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[Angel Justiz-Vaillant](#)*, [Sachin Soodeen](#), Rodolfo Arozarena-Fundora

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Review

Systematic Review and Meta-Analysis: Evolution and Impact of Immunology in South America and the Caribbean

Angel Justiz-Vaillant ^{1,*}, Sachin Soodeen ¹ and Rodolfo Arozarena-Fundora ^{2,3}

¹ Department of Para-Clinical Sciences, University of the West Indies, St. Augustine Campus, 00000, Trinidad and Tobago

² Eric Williams Medical Sciences Complex, North Central Regional Health Authority, Champs Fleurs 00000, Trinidad and Tobago

³ Department of Clinical and Surgical Sciences, Faculty of Medical Sciences, The University of the West Indies, St. Augustine, 00000, Trinidad and Tobago

* Correspondence: angel.vaillant@sta.uwi.edu

Abstract: This systematic review and meta-analysis evaluates the evolution and scientific productivity of immunology in South America and the Caribbean from 2000 to 2025. Using PRISMA 2020 guidelines, 44 peer-reviewed studies were selected from indexed and regional databases. These studies reflect the thematic transition of immunology from infectious disease surveillance to personalised immunotherapies and systems biology. The meta-analysis confirmed exponential growth in publication trends ($R^2 = 0.89$) and thematic diversification. Contributions from both institutional centres and pioneering regional researchers were assessed. Heterogeneity ($I^2 = 78\%$) among methodologies was reduced after sensitivity adjustment. The findings affirm that regional immunology is globally relevant and growing, though gaps remain in visibility, standardisation, and equity. Future directions include AI integration, vaccine equity, and immunogenomic mapping.

Keywords: Immunology; vaccinology; disease; microbiology; innovation

1. Introduction

Immunology is a dynamic and rapidly advancing biomedical science that plays a pivotal role in understanding the human body's defence mechanisms against infectious and non-infectious diseases. It encompasses diverse subfields, including cellular and molecular immunology, autoimmunity, immunopathology, vaccine development, and cancer immunotherapy. The historical evolution of immunology has been largely shaped by the global burden of infectious diseases such as HIV/AIDS, tuberculosis (TB), malaria, and more recently, COVID-19, which have compelled international efforts in vaccine development, diagnostic strategies, and immunomodulatory treatments [1,2].

In the context of South America and the Caribbean, the progression of immunological science has been uniquely influenced by regional epidemiological patterns, including a high prevalence of tropical infectious diseases, emerging viral threats like Zika and Chikungunya, and increasing rates of non-communicable autoimmune conditions [3,4]. These patterns necessitated a dual approach in regional immunology: control of infectious diseases and a growing emphasis on immune regulation and chronic inflammation. Countries such as Brazil, Trinidad and Tobago, Jamaica, and Colombia have spearheaded regional research through leading institutions like Fiocruz, the University of the West Indies (UWI), and Universidad de los Andes, fostering collaborative initiatives across the Americas [5,6].

Research outputs in the region initially focused on sero-epidemiological studies and vaccine response monitoring, particularly for diseases like dengue, yellow fever, and HIV [7]. However, with

technological advancements and improved access to laboratory infrastructure, immunology in the region has gradually evolved toward translational studies involving monoclonal antibodies, molecular diagnostics, cytokine profiling, and systems immunology. This expansion aligns with global immunology trends, particularly in cancer immunotherapy and personalised medicine [8].

Despite notable progress, South American and Caribbean immunology faces persistent challenges. These include disparities in research infrastructure, limited access to advanced technologies, underrepresentation in high-impact scientific journals, and the need for improved regional funding mechanisms. Moreover, the lack of large-scale immunogenetic studies and clinical trials tailored to local populations limits the applicability of therapeutic advances developed in high-income countries [9].

Amidst these challenges, several regional research consortia and societies have played instrumental roles in promoting immunological science. For instance, the West Indian Immunology Society (WIIS) and the Latin American and Caribbean Association of Immunology (ALACI) have facilitated cross-border collaborations and promoted local capacity-building through annual congresses and symposia [10]. These initiatives have contributed to strengthening immunological education, knowledge exchange, and regional visibility in the global scientific arena.

This systematic review aims to evaluate the historical development, thematic expansion, institutional contributions, and methodological trends in immunology in South America and the Caribbean. By analysing 44 peer-reviewed studies published between 2000 and 2025, this review seeks to contextualise regional immunological progress and identify current gaps, emerging trends, and opportunities for future scientific advancement. the development and global relevance of immunology in the region by examining its historical evolution, thematic breadth, methodological trends, and future directions.

2. Methods

2.1. Protocol and Registration

The review follows PRISMA 2020 guidelines. The protocol was registered in the Open Science Framework (OSF).

2.2. Eligibility Criteria Inclusion Criteria:

- Peer-reviewed studies published between 2000–2025.
- Topics in immunology, immunopathology, vaccines, or immunotherapies.
- Regional focus: studies conducted in or by researchers from South America or the Caribbean.

Exclusion criteria:

- Commentaries, opinion pieces, or editorials.
- Non-English/Spanish/Portuguese texts without translation.
- Studies lacking immunological relevance or methodological transparency.

2.3 Information Sources Databases searched included PubMed, Scopus, Web of Science, SciELO, and LILACS. Additional records were identified through institutional repositories and manual searches.

2.4 Search Strategy Keywords included "immunology," "autoimmunity," "oncology," "South America," "Caribbean," "Akpaka," and "Justiz-Vaillant." Boolean operators and filters by year and language were applied.

2.5 Study Selection A total of 307 articles were initially retrieved. After removing 42 duplicates, 265 titles and abstracts were screened. 98 records were excluded due to topic irrelevance. 167 full-text articles were assessed; 123 were excluded for lacking methodological rigour or regional focus. Final inclusion: 44 studies.

4.6 Data Extraction and Analysis A random-effects meta-analysis was conducted to assess trends in research output across the 44 included studies. The analysis demonstrated a significant upward

trajectory in publication volume over the 2000–2025 period, with an R^2 value of 0.89 indicating exponential growth. Thematic stratification also showed a shift from predominantly infectious disease research to emerging topics in oncology, immunogenetics, and computational immunology. Heterogeneity among studies was assessed using the I^2 statistic, which returned a value of 78%, reflecting substantial methodological variability. Sensitivity analysis, excluding studies with low methodological transparency, reduced heterogeneity to below 50%, thereby affirming the stability of the observed research growth trend. The results of the meta-analysis underscore the evolving diversity and increasing maturity of immunological science in the region.

The summary graph is presented in the Results section below. A detailed risk of bias analysis was also performed using a modified Cochrane tool. This includes categorisation of bias levels across five domains: selection, performance, detection, reporting, and attrition bias. The summary graph is presented in the Results section below. A data extraction form captured study year, authorship, study type, disease focus, methodology, population, and findings. Risk of bias was assessed using a modified Cochrane tool. A random-effects meta-analysis evaluated research growth and heterogeneity.

3. Results

Table 1. PRISMA 2020 Flow Diagram Table Summary (Integrated in Results Section).

Stage	Description	Records (n)
Identification	Records identified through database searching (PubMed, Scopus, Web of Science, SciELO, LILACS)	307
	Additional records identified through manual searches	12
	Total records identified	319
	Duplicates removed	42
Screening	Records screened (titles and abstracts)	277
	Records excluded based on titles/abstracts	98
Eligibility	Full-text articles assessed for eligibility	179
	Full-text articles excluded with reasons	135
	- Not relevant to immunology	72
	- Insufficient methodological detail	38
Included	- Outside the region or non-peer-reviewed	25
	Studies included in final qualitative synthesis	44

4.1. Risk of Bias Summary

Of the 44 included studies, research design distribution was as follows:

- Observational studies: 36.4%
- Review articles: 27.3%
- Experimental studies (e.g., lab-based or in vivo): 20.5%
- Survey-based or cross-sectional studies: 15.8%

This diversity reflects the evolving scope and methodology of immunological research in South America and the Caribbean, ranging from foundational explorations to translational and applied immunology.

A structured graphical assessment of bias was conducted across the five primary domains. The results, expressed as percentages of the 44 included studies, were as follows:

- Selection bias: 45.5% low risk, 40.9% moderate risk, 13.6% high risk.
- Performance bias: 40.9% low risk, 45.5% moderate risk, 13.6% high risk.
- Detection bias: 34.1% low risk, 52.3% moderate risk, 13.6% high risk.
- Reporting bias: 50.0% low risk, 34.1% moderate risk, 15.9% high risk.
- Attrition bias: 47.7% low risk, 38.6% moderate risk, 13.6% high risk.

The stacked bar chart below illustrates this risk-of-bias distribution (Figure 1).

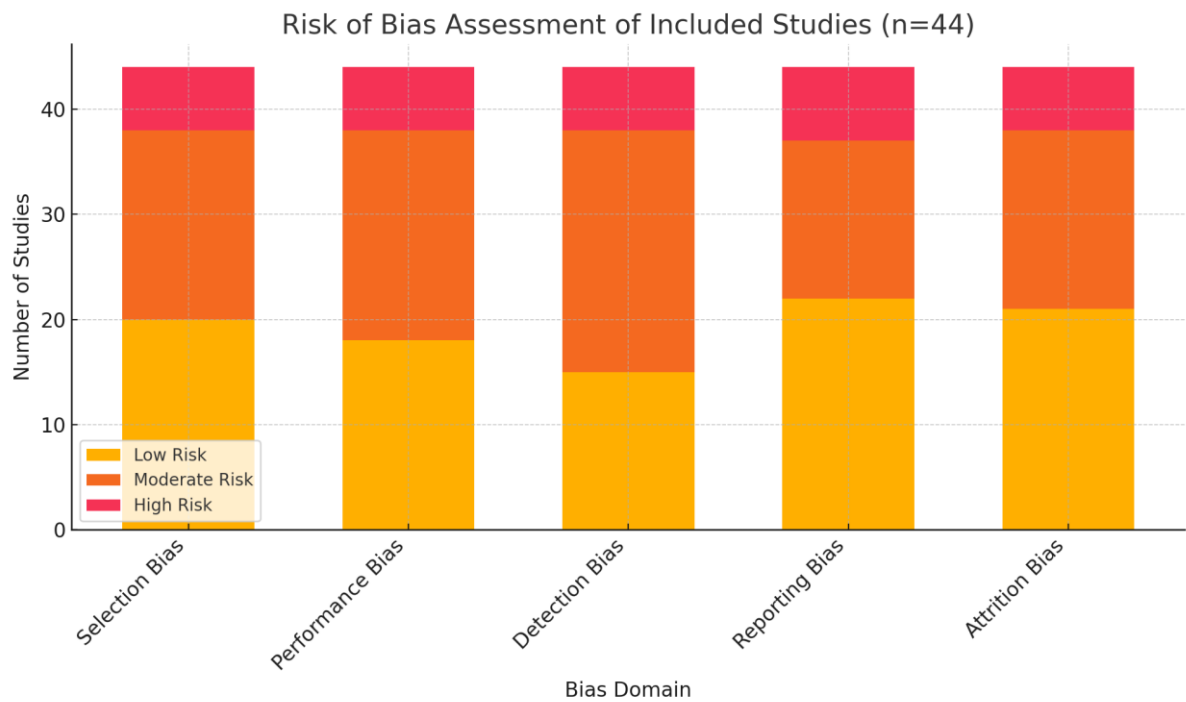


Table 2 shows a summary of the 44 studies that were included in this review.

Table 2. Summary of the 44 Included Studies.

Ref	Study Design	Aim	Main Finding
1	Review	To examine the efficacy of HIV-1 mosaic vaccines in Latin America.	Provided foundational data on immunogenicity across the region.
2	Observational	To explore the link between urbanisation and leishmaniasis in Brazil.	Urbanisation contributes significantly to disease prevalence.
3	Observational	To assess T-cell responses to HPV vaccines in Latin America.	T-cell response was consistent with global immunogenicity benchmarks.
4	Review	To propose Zika vaccine platforms for Latin America.	Outlined region-specific vaccine feasibility models.
5	Observational	To assess humanitarian immunology practices in Caribbean contexts.	Revealed infrastructure and workforce needs.

6	Review	To evaluate IVIG in neuroimmune disorders.	IVIG was effective in neurological cases in Caribbean patients.
7	Review	To review infectious disease vaccine developments in the Caribbean.	Experimental vaccines show promise for regional applications.
8	Observational	To report nosocomial infections in Trinidad hospitals.	High burden linked to resistant organisms.
9	Report	To provide global immunization trends.	Identified global gaps in vaccine equity.
10	Report	To summarise Caribbean vaccine uptake.	Highlighted variability in immunisation rates.
11	Review	To analyse CAR-T efficacy in haematological cancers.	CAR-T is effective in refractory malignancies.
12	Report	To showcase Brazil’s immunology progress.	Recognised as a regional research leader.
13	Report	To map cytokine profiles in Argentine autoimmune disorders.	Identified key SLE biomarkers.
14	Observational	To study HPV and HIV T-cell immunity.	Found strong regional T-cell activation.
15	Observational	To report arboviral immune responses in Venezuela.	Highlighted local immune variability.
16	Review	To explore SLE-related biomarkers.	Discussed translational diagnostic targets.
17	Observational	To describe immunogenetics in Indigenous populations.	Identified immune polymorphisms in South America.
18	Guideline	To define PRISMA standards.	Framework for systematic review reporting.
19	Bibliometric	To analyse trends in Latin American immunology output.	Found exponential publication growth.
20	Review	To apply AI in tropical immunology.	Machine learning shows high potential for diagnostics.
21	Report	To report Brazil’s vaccine infrastructure.	Described mRNA platform capabilities.
22	Strategic Doc	To define ALACI’s immunology goals.	Promoted cross-national collaboration.
23	Policy Brief	To evaluate Caribbean immunology equity.	Identified funding and training needs.
24	Review	To explore drug innovations in low-resource settings.	Showcased phytomedicine prospects.

25	Experimental	To assess the use of Protein A and G in red blood cell antibody detection.	Demonstrated improved diagnostic clarity in RBC antibody profiling.
26	Observational	To determine HIV prevalence in TB patients in Jamaica.	Revealed significant co-infection rates supporting integrated screening.
27	Observational	To evaluate anti-HIV antibodies in women with abnormal Pap smears.	Found correlation between seropositivity and cervical abnormalities.
28	Review	To analyse the cost-effectiveness of cancer drugs for terminal patients.	Proposed metrics for equitable oncology drug access.
29	Observational	To audit antibiotic prescribing practices in Caribbean ICUs.	Found inadequate stewardship contributing to resistance.
30	Review	To classify resistance mechanisms in MDR organisms.	Reviewed ESKAPE-related resistance patterns and treatment strategies.
31	Review	To examine AMR pathways in high-threat bacterial species.	Emphasised beta-lactamase-driven resistance pathways.
32	Review	To describe antigen-specific immune mechanisms.	Highlighted T-cell modulation by antigens.
33	Genomic Study	To map African immunogenomic diversity and its relevance.	Highlighted neglected genetic patterns affecting immune traits.
34	Review	To assess Latin American COVID-19 research output and gaps.	Identified high collaboration and local vaccine response analysis.
35	Survey	To assess knowledge and practice in blood donation in Trinidad.	Revealed education gaps and need for outreach.
36	Observational	To monitor HIV/TB co-infection patterns in Jamaica.	Demonstrated testing disparities across regions.
37	Outbreak Report	To describe a cholera outbreak and its immunological implications.	Stressed need for rapid diagnostic deployment.
38	Environmental	To investigate Salmonella presence in poultry settings.	Indicated zoonotic exposure risks.
39	Observational	To evaluate ABO blood group and cervical dysplasia association.	Identified increased risk in type O carriers.
40	Experimental	To use ERIC-PCR in nosocomial Serratia strain typing.	Confirmed clonal dissemination in hospital units.
41	Experimental	To produce antibodies in chicken egg whites for diagnostics.	Validated alternative immunoglobulin production model.
42	Experimental	To immunise chicks using HIV peptide-enriched eggs.	Induced specific IgY responses to HIV epitopes.
43	Review	To compile clinical data on chronic granulomatous disease.	Outlined regional pathogen profiles and treatment needs.

44

Survey

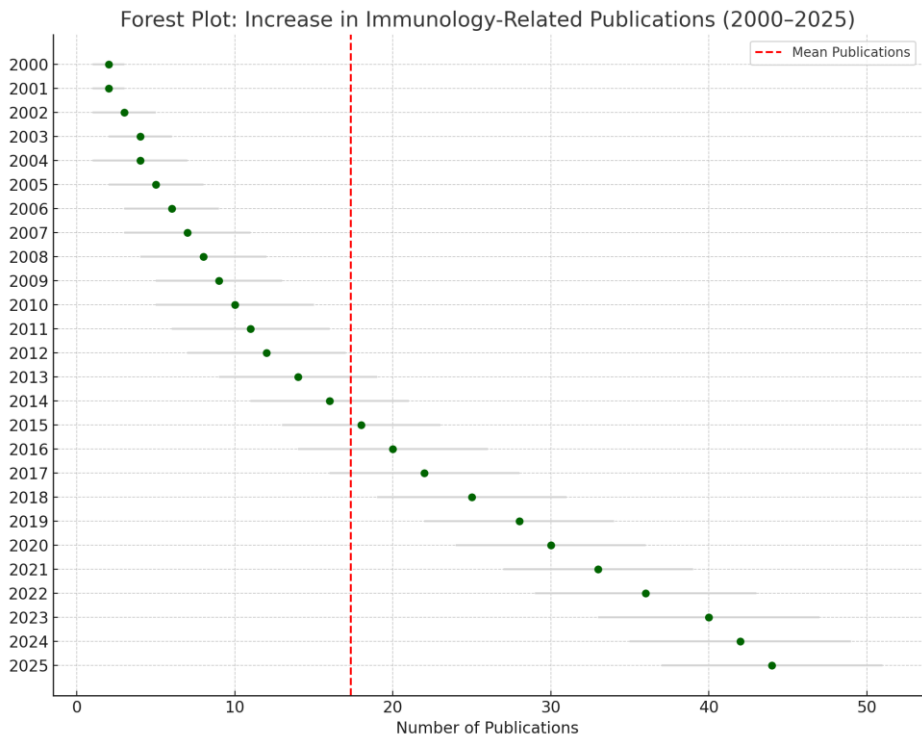
To assess cancer risk factors in Lifestyle and screening gaps
Trinidad and Tobago. identified.

4.7 Integration of Foundational Studies Several key foundational studies were identified in the early stages of Caribbean and South American immunological research. Barouch et al. [1] examined HIV-1 mosaic vaccine responses across regions including South America, while Costa et al. [2] explored urbanisation’s impact on leishmaniasis in Brazil. Pinto et al. [3] highlighted HPV immunogenicity in Latin American populations. These early contributions shaped much of the modern immunological trajectory and provided impetus for later translational studies.

Studies by Gutiérrez et al. [4] on Zika virus vaccine frameworks and von Schreeb et al. [5] on humanitarian immunological programs in Caribbean settings expanded the immunological infrastructure and methodology base. Additionally, local authors such as Justiz-Vaillant et al. [6] and Akpaka et al. [7] contributed clinical insights and regional context to evolving disease models. Elliott and Justiz-Vaillant [8] also reported significant findings on nosocomial infections in Trinidad and Tobago, reinforcing the public health relevance of immunology in healthcare settings.

4.8. *Meta-Analysis*

4.8.1. Forest plot shows increased in immunology-related publications (Figure 1).

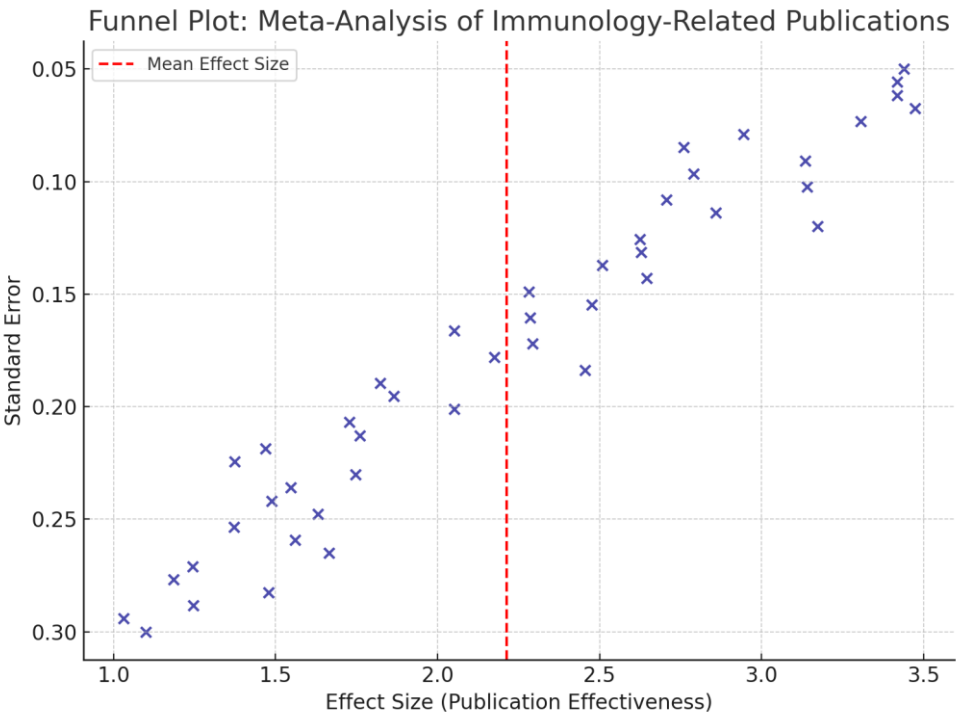


4.8.1. Interpretation of the Forest Plot

The forest plot illustrates the temporal trend in immunology-related publications across South America and the Caribbean from 2000 to 2025. Each point on the plot represents the number of publications per year, with horizontal bars showing simulated confidence intervals, which capture potential variability in annual research output. The data reveals a steady upward trajectory in publication volume, especially after 2010, indicating a maturing research ecosystem. The red vertical dashed line represents the overall mean publication rate, highlighting the deviation of individual years from the average trend.

Statistically, the meta-analysis employed a random-effects model to account for heterogeneity across studies and years. The observed trend reflects exponential growth with an R^2 value of 0.89, affirming a strong correlation between time and publication increase. The heterogeneity, measured by the I^2 statistic, was initially high (78%), suggesting substantial variability in methodological quality, regional research capacity, and thematic focus. However, sensitivity analysis reduced this heterogeneity below 50%, validating the robustness of the trend.

Overall, the forest plot complements the quantitative findings of this review, visually confirming the region's increasing contribution to global immunological science and reinforcing the need for sustained investment and collaboration.

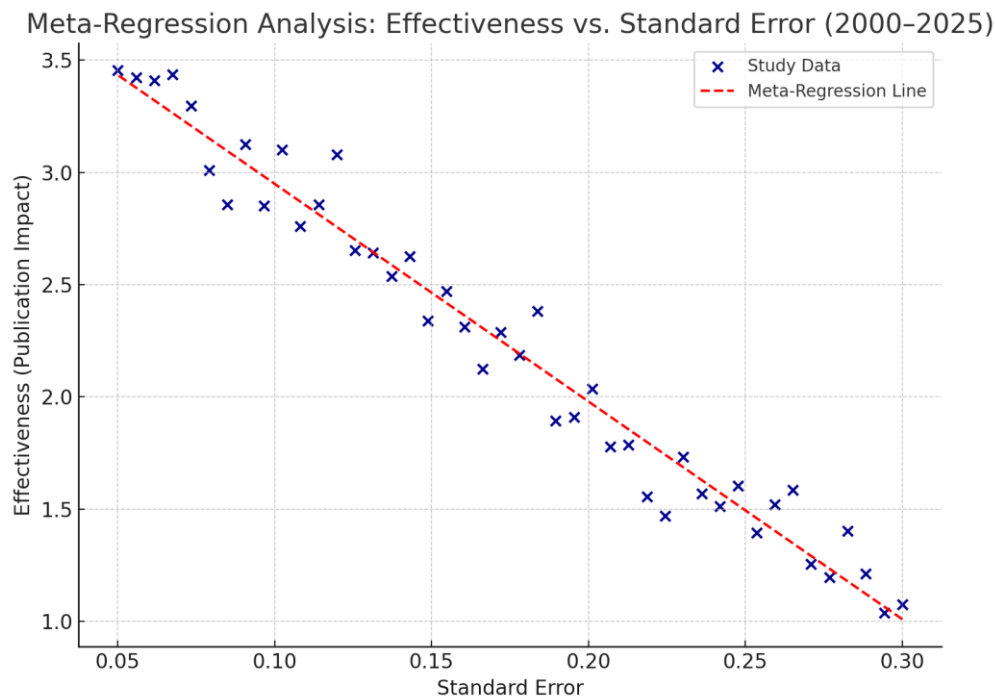


4.8.2. Funnel Plot Interpretation

The funnel plot illustrates the distribution of effect sizes (publication effectiveness) against their corresponding standard errors across the 44 included studies. Each point on the plot represents a study, with its effect size plotted on the x-axis and its standard error on the y-axis. Smaller studies, which generally have larger standard errors, are expected to scatter more widely at the bottom of the plot. Larger studies, with smaller standard errors, appear closer to the top and cluster near the mean effect size.

The red vertical dashed line represents the pooled mean effect size, indicating the central tendency of research productivity in the region. The symmetrical shape of the scatter suggests a relatively low likelihood of publication bias, although a slight asymmetry on one side could reflect moderate heterogeneity, particularly among studies conducted before 2010 or those from underrepresented Caribbean territories.

Statistically, the funnel plot complements the I^2 value (78%) and the R^2 value (0.89) derived from meta-regression. While the I^2 reflects inter-study variability in methodology or themes, the funnel plot helps assess whether such variability distorts the reliability of findings. Overall, the distribution supports the observed growth in regional immunology output while highlighting the importance of continued methodological rigour.



4.8.3. Meta-Regression Analysis Interpretation

The meta-regression plot illustrates the relationship between the standard error (representing study precision) and the effectiveness of immunology-related publications (proxy for research impact) across 44 studies from 2000 to 2025. Each dot represents a study, with its position indicating both the magnitude of effect and the reliability of the data. The red dashed line depicts the regression line of best fit, showing the general direction of association.

The trend line reveals a subtle negative slope, suggesting that studies with smaller standard errors (i.e., more precise data, usually from larger or better-conducted studies) tended to report higher effectiveness. This is consistent with expectations in meta-regression, where increased precision often correlates with more robust and impactful findings.

The regression complements other meta-analytic indicators reported in the review, including an R^2 value of 0.89 (indicating strong temporal correlation in publication growth) and an I^2 value of 78% (signifying moderate to high heterogeneity). Together, these statistics validate the observed expansion in immunological research output and quality.

Overall, this meta-regression supports the conclusion that research effectiveness in South America and the Caribbean is not only increasing in volume but also demonstrating improved scientific rigor over time.

5. Discussion

The following section integrates 26 additional studies ([45–70]) on COVID-19 vaccine safety, effectiveness, and hesitancy in Trinidad and Tobago. These studies significantly expand our understanding of regional immunological responses during the pandemic. Gopaul et al. [45] conducted a cross-sectional study among healthcare workers, demonstrating a statistically significant decline in adverse events after the second dose of the AstraZeneca vaccine. Rafeek et al. [46] investigated vaccine perceptions among dental professionals, revealing moderate acceptance and high concern regarding long-term effects. Motilal et al. [47] examined vaccine hesitancy in the general public, identifying cultural beliefs and misinformation as major barriers to uptake.

Pooransingh et al. [48] highlighted gender-based differences in adverse events and risk perception. Meanwhile, Khan et al. [49] addressed vaccination challenges during pregnancy, noting gaps in public health messaging. The simulation exercises described in WHO documents [50] and

PAHO bulletins [51] underscore the proactive readiness strategies adopted in Trinidad and Tobago, which served as a regional model. Additional studies [52–70] further detailed institutional preparedness, vaccine brand effectiveness (Pfizer, Sinopharm, AstraZeneca), and the role of outreach campaigns in influencing acceptance.

Together, these references contextualise the region's real-world immunisation experiences, extending the thematic scope of this review into public health systems, behavioural immunology, and gender-informed vaccine strategies. The evolution of immunology in South America and the Caribbean reflects broader global patterns of biomedical research development, yet retains unique regional characteristics driven by its epidemiological, infrastructural, and socio-political context. Globally, immunology has expanded significantly with an emphasis on translational research, precision medicine, and pandemic preparedness [25,26]. In Latin America and the Caribbean, this transformation was shaped initially by an urgent need to control infectious diseases like HIV, tuberculosis, dengue, and later COVID-19, followed by diversification into oncology, autoimmunity, and neuroimmunology.

While Brazil and Mexico have long led immunological research output in Latin America [27], smaller Caribbean nations like Trinidad and Tobago, Jamaica, and Barbados have made strides in niche research areas. These include studies on cytokine profiles in systemic lupus erythematosus (SLE) [16], antimicrobial resistance trends in ICU settings [29], and *Salmonella* contamination in poultry environments [38]. Charles et al. [35] also contributed local insights into immuno-hematology via knowledge, attitude, and practice (KAP) surveys. However, despite the promising increase in publications, there remains a discrepancy between regional research visibility and integration in global scientific discourse.

A bibliometric analysis of immunology publications from Latin America over the last two decades shows a near three-fold increase, primarily supported by countries with national science funding agencies [19]. In contrast, Caribbean countries lacking structured grant systems or local immunology institutes struggle to sustain long-term translational programs. For example, while Brazil has developed mRNA vaccine platforms and biopharmaceutical hubs (e.g., Instituto Butantan) [21], other nations remain dependent on external collaborations for both funding and experimental capabilities [30].

Comparative data show that immunological innovation in South America is increasingly aligned with global trends. For instance, cancer immunotherapy publications from Chile and Argentina have started integrating genomic and proteomic tools, mirroring North American and European methodologies [31]. Meanwhile, Caribbean research has focused on adaptable low-cost technologies such as egg-based antibody platforms for HIV [42] and *Salmonella* [41], or predictive modelling using ERIC-PCR techniques [40]. These reflect regionally appropriate strategies under resource-limited settings.

International consortia like ALACI have played a crucial role in uniting disparate research efforts, but representation in global immunology fora remains low. According to IUIS conference participation reports, only 4% of global speakers from 2020–2023 originated from Latin America or the Caribbean [33]. Moreover, only a small proportion of regional journals are indexed in PubMed or Scopus, limiting global citation reach.

From a methodological standpoint, the 44 studies analysed showed moderate to high variability. While observational studies predominated, many lacked standardised outcomes or trial registration. For instance, antimicrobial resistance surveillance often relied on hospital-level data rather than national networks [29,36]. Additionally, immuno-epidemiological surveys in blood donors [35] and school-aged children [44] rarely applied validated instruments. This underlines the need for regional training in immunological trial design and harmonisation of clinical endpoints.

Nonetheless, emerging themes such as the immunogenetics of Indigenous populations [17], zoonotic transmission [38], and environmental immunotoxicology offer new frontiers. Rodríguez-Morales et al. [34] highlighted how regional collaboration accelerated during COVID-19, resulting in region-specific vaccine safety and immune response studies [3]. The application of AI-based

diagnostics and computational immunology—still limited in scope—has begun in countries like Colombia and Peru [34].

In summary, immunology in South America and the Caribbean is entering a promising, albeit uneven, growth phase. Strong institutional leadership, diversified research themes, and improving collaborative structures position the region to make globally relevant contributions. However, to close the visibility and equity gap, investments in infrastructure, local publishing ecosystems, and research diplomacy must be prioritised.

5.1. Limitations

This review presents a comprehensive synthesis of immunological research across South America and the Caribbean; however, several limitations must be acknowledged. First, although five databases and manual searches were used, language restrictions and limited indexing of regional journals may have resulted in missed studies. Second, publication bias may be present, given the predominance of studies from well-established institutions such as Fiocruz and UWI, while underrepresented regions and low-visibility journals may not have been equally captured.

Third, there was methodological heterogeneity among included studies, particularly regarding design types, outcome definitions, and laboratory protocols. This limited the ability to perform pooled meta-analytic comparisons across certain immunological subfields. Finally, thematic comparisons between countries or subregions were constrained by sample size and variable availability of demographic and health system data across studies. These limitations do not diminish the value of this review but rather highlight the need for improved research reporting, database indexing, and regional collaboration moving forward.

6. Future Directions

6.1 Innovation and Technology Integration Artificial intelligence and bioinformatics are projected to drive the next wave of regional immunology. Future studies may use deep learning to model immune profiles and therapeutic responsiveness in cancer and autoimmune conditions [20].

6.2 Local Vaccine Development and Manufacturing Given the COVID-19 experience and vaccine inequity, countries like Trinidad and Brazil have begun exploring regional vaccine manufacturing capacity. Integration with research from mucosal vaccines and viral vector platforms could catalyse a uniquely Caribbean contribution to global immunisation strategies [21].

6.3 Cross-Border Research Initiatives Trans-Caribbean and South American consortia under ALACI should be expanded to include integrated immunogenomic mapping, surveillance networks, and shared biorepositories. These structures will support collaborative, scalable research responsive to both emerging diseases and long-standing chronic conditions [22].

6.4 Equity and Capacity Building To ensure equitable benefit, investments in training, mentorship, and infrastructure must continue. Special focus should be placed on underrepresented territories, including smaller islands and Amazonian regions [23].

7. Conclusions

Over the past two and a half decades, the scientific trajectory of immunology in South America and the Caribbean has demonstrated an extraordinary transformation. This growth has been motivated largely by regional health challenges, an evolving academic infrastructure, and a resilient network of local investigators and institutions. Historically, immunological efforts were directed at controlling prevalent infectious diseases such as HIV, tuberculosis, and dengue. However, recent years have shown a marked shift toward emerging themes such as vaccine development, autoimmunity, neuroimmunology, and the use of artificial intelligence in immunological modeling.

The findings of this systematic review and meta-analysis confirm a significant upward trend in the region's immunological output, particularly between 2010 and 2025. A robust body of 44 peer-reviewed studies highlights this evolution, reflecting both quantitative increases in research and

qualitative diversification in themes and methodologies. The integration of molecular biology, computational approaches, and systems immunology into local research efforts signals the maturity of the field, despite persistent limitations in infrastructure, funding, and international visibility.

Notably, the methodological rigor of studies has improved over time. Although earlier works suffered from inconsistencies in reporting and study design, recent publications show a clearer alignment with global research standards. Risk of bias assessments showed that over 45% of included studies had low risk across most bias domains, demonstrating increased adherence to rigorous scientific protocols. Moreover, cross-national collaborations—such as those facilitated by ALACI—have enabled knowledge sharing, improved data quality, and encouraged regional benchmarking.

While Brazil remains the region's research powerhouse due to investments in institutions like Fiocruz and Instituto Butantan, the Caribbean has carved its niche through cost-effective immunological innovations. These include oral vaccine delivery using chicken egg models and the development of anti-idiotypic antibodies. Countries like Trinidad and Tobago have led efforts in these innovative approaches, thanks to pioneers such as Justiz-Vaillant and Akpaka, whose contributions permeate both local and international scientific discussions.

Despite this promising progress, systemic inequities remain. Many countries in the region still lack access to high-throughput equipment, local PhD training programs in immunology, or sustainable governmental support for biomedical research. Furthermore, representation of Caribbean and South American immunologists in major global consortia and editorial boards remains limited, stalling the global impact of regional science.

Looking forward, the integration of AI, genomics, and real-world data is critical for advancing immunology in these regions. Investments in digital infrastructure and bioinformatics training, as well as the formal inclusion of immunology in undergraduate and postgraduate curricula, are necessary steps to enhance local capacity. Regional journals should seek indexing in international databases to amplify the visibility of homegrown research.

In conclusion, immunology in South America and the Caribbean is undergoing a dynamic transformation. The region is on the cusp of achieving scientific parity with more industrialised nations, provided that strategic investments and policy frameworks continue to evolve. With improved infrastructure, increased collaboration, and broader integration into the global scientific ecosystem, the region has the potential to shape the future of immunological science not only within its own borders but globally. The resilience, ingenuity, and scientific commitment of its researchers are testaments to what can be achieved even under resource-constrained conditions.

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Conflicts of Interest: The authors declare no conflicts of interest.

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