transfer through return migration and enhanced educational access for students in rural areas of home countries.

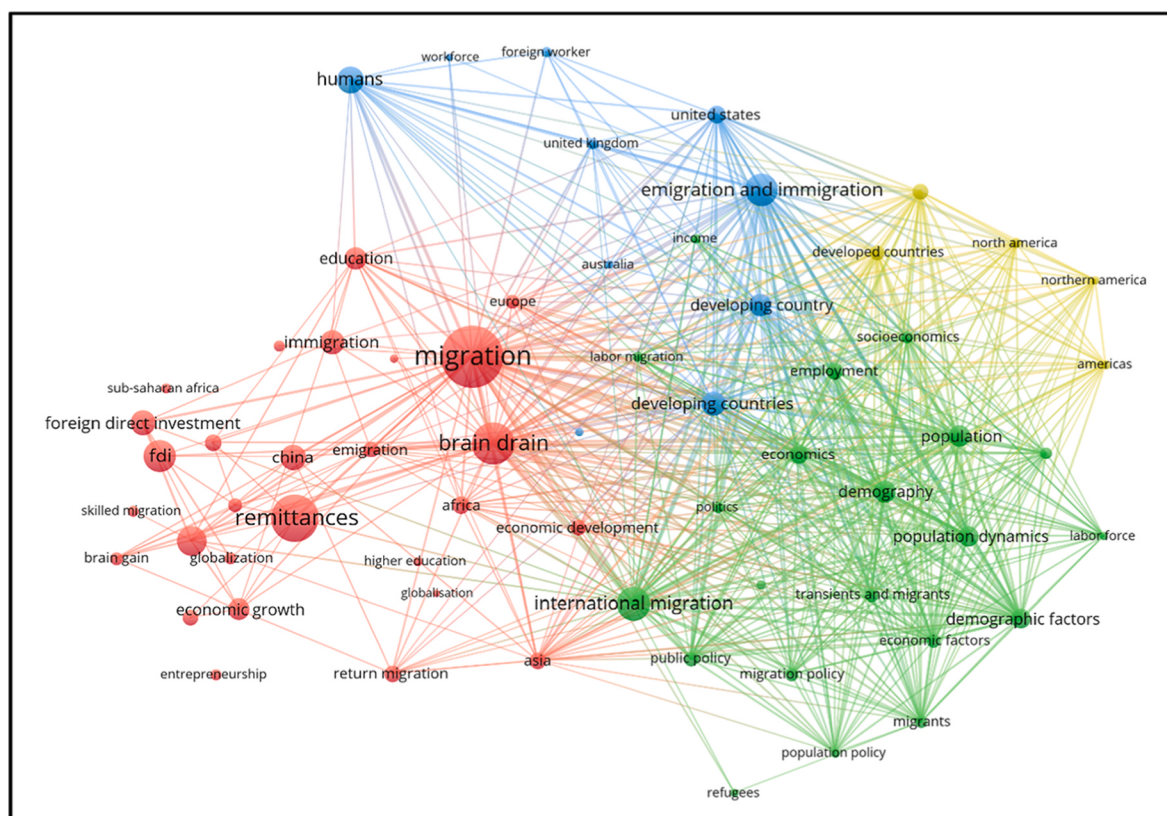
With regards to the impact of remittances in LICs, many studies find that remittance inflows have a positive impact on nominal GDP and nominal GDP per capita and are a vital source of external funding for many countries, with significant implications for economic development (Kurokawa & Kusakabe, 2025; Lee et al., 2025; Prakash et al., 2025). However, this indicates that remittances helped consumption and basic minimum welfare among the poorest households rather than investments or savings (Adams & Cuecuecha, 2010; Clemens et al., 2018). Contrary to the growth literature, Adams and Cuecuecha (2010) argue that remittances in LICs were mainly used for food, healthcare, and education rather than for production or to limit macroeconomic transformation.

Additionally, many previous studies claim that FDI has not produced strong economic effects in the LIC group. Weak institutions, political instability, poor infrastructure, and high investment risk discouraged

productive FDI inflows (Carkovic & Levine, 2002; Chtioui & Boushieb, 2026; Lahiri et al., 2024). According to Wang and Blomström (1992), technology spillovers from FDI were contingent on minimum levels of human capital, which LICs more often lacked.

In LICs, the effects of FDI, remittances, and net migration are highly contingent and often unsteady across contexts. FDI increases economic growth mainly where institutional quality and human capital are sufficient to absorb spillovers (Alfaro et al., 2004; Borensztein et al., 1998), which resonates with the Endogenous Growth Theory. This emphasizes the importance of knowledge spillovers, technology transfer, and human capital accumulation in sustaining long-run economic growth. However, FDI remains ineffectual in weaker environments (Javorcik, 2004). Remittances increase financial flexibility but often fund consumption rather than long-term investment, restricting macroeconomic influence unless financial involvement is deep. Meanwhile, migration can either increase domestic labor or reduce economic growth through highly skilled migration.

While a vast amount of previous literature examines the significance and impact of migration and its consequences, it fails to reach a single conclusion. Moreover, the majority of these studies have focused on independent countries or regions. Moreover, they have used datasets from the early 2000s, and many of those acknowledge the limitations of endogeneity and autocorrelation in the data. Furthermore, those studies use standard panel regression methods that estimate based on mean values, yielding an average effect. Results from those may yield misleading insights when analyzing macroeconomic variables. To address these gaps in the literature, we study how migration, remittances, and FDI influence economic growth using a method of moments quantile regression to derive accurate results.



Source: Authors' illustration using VOS Viewer Software.

Fig. 4. Graph of keywords in Co-occurrence.

Source: Authors' illustration using VOS Viewer Software.

2.5. Visualizing key trends

Fig. 4 illustrates the keyword co-occurrence network of the scientific literature used in this study. As shown in the illustration, the most dominant node is “migration”. “Remittances”, “brain drain”, “FDI”, and “economic development” show close connections to the central node. This suggests that previous literature has mainly studied migration's relationship with economic development and concepts such as brain drain and remittances. Moreover, as shown in the network diagram, the focus of previous studies has mostly been on specific countries. This suggests that the impact of migration, remittances, and FDI on economic development across world regions or income groups has not been studied globally.

3. Data and methodology

In the following section, the conceptualization of this study, the research design, the data to be used, and the methodologies to be employed to conduct the study will be described and justified.

3.1. Data

This study will be a quantitative global study using secondary data collected from various sources listed in Table 1.

To conduct a comprehensive assessment, a balanced panel dataset comprising 118 countries from 1995 to 2023. The study's timeframe was primarily selected based on data availability. To measure a country's economic development, this study will use PGDP, an economic indicator widely used by scholars in similar studies (Adow, 2025; Carrasco & Ruiz-Castillo, 2019; Kaluarachchi & Jayathilaka, 2024). Moreover, study employees Per Capita Net Migration (PNM), Remittances (REM), and FDI in line with previous empirical studies that have used similar indicators to assess BBD (Dissanayake et al., 2025; Docquier, 2014; Okunade et al., 2025; Vega-Muñoz et al., 2025; Wang et al., 2025).

The dataset used for the analysis is provided in Appendix 1, and the process employed in the final analysis is illustrated in the methodology map below (Fig. 5).

3.2. Empirical methodology

3.2.1. Diagnostic tests

The multicollinearity of the data was tested employing the VIF test, and showed no multicollinearity problem. The Jarque-Bera normality test was used to assess the distribution of residuals; as shown in Appendix 3, the statistics are highly significant, suggesting that the residuals do not follow a normal distribution. Following the above, the

Table 1
Data sources.

Variable	Measure	Measurement	Source
Economic Growth	PGDP (Per Capita Gross Domestic Product)	USD, Per Person	https://data.worldbank.org/indicator/NY.GDP.PCAP.CD
Migration	PNM (Per Capita Net Migration)	Per Person	https://data.worldbank.org/indicator/SM.POP.NETM
Remittances	REM (Personal Remittances, received)	Percentage of GDP	https://data.worldbank.org/indicator/BX.TRF.PWKR.DT.GD.ZS
FDI	FDI (Foreign Direct Investments, Net Inflows)	Percentage of GDP	https://data.worldbank.org/indicator/BX.KLT.DINV.WD.GD.ZS

Source: Compiled by the Authors.

Pesaran Cross-sectional Dependence test was employed to assess cross-sectional dependence in the dataset, which revealed cross-sectional dependence across the module (Appendix 3.4). Pesaran and Yamagata's slope homogeneity test was applied to check the slope heterogeneity. The test strongly suggests heterogeneity across the dataset. The stationarity of the variables was assessed using the Cross-sectionally Augmented Im-Pesaran-Shin (CIPS) test. Variables that were non-stationary at first were reassessed with a single level of difference. The CUSUM test was run to test the stability of the regression model over time. Results of the unit root test and CUSUM test are detailed in Appendix 4.

Furthermore, the Wooldridge test indicates significant autocorrelation, which may lead to biased or misleading estimates. Raincloud plots in Fig. 6 show extreme outliers. The above-mentioned tests of normality, autocorrelation, cross-sectional dependence, heterogeneity across panels and outliers demonstrate the violation of assumptions in standard panel regression (Born & Breitung, 2016), suggesting that the standard OLS regression may not be suitable for our model.

3.2.2. Method-of-moments quantile regression (MM-QR) with fixed effects

Panel quantile regression is an extension of traditional mean-based estimation methods such as Pooled OLS, fixed effects, or random effects models. It has been built to overcome difficulties in traditional methods, such as overestimation of coefficients, high sensitivity to outliers, and unobserved heterogeneity (Koenker & Bassett, 1978; Lamarche, 2010; Mensah et al., 2025). Method of moments quantile regression model introduced by Machado and Santos Silva (2019) is highly effective in allowing heterogeneous slope coefficients for each quantile, handling skewed data, non-normal error distributions, making this method highly suitable in this study. This allows to overcome the methodological gap, which previous studies have been unable to address. Moreover, researchers from many different disciplines such as agriculture and energy (Abdullahi et al., 2025; Anwar et al., 2021; Hossain et al., 2024; Ike et al., 2020), economics and finance (Gupta et al., 2025; Javed et al., 2025; Khah & Ahmad, 2024), healthcare (Chaturvedi et al., 2025), is adopting MM-QR as a highly suitable method for analyzing macroeconomic factors.

The core structural form of the estimation model used is indicated by equation (1),

$$Q_{y_{it}}(\tau | X_{it}, \alpha_{it}) = \alpha_i(\tau) + X_{it}\beta(\tau) \quad (1)$$

In the equation where y represents the dependent variable, i represents the entity, and the time period is denoted by t . $Q_{y_{it}}(\tau | X_{it}, \alpha_{it})$ represents the conditional quantile function where X_{it} is the vector for the independent variables. $\beta(\tau)$ is the vector for quantile-specific slope coefficients for the independent variables. $\alpha_i(\tau)$ denotes the individual fixed effects for the entity i , and this term captures the unobserved, time-invariant heterogeneity uniquely to each entity.

The method-of-Moments model proposed by Machado and Santos Silva (2019) adds location and scale components, simplifying the model by decomposing the quantile effect (Equation (2)). Furthermore, this equation can be simplified by defining the quantile-specific coefficients (Equations (3) and (4)), where β presenting the location coefficients, γ representing the scale coefficients, and $F_e^{-1}(\tau)$ representing the τ -th quantile of the standardized error distribution.

$$Q_{y_{it}}(\tau | X_{it}) = X'_{it}\beta + \alpha_i + (X'_{it}\gamma + \delta_i)F_e^{-1}(\tau) \quad (2)$$

$$\beta(\tau) = \beta + \gamma F_e^{-1}(\tau) \quad (3)$$

$$\alpha_i(\tau) = \alpha_i + \gamma_i F_e^{-1}(\tau) \quad (4)$$

Based on the above, the empirical equation used in this study is formulated by substituting the study's variables. Equation (5) denotes the base equation employed in the analysis. Required variables were differenced based on the unit-root test results and used to obtain results

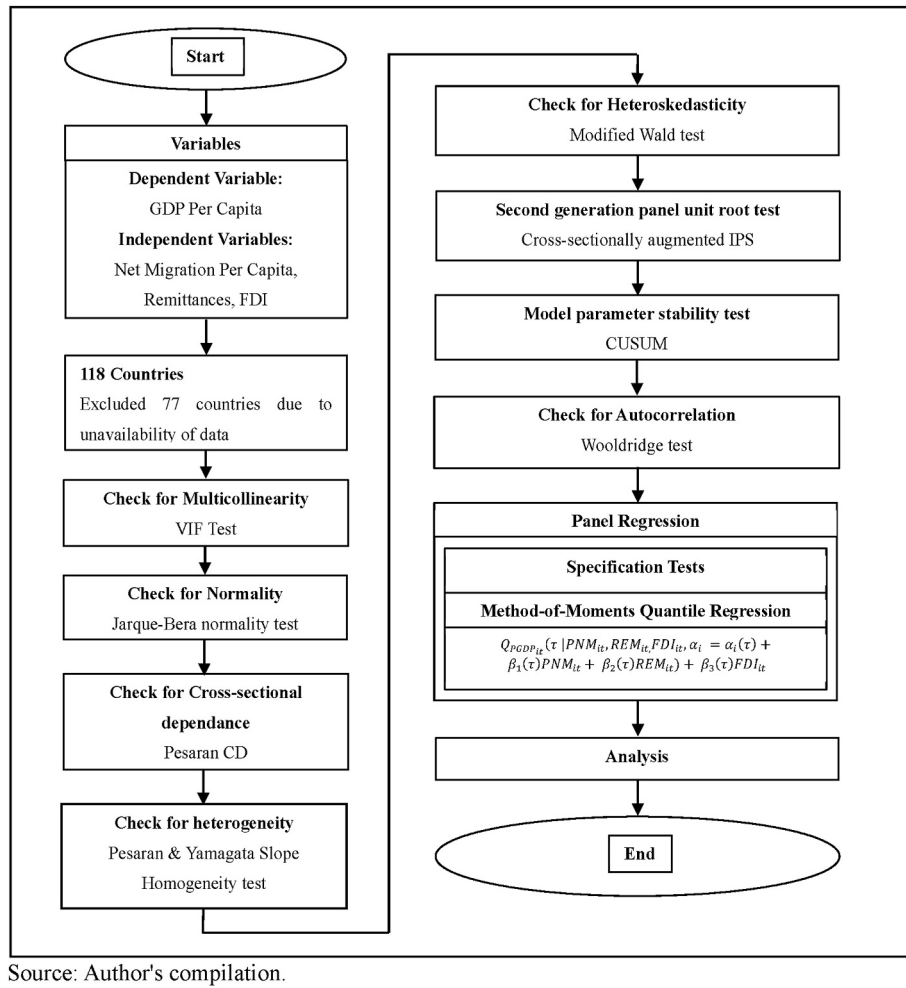


Fig. 5. Methodology mapping.
Source: Author's compilation.

for each income group.

$$Q_{PGDP_{it}}(\tau | PNM_{it}, REM_{it}, FDI_{it}, \alpha_i) = \alpha_i(\tau) + \beta_1(\tau)PNM_{it} + \beta_2(\tau)REM_{it} + \beta_3(\tau)FDI_{it} \quad (5)$$

This study estimates $\beta_1, \beta_2, \beta_3$ and α_i uniquely for the quantiles $\tau = 0.10, 0.25, 0.5, 0.75$, and 0.90 .

4. Results and discussion

4.1. Descriptive statistics

Fig. 6 illustrates the distribution of the test variables in raincloud graphs and boxplots for clear visualization. From these illustrations, it is clear that PGDP, the measure of economic growth, is distinct and shows clear segregation, underscoring the importance of the income-level analysis in the study. Also, high dispersion and a higher number of outliers are evident in higher-income countries than in lower-income countries, indicating structural constraints on growth.

While PNM results are rather stable comparatively, lower-income countries tend to exhibit higher dispersion and volatility, suggesting greater sensitivity to migration shocks. Similar results are observed in FDI data, where most values are concentrated around zero, with higher dispersion in HICs. Once again, clear evidence of distributional inequity across income levels.

Remittances, on the other hand, clearly indicate countries' dependence on set income levels: lower-income countries show greater

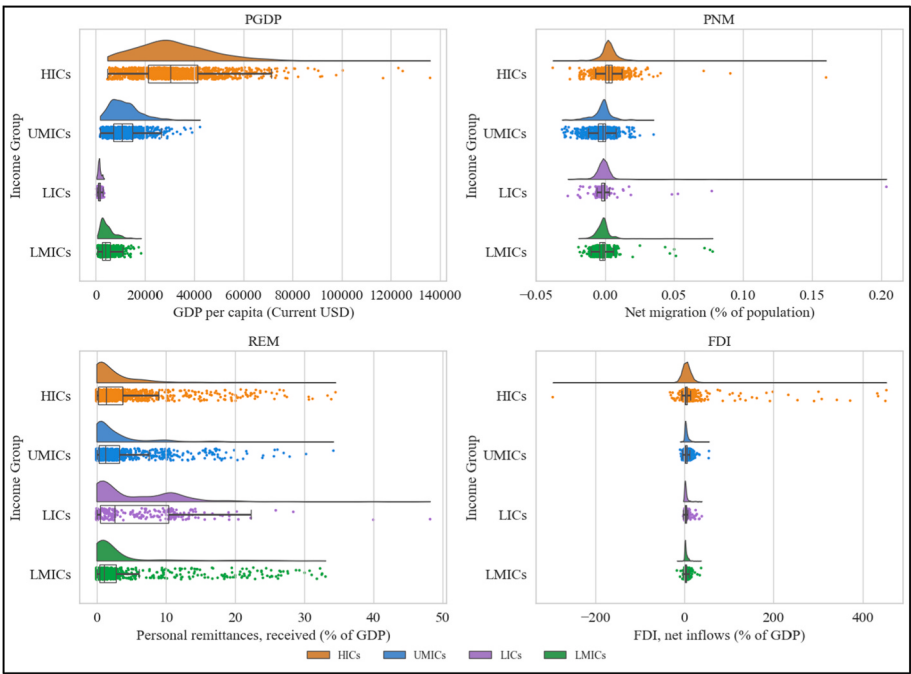
dependence, while higher-income countries show less. Overall, the distributional statistics reveal a clear structural gradient: high-income countries show high income variance and less dependence on external financial flows, whereas the opposite is true in lower-income countries.

4.2. MM-QR results

Fig. 7 reports the results of the method-of-moments quantile regression for all income groups for the test variables PNM, REM, and FDI against PGDP. The coefficient for each variable at different quantiles is shown in the table, and the color intensity indicates significance. Comprehensive results, including the standard error values given in Appendix 5.

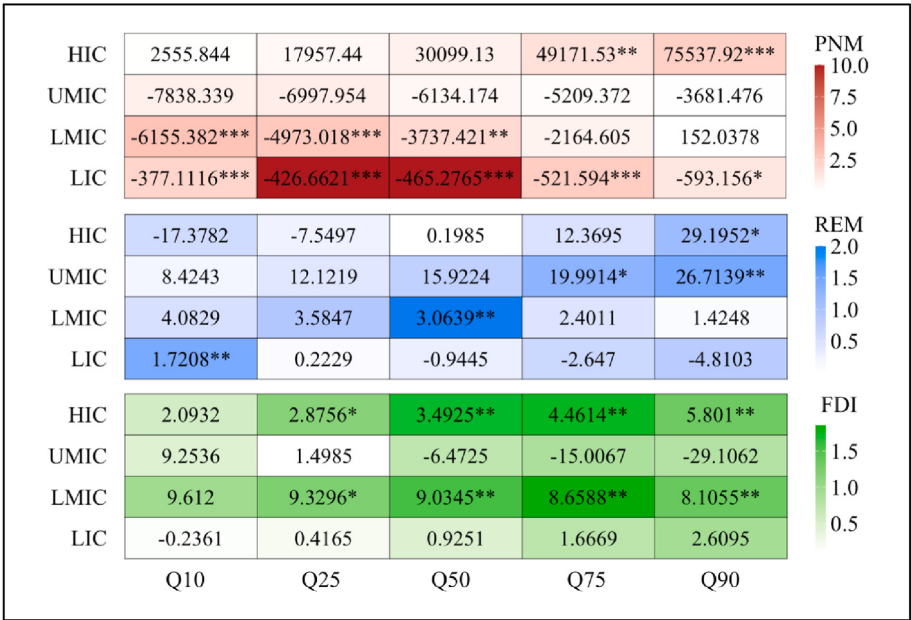
A striking observation when the results are analyzed is the highly significant negative coefficients in LMICs (Q10-Q50) and especially in LICs. This indicates that PNM has a significant negative impact on economic growth in poorer economies. The results align with the theory of Brain Drain, which holds that labor outflows from countries disrupt human capital formation and reduce domestic productivity. Many similar studies have discussed this phenomenon (Beine et al., 2001; Docquier & Rapoport, 2012) where countries with already scarce human resources experience a sizable economic impact from modest changes in migration.

With MM-QR, it is clear how the effects of the variables differ across points in the GDP distribution. In LMICs, the negative effects of migration are strongest at Q10 and as the economies are moving towards the



Source: Authors’ compilation based on the World Bank Open Data portal using Python.

Fig. 6. Distribution of variables.
Source: Authors’ compilation based on the World Bank Open Data portal using Python.



Source: Authors’ illustration based on results from STATA 19.5 software.

Fig. 7. MM-QR results for different income groups.
Source: Authors’ illustration based on results from STATA 19.5 software.

upper quantiles, the negative effect diminishes and becomes insignificant indicating that, as economies grow, they become more resilient towards migration shocks and domestic human capital structures are strong enough to sustain their economies and attract skilled or semi-skilled labor from lesser developed countries. This also indicates the presence of a development threshold effect, in which the effects of migration and related consequences become significant only beyond certain income levels.

An interesting insight emerges when observed closely at the upper

quantiles of HICs, where migration shows significant positive coefficients (Q75 & Q90). These positive coefficients provide clear evidence of a potential brain gain or BBD. In Brain Gain studies and BBD studies, this phenomenon is discussed, where, through migrant returnees, skilled migrant absorption and various other means, developed countries are able to optimize their human capital formation and obtain economic benefit from migration (Beine et al., 2011; Kuhn & Mcausland, 2009). Location and scale component results indicate that migration not only alters growth levels but also increases inequality (dispersion) in

growth outcomes across countries.

On the other hand, FDI shows positive and significant coefficients only in LMICs and HICs and no significant coefficients in any other income level. This selective growth-enhancing pattern of FDI indicates an absorption capacity threshold, where FDI becomes growth-enhancing only when the host country fulfills the minimum absorptive capacity requirements (Borensztein et al., 1998; Iamsiraroj, 2016). According to the location-scale results, FDI in LMICs stabilizes economic growth and reduces dispersion.

A different insight into the effect of FDI in LMICs can be seen in UMICs, where FDI coefficients are negative and insignificant, potentially suggesting crowding-out effects in these economies. Here, the scale component results indicate that FDI causes greater income inequality, potentially diminishing domestic investment and limiting technological and productivity advancements. Results provide evidence to similar studies conducted to identify the potential crowding-out effects of FDI (Aitken & Harrison, 1999; Akanbi, 2017).

Remittances show highly divergent results as they show significance at the lowest quantile of LICs as well as the upper quantiles in UMICs and HICs. The role of remittances in LICs is to prevent the poorest countries from falling into deeper poverty (Ruiz-Arranz & Giuliano, 2009). Other than LICs, remittances act as a consumption smoother rather than a growth-driving mechanism, and, as existing studies show, they increase inequality as remittances are diverted across economies (Bajra, 2021; Hung & Peng, 2021).

In more developed economies, the upper quantiles of UMICs and HICs show that remittances indicate growth effects when used for economic benefits rather than consumption. Apart from those specific situations, the role of remittance in development shows almost negligible effect, which aligns with existing studies (Bredl, 2011; Lim & Simmons, 2015). These varied results also signify the methodological importance of using MM-QR with location-scale components, where mean-based methods cannot capture these hidden insights.

Moreover, it is evident that the impact of the test variables is heavily dependent on the country's economic performance and exhibits high heterogeneity, further encouraging the use of MM-QR in this study, which can address masked heterogeneity. Finally, it is clear that, by using MM-QR and incorporating location and scale components, migration, FDI, and remittances not only affect the level of economic growth but also shape its distribution, highlighting the diversified global economy and the importance of development-stage-specific policies and strategies to maximize growth. Table 2 summarizes the main MM-QR findings across income groups.

5. Conclusion

The study emphasized and examined the impact of net migration, remittances and FDI using a structured panel by employing MM-QR with location and scale components with the core objective of understanding the behavior and impact of these variables across income groups, which provided more granular and precise insights than traditional mean-

based methods.

Findings from the study highlighted the diverse impact of these variables across income groups and challenged the general assumption that they exert linear effects on economic growth, thereby capturing masked heterogeneity.

Migration contributes to global inequality, enhancing growth in already advanced economies and signaling brain-gain effects, while diminishing the poor economies aligned with brain-drain theories. LICs and lower quantiles of LMICs experience brain drain, while high quantiles of HICs experience brain gain.

FDI showed conditional growth-enhancing capabilities across LMICs and HICs, indicating absorption capacity threshold effects: FDI induced economic growth when minimum human capital and technology conditions were met. FDI did not show a significant effect on economic growth in LICs, indicating that these economies are not well equipped to absorb FDI, whereas UMICs showed an insignificant impact due to potential saturation and crowding-out effects from FDI.

Remittances, on the other hand, play a limited role in economic development, where they are mostly used as a consumption smoother and a short-term economic stabilizer rather than a long-term driver. The poorest economies use remittances as an economic stabilizer, helping them prevent further poverty.

Overall, the study signifies that migration, remittances and FDI exert fundamentally heterogeneous and development stage dependent effects on economic growth and also highlights the methodological importance of using MM-QR with location and scale components to capture both development level and dispersion effects from these variables and highlights the importance of employing development stage dependent policies and strategies to maximize the economic impact from these variables.

5.1. Policy recommendations

Throughout the study, the importance of employing development stage-dependent policies and strategies was highlighted due to the high heterogeneity in the variables. Migration policies should focus primarily on retention and circulation. For LICs and LMICs with high brain drain, policies should prioritize human capital retention and implement programs to attract return migration and diaspora engagement. As for UMICs and HICs, policies should focus on selective skilled migration to improve domestic human capital formation and maximize productivity gains.

FDI indicated absorptive capacity constraints; therefore, LICs should specifically focus on strategies and policies to improve institutional quality, infrastructure, and technological advancement to utilize FDI for productive growth. For LMICs, policies should focus on attracting more growth-enhancing FDI and improving international relations between the business sector and foreign entities. For UMICs, the focus should be on the quality and purpose of FDIs rather than their quantity, given potential crowding-out effects.

Remittances, on the other hand, do not act as a significant growth factor globally. Therefore, a global focus on policies and strategies to convert remittances into a growth driver would be to implement investment programs and utilize diaspora channels for investment-driven transfers rather than for household consumption.

Overall, strengthening governance structures, improving institutional quality, and investing in quality education can drive growth from these variables under any economic condition, so the final verdict is to ensure that the optimal growth environment is focused on attracting external labor flows and financing.

5.2. Limitations and future research

This study focuses on income-group classification, which may overlook the geographical and geopolitical impacts, and the use of only macroeconomic variables may obscure valuable microeconomic

Table 2
Summary of mm-QR results by income group.

Income Group	Migration	FDI	Remittances
LIC	Brain drain and economic hindrance	Weak impact	Consumption smoother
LMIC	Declining negative effect	Strongest and stable	Moderate effects
UMIC	Weak insignificant effects	Declining insignificant effects	Selective growth effects at upper quantiles
HIC	Brain gain and inequality	Inclining positive effects	Minimal impact

Source: Authors' compilation

patterns. Future studies could explore the mediating impact of institutional quality and governance on the test variables. Extending the current study, future research can differentiate net migration into skilled and unskilled for more granular insights. Also, a study can be conducted to identify the regional impact of these variables and incorporate regional dynamics into the study.

CRedit authorship contribution statement

Anupa Lokuliyana: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jayod Perera:** Writing – review & editing, Writing – original draft, Visualization, Resources, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Ranuka Perera:** Writing – review & editing, Writing – original draft, Visualization, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Nethmi Marina:** Writing – review & editing, Writing – original draft, Visualization, Resources, Formal analysis, Data curation, Conceptualization. **Thakshila Samarakkody:** Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Heshan Sameera Kankanam Pathiranaage:** Writing – review & editing, Writing – original draft, Validation, Supervision, Software, Resources, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization.

Data availability statement

All data generated or analyzed during this study are included in this published article and its supplementary information files.

Ethical statement

This study is based entirely on secondary, publicly available data. No human participants, human tissue, or animal subjects were involved. Therefore, ethical approval was not required for this study.

Declaration of the use of AI

The authors declare that no AI assisted technologies were used during any stage in the preparation of this article.

Funding statement

No external funding was received for this research by any funding agencies in public, private or non-profit sectors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssaho.2026.103091>.

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