aerobiology

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Review

Aerobiology in Latin America: Past, Present and Future Directions for Atmospheric Pollen Surveillance

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Abstract

Aeropalynology, the monitoring and interpretation of airborne pollen, has become increasingly relevant in Latin America as allergic rhinitis and asthma rise alongside rapid urbanization, land-use change, and climate variability. Yet the region's capacity remains heterogeneous: long-standing traditions in the Southern Cone coexist with emerging programs in tropical and Andean settings, and many series are not translated into standardized products useful for clinical care or public health. We conducted a structured literature review guided by PRISMA 2020 to synthesize the historical evolution, current monitoring infrastructure, dominant pollen taxa, and translational outputs reported across Latin American countries. Evidence indicates that Mexico currently represents the most mature aeropalynological ecosystem in the region, supported by multi-site monitoring, open weekly reporting (REMA), multiple city-level pollen calendars, and emerging computational approaches for pollen identification. Across countries, recurrent high-impact taxa include Cupressaceae, *Fraxinus*, *Platanus*, *Olea*, *Poaceae*, Urticaceae, Amaranthaceae, *Rumex*, *Ambrosia*, and *Parietaria*, with local dominance shaped by biogeography and urban vegetation. Key gaps include limited long-term continuity outside a few cities, variable methodology (sampler type, taxonomic resolution, units, thresholds), and scarce linkage of pollen exposure metrics with clinical outcomes. Future priorities include harmonized volumetric monitoring, interoperable data standards, routine publication of pollen calendars and thresholds, integration with meteorology for forecasting, and expansion of digital decision-support tools to improve prevention and management of allergic respiratory diseases in Latin America.

Keywords: aerobiology; aeropalynology; airborne pollen; pollen calendar; Latin America; surveillance networks; standardization; allergic diseases; climate variability

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Academic Editor: Helena Ribeiro

Received: 7 January 2026
Revised: 24 February 2026
Accepted: 9 March 2026
Published: 31 March 2026

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1. Introduction

Aerobiology examines the occurrence, transport, and temporal dynamics of biological particles suspended in the atmosphere, including pollen grains, fungal spores, bacteria, and viruses [1]. In clinical and public health contexts, aeropalynology is especially important because inhaled pollen is a major trigger of seasonal allergic rhinitis, conjunctivitis, and asthma exacerbations [1,2].

Latin America encompasses highly diverse climates and biomes, ranging from tropical rainforests and savannas to arid deserts and high-altitude Andean ecosystems, creating strong spatial heterogeneity in airborne pollen spectra and seasonality [1]. At the same time, urban greening, ornamental planting, invasive weeds, and climate change can reshape local pollen exposure profiles, often faster than clinical diagnostic panels or immunotherapy extracts are updated [1,3].

For the purposes of this review, Latin America was defined geographically as Mexico, the countries of Central America, South America, and the Caribbean. The term Southern Cone is used strictly in its geographic sense to refer to Argentina, Chile, Uruguay, and Paraguay. This objective delimitation was adopted to avoid culturally subjective inclusion criteria and to improve comparability across regional surveillance efforts [1].

Despite clear clinical relevance, aeropalynology programs across Latin America have developed unevenly. Some countries have produced multi-year city series and atlas-type resources, whereas others rely on short-term campaigns or gravimetric surveys with limited clinical translation [1]. In 2023, the Latin American Aerobiology Network (RLA/LAAN) was launched to facilitate collaboration, training, and communication between monitoring groups and clinicians [1]. In parallel, Mexico's Mexican Aerobiology Network (REMA) provides routine, public-facing weekly pollen reports across multiple localities, representing one of the most established surveillance infrastructures in the region [4].

This review synthesizes the past and present state of aeropalynology in Latin America, emphasizing dominant pollen taxa, monitoring approaches, and the extent to which data are translated into actionable products such as pollen calendars, thresholds, alerts, and decision-support tools [1,3,5]. We further highlight Mexico's role as a regional reference due to its comparatively extensive datasets and the adoption of emerging computational identification tools [4]. Finally, we propose a roadmap for harmonization and future capacity building across the region.

A schematic timeline of key aeropalynology milestones and network developments in Latin America is summarized in Figure 1.

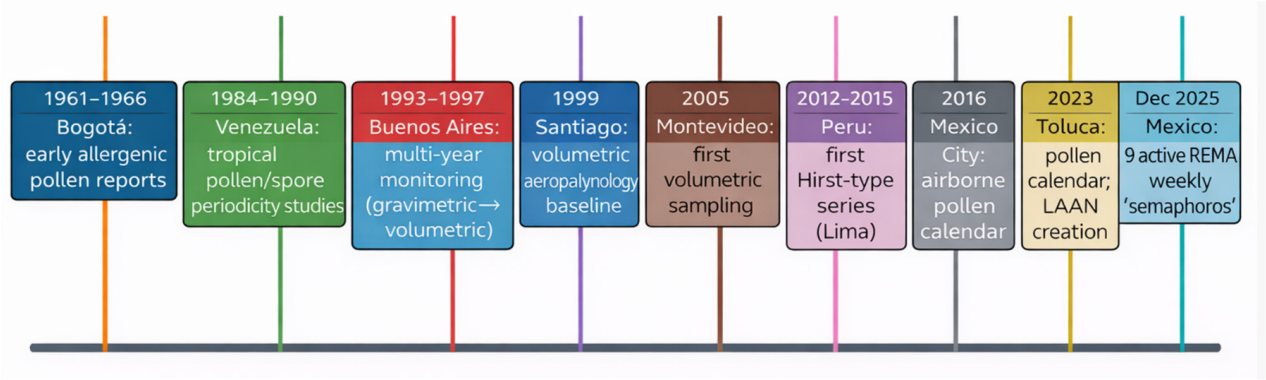


Figure 1. Schematic timeline of aeropalynology milestones in Latin America, including monitoring platforms and regional coordination initiatives.

2. Materials and Methods

This manuscript was prepared as a structured literature review following PRISMA 2020 guidance for transparent reporting of evidence synthesis [6].

We searched PubMed/MEDLINE, Scopus, Web of Science, SciELO, Google Scholar, and LILACS for articles published up to May 2025. Search terms included combinations of "aerobiology", "aeropalynology", "pollen", "airborne pollen", "bioaerosols", "allergic rhinitis", and "asthma", paired with country names in English, Spanish, and Portuguese.

Reference lists of included studies were also screened to identify additional relevant sources.

Additionally, official surveillance platforms were consulted, including the Mexican Aerobiology Network (REMA) and the Latin American Aerobiology Network (RLA/LAAN). These sources were accessed between March and December 2025 to extract information on active monitoring sites, reported taxa, and available pollen calendar or alert products.

Inclusion criteria were:

1. Studies, reviews, or technical reports describing airborne pollen monitoring in Latin American countries.
2. Studies reporting quantitative pollen metrics (counts, indices, seasonal patterns, calendars, thresholds); and/or
3. Studies linking pollen exposure with allergic or respiratory outcomes.

Extractable aeropalynological results were defined as datasets providing numerical pollen counts, seasonal indices, pollen calendars, or interpretable graphical information.

Duplicate records and publications without Latin American scope or accessible full text were excluded.

Two-stage screening was performed (title/abstract followed by full-text review). Data were extracted into structured matrices and synthesized narratively by country.

Due to substantial heterogeneity in sampling devices, counting rules, taxonomic resolution, and reporting units, quantitative meta-analysis was not attempted. Findings were therefore integrated qualitatively and summarized in structured tables.

A PRISMA flow diagram summarizing the screening process is provided in Supplementary Figure S1 [6].

3. Development by Country: Past and Present State

3.1. Argentina

Past state. Argentina hosts one of the oldest and most diverse aeropalynology traditions in Latin America, spanning early gravimetric "pollen rain" surveys and later adoption of volumetric monitoring in major urban centers. Early multi-year monitoring in Buenos Aires provided baseline taxonomic profiles, later complemented by daily volumetric series that enabled higher temporal resolution of atmospheric pollen dynamics [7–10].

Present state. The city-level series expanded coverage across climatic regions, including coastal Mar del Plata, temperate Bahía Blanca, and inland settings, supporting interannual comparisons of key arboreal and herbaceous taxa. Monitoring consistently documents spring dominance of tree pollen, with Poaceae and major weeds contributing seasonally. Allergenic pollen atlases and multi-city surveys highlight the feasibility of national-scale characterization; however, harmonization of sampler types, reporting units, and clinical linkage remains necessary to strengthen comparability and translational relevance [10–15].

3.2. Chile

Past state. Chilean aeropalynology evolved from early urban series to standardized volumetric monitoring that supported the development of local aeroallergen panels. Multi-year monitoring in Santiago provided one of the earliest systematic urban pollen datasets in the country [16,17].

Present state. In the south-central region, Burkard/Hirst monitoring in Temuco quantified strong seasonal peaks (September–March), dominated by Poaceae and key weeds such as *Rumex*. In coastal Valparaíso, combined environmental monitoring and patient sensitization data identified Urticaceae-type pollen (including taxa historically reported as *Parietaria*) as clinically relevant, illustrating the value of integrating exposure surveillance with clinical investigation. Continued surveillance in Santiago documents long-term trends and threshold exceedances, emphasizing the importance of accounting for climatic gradients and urban vegetation management [18–20].

3.3. Mexico

Past state. Mexico has a longstanding tradition of aerobiological and allergy research, with early adoption of volumetric Hirst-type sampling in large metropolitan areas. Multi-year monitoring in Mexico City enabled the first airborne pollen calendars and quantified relationships between pollen peaks and bioclimatic factors, typically showing winter maxima driven by arboreal taxa (*Fraxinus*, Cupressaceae, and *Alnus*) alongside persistent Poaceae and Urticaceae. Additional foundational datasets were generated in Monterrey and other regions, establishing the value of city-level calendars across distinct [2,3,5,21–27].

Present state. Mexico now represents the most developed aeropalynological ecosystem in Latin America. The Mexican Aerobiology Network (REMA) provides routine public-facing weekly pollen reporting across nine localities, supporting continuity and risk communication [2]. High-resolution city series remain active, including the 53-month Burkard/Hirst dataset from Toluca, which reported strong tree dominance (Cupressaceae 52.6%) and quantified diurnal patterns and meteorological associations [5,21].

National coverage is strengthened by additional calendars from Monterrey and arid northern regions such as the Sonoran Desert, where *Ambrosia* and Amaranthaceae assume greater prominence [22,23]. Importantly, Mexico is also adopting computational approaches for pollen recognition: PollenSense integrates automated image analysis models with user-facing exposure reporting through the Pollen Wise app, illustrating a pathway from microscopy to digital decision support [24]. Complementary metagenomic work in Mexico City further demonstrates methodological diversification beyond classical pollen microscopy, while reinforcing the need for harmonized aeropalynology for comparability across sites [25,26].

3.4. Peru

Past state. Volumetric aeropalynology in Peru was established relatively recently, with Hirst-type monitoring in Lima beginning in 2012. Early series characterized the local pollen spectrum, including Oleaceae, Poaceae, Myrtaceae, and Betulaceae, and provided the methodological foundation for subsequent studies [28,29].

Present state. Peru's evidence base remains concentrated in Lima, where monitoring has expanded to include both pollen and fungal spores and has been linked to clinical sensitization patterns in symptomatic patients. Studies in southern cities documented exposure to *Olea europaea* and grasses, reporting measurable skin-test sensitization. Recent work also suggests locally important taxa such as *Tipuana tipu*, emphasizing the need for locally adapted diagnostic panels. Comparative studies with other Southern Hemisphere

cities illustrate that seasonality can differ markedly even within the same hemisphere, reinforcing the value of local monitoring rather than extrapolation [30–33].

3.5. Ecuador

Past state. Published aeropalynology from Ecuador remains limited compared with Mexico or the Southern Cone. Early clinical studies in the Andes emphasized house dust mites rather than grass pollen as sensitizers, and aerobiological characterization has often focused on airborne microorganisms in tropical coastal settings [34].

Present state. Recent initiatives include preliminary pollen and fungal monitoring in Samborondón, with Poaceae among the predominant pollen types. Coastal studies measuring airborne bacteria and fungi and their meteorological correlates further highlight the need for expanded pollen surveillance linked to clinical endpoints. Sensitization profiling from Portoviejo demonstrates frequent aeroallergen sensitization in clinical populations, supporting the rationale for strengthened monitoring capacity [34–36].

3.6. Paraguay

Past state. Systematic aeropalynology in Paraguay has historically been sparse, with limited documentation relative to neighboring countries [37].

Present state. One year of volumetric Hirst monitoring in Asunción (2018) identified a diverse pollen spectrum, including *Cecropia*, Poaceae, Urticaceae, Cyperaceae, and Moraceae. Although grasses are a recognized allergenic group, the clinical relevance of some abundant taxa (e.g., *Cecropia*) remains uncertain, highlighting the need for paired exposure–sensitization studies and multi-year continuity [37].

3.7. Uruguay

Past state. Uruguay's earliest volumetric pollen monitoring was reported in Montevideo in the early 2000s, demonstrating the feasibility of city-level airborne pollen surveillance in a temperate coastal environment [38].

Present state. Monitoring has not yet consolidated into a continuous national program, but available series documented broad taxonomic diversity and extended seasons (late winter through autumn), with Poaceae typically representing a major contributor. Re-establishing continuous surveillance and harmonized reporting would enable trend analyses and improve clinical utility [38].

3.8. Colombia

Past state. Colombia has historically had limited aerobiology infrastructure, yet early work in Bogotá described allergenic pollens and their clinical relevance in the mid-20th century. Subsequent surveys incorporated both pollen and spores in a neotropical urban environment and motivated the development of local calendars [39,40].

Present state. Recent progress includes open biodiversity-linked datasets such as the Ibagué aeropalynological–aerobiological dataset. Scaling these efforts will require routine volumetric sampling, harmonized taxonomy, and integration with clinical and meteorological datasets to translate exposure into actionable information [41–43].

3.9. Venezuela

Past state. Foundational aerobiology in tropical America includes studies from Venezuela describing the frequency and periodicity of airborne pollen and spores under high humidity conditions [44].

Present state. These tropical datasets remain informative for interpreting year-round exposure patterns, where fungal spores and certain pollen taxa may exhibit sustained presence rather than narrow seasonal peaks. However, the absence of long-term contin-

uous monitoring networks limits the ability to generate alerts or assess temporal trends. Establishing sustained surveillance integrated with meteorological data remains a key priority [45].

3.10. Brazil

Past state. Reports of pollinosis in Brazil date to the 1970s, particularly in the South, where grass pollen (notably *Lolium multiflorum*) has long been recognized as clinically relevant. In much of the country, however, aeropalynology has historically been less systematic than studies of other bioaerosols [46].

Present state. Recent work confirms strong regional specificity: grass pollen remains central for pollinosis in southern Brazil, while *Anacardium occidentale* (cashew) pollen represents a distinct trigger in parts of the Northeast. Nevertheless, nationwide pollen surveillance remains fragmented and less standardized than fungal monitoring. Available series suggest shifts in Poaceae seasonality that may reflect climate variability, underscoring the need for sustained volumetric networks and linkage with clinical sensitization data [47–49].

3.11. Bolivia and Central America/Caribbean: Evidence Gaps

Across Bolivia and several Central American and Caribbean countries, published volumetric aeropalynology remains scarce or absent in the indexed literature. Given the high burden of allergic diseases and the likelihood of near year-round exposure in tropical climates, targeted capacity building, cross-border collaboration, and incorporation of these settings into regional networks (RLA/LAAN) represent important priorities. Puerto Rico provides an exemplar from the Caribbean where aerobiological studies have emphasized the predominance of fungal spores, illustrating that bioaerosol burdens in humid island environments may not be pollen-dominated [50,51].

Current monitoring capacity reported by REMA in Mexico and by RLA/LAAN member stations elsewhere in Latin America is summarized schematically in Figure 2.

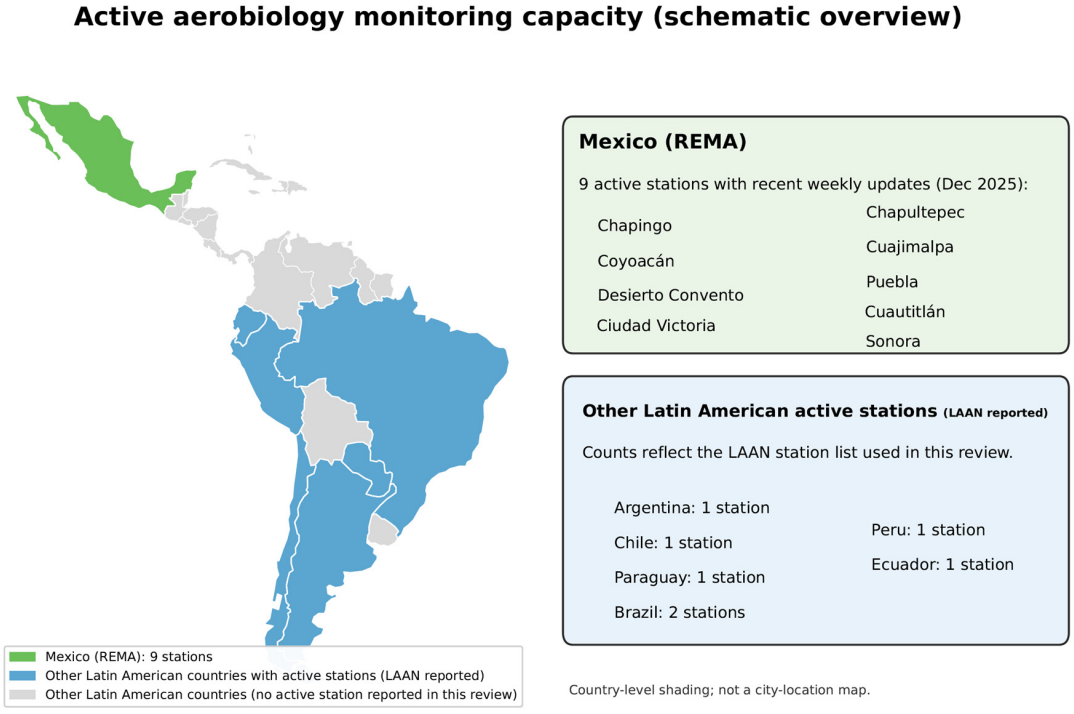


Figure 2. Schematic overview of active aerobiology monitoring capacity in Latin America. Mexico currently reports nine localities with recent weekly REMA updates; other counts reflect RLA/LAAN-reported

stations included in this review. Active aerobiology monitoring capacity (schematic overview). Country boundaries were obtained from publicly available cartographic data, and the final layout and labeling were edited in Canva.

4. Cross-Cutting Aeropalynology Findings in Latin America

Across Latin America, the most consistently reported high-impact airborne pollen taxa can be grouped into three major categories: (i) urban and peri-urban trees (Cupressaceae, *Fraxinus*, *Platanus*, *Olea*, *Alnus*, *Quercus*, Pinaceae); (ii) *grasses* (Poaceae), often present across seasons and associated with broad sensitization; and (iii) weeds and ruderal taxa (Urticaceae, Amaranthaceae, *Rumex*, *Ambrosia*). Local dominance is strongly shaped by biogeography, altitude, and urban vegetation management, including the planting of introduced ornamentals and the spread of invasive weeds (Table 1) [1,3,5,36].

Table 1. Summary of country-level development, monitoring approaches, and representative high-impact pollen taxa reported in the reviewed literature [1–5,7–26,28–51].

Country	Past State (Milestones)	Present State (Capacity/Outputs)	Primary Sampling Approaches	Representative High-Impact Taxa
Argentina	Early gravimetric and later daily volumetric monitoring in major cities.	Multi-city series; atlas resources; interannual analyses; limited standardized clinical linkage.	Gravimetric and Rotorod/Burkard/Hirst volumetric (city-dependent).	Tree pollen (*Cupressaceae*, *Olea*, *Platanus*), Poaceae, major weeds.
Brazil	Pollinosis described since 1970s (South), mainly grass-related.	Fragmented monitoring; regional pollen relevance (*Lolium*, *Anacardium*); limited standardized networks.	Hirst-type monitoring in selected sites; mixed approaches; many studies focus on other bioaerosols.	Poaceae (*Lolium*), *Anacardium*, urban tree pollen locally.
Chile	Early urban monitoring (Santiago) supporting local allergen panels.	Burkard/Hirst series in Temuco and Santiago; emerging allergens Urticaceae	Hirst/Burkard volumetric monitoring.	Poaceae, *Rumex*, Cupressaceae, Platanus, Urticaceae.
Mexico	Early multi-year Hirst monitoring in major metros; first calendars and bioclimatic analyses.	REMA weekly public reporting (9 localities); multiple city calendars; computational identification tools emerging.	Hirst/Burkard volumetric; additional computational/AI-assisted workflows.	*Fraxinus*, Cupressaceae, *Alnus*, Poaceae, Urticaceae, *Ambrosia*, Amaranthaceae.
Peru	Hirst-type monitoring established in Lima (2012).	Continuous monitoring in Lima; linkage to sensitization; identification of locally relevant taxa (e.g., *Tipuana*).	Hirst/Burkard volumetric; Andersen impact sampling for fungi in some studies.	Poaceae, Oleaceae, Myrtaceae; *Tipuana*; key weeds locally.
Ecuador	Limited aeropalynology; clinical evidence highlights mites in Andes.	Emerging monitoring in Samborondón; coastal bioaerosol studies; need for expansion.	Early-stage monitoring; Petri dish methods for microbes; volumetric pollen monitoring emerging.	Poaceae; local trees/weeds under characterization.
Paraguay	Sparse historical monitoring.	First year-long Hirst monitoring in Asunción; diverse taxa reported; clinical relevance still uncertain for some taxa.	Hirst/Burkard volumetric.	*Cecropia*, Poaceae, Urticaceae, Cyperaceae, Moraceae.
Uruguay	Initial volumetric monitoring in Montevideo (early 2000s).	Intermittent activity; extended seasons reported; need for continuity and standardization.	Volumetric monitoring (reported).	Poaceae and diverse temperate taxa.
Colombia	Early Bogotá allergenic pollen descriptions and one-year surveys.	Recent open datasets (Ibagué); limited routine volumetric monitoring.	Mixed methods; need for volumetric standardization.	Local urban taxa; pollen vs. spores balance likely climate-driven.
Venezuela	Tropical America air sampling studies describing frequency/periodicity.	Limited continuous surveillance; high relevance for year-round exposure patterns.	Air sampling in tropical contexts (historical studies).	Likely sustained pollen/spore presence; taxa vary by urban vegetation.

Where quantitative series exist, pollen seasons typically show pronounced peaks in temperate latitudes. In the Southern Hemisphere, arboreal pollen peaks generally occur during austral spring (September–November), whereas tropical and subtropical settings can display extended or multi-modal seasons with substantial year-round background levels. These patterns complicate the direct transfer of diagnostic panels or immunotherapy extracts between cities and emphasize the need for locally derived exposure metrics [1,3,5,27,36,52].

5. Discussion

Latin American aeropalynology has expanded substantially in recent decades, yet development across the region remains uneven. Countries with long-standing traditions have demonstrated that sustained, multi-year monitoring series are feasible and can support interannual trend analyses. However, many datasets remain short, discontinuous, or geographically limited, restricting the ability to detect climate-driven shifts, assess the effects of changing vegetation, or design robust early-warning systems (Table 2).

Table 2. Highlights of recurrent high-impact pollen taxa in Latin America and their typical contexts of dominance [1–5,7–26,28–51].

Taxon/Group	Where Frequently Reported	Typical Seasonal Pattern (General)	Clinical/Translational Notes
Cupressaceae	Mexico; Chile; Argentina; widely planted in urban environments.	Often winter–spring peaks in temperate settings; extended seasons where ornamentals are common.	Common urban allergen; useful for early-season alerts and diagnostic panel inclusion.
Fraxinus	Mexico City region; other urban corridors.	Winter peak in Central Mexico.	High winter counts; linked to symptom burden and public alerts in Mexico.
Platanus	Chile; Argentina; other cities with ornamental plantings.	Spring peaks (particularly austral spring in Southern Hemisphere settings).	Urban ornamental with high exposure in some cities; frequently dominant in tree pollen counts.
Olea europaea	Argentina (Bahía Blanca); Peru (southern); Chile (localized areas).	Spring peaks with marked interannual variability.	High sensitization reported in some regions; climate sensitivity documented.
Poaceae (*grasses*)	Region-wide; major contributor in Chile, Argentina, Mexico, southern Brazil.	Late winter–summer in temperate zones (austral spring–summer in the Southern Hemisphere); persistent background in tropical/subtropical cities.	Broad sensitization; priority taxon for pollen calendars, thresholds, and forecasting.
Urticaceae	Mexico; Chile; Paraguay; Argentina.	Variable; can persist across seasons in many climates.	Common weed group; often included in diagnostic panels; may be underestimated without higher taxonomic resolution.
Amaranthaceae	Arid and semi-arid Mexico; dry urban settings.	Warm-season peaks; may overlap with dust and pollution episodes.	Important in desert-city calendars; relevant for dry-region allergen surveillance.
Rumex	Chile; Southern Cone countries.	Spring–summer; may persist seasonally.	Associated with sensitization in some temperate urban environments.
Ambrosia (ragweed)	Northern/arid Mexico; reported in multi-city comparisons.	Late summer–autumn in many regions; variable by latitude and biome.	Highly allergenic; recommended for close monitoring and invasive spread assessment.

A central barrier to regional comparability is pronounced methodological heterogeneity. Differences in sampler types (gravimetric versus volumetric; Rotorod versus Hirst/Burkard), counting rules, taxonomic depth (family versus genus/species), reporting

units, and threshold definitions impede synthesis across cities and countries. Adoption of a minimum standardized reporting set including sampler metadata, harmonized counting protocols, standardized units, and clearly defined thresholds would enable benchmarking across Latin America and facilitate integration with meteorological modeling and forecasting efforts.

Translation of aeropalynological monitoring into health outcomes and clinical decision-making also remains limited. While multiple studies identify dominant pollen taxa, only a subset links exposure metrics with sensitization profiles, symptom burden, health-care utilization, or targeted immunotherapy strategies. Mexico provides a pragmatic example of translational infrastructure through the Mexican Aerobiology Network (REMA), which offers routine public risk communication, city-level calendars, and emerging computational identification tools that extend surveillance toward digital decision support. Similar translational pipelines could be developed elsewhere by pairing monitoring with clinical cohorts and by co-designing outputs with allergists, public health agencies, and patients.

Despite growing interest in automated and computational approaches, classical pollen morphology remains the indispensable foundation of aerobiology. Accurate morphological identification anchors longitudinal datasets, enables inter-regional comparison, and provides the interpretability required for allergy diagnosis and immunotherapy planning. As emphasized in recent clinician-focused editorials, surveillance data are most impactful when they directly inform real-world practice, guiding which aeroallergens are tested, when testing is performed, and how immunotherapy extracts are selected and updated as exposure patterns evolve [53].

A practical challenge in Latin America is that many rural, high-altitude, and underserved communities lack sustained station-based monitoring. In such contexts, exposure "proxies" may offer interim decision support. These models combine meteorology (temperature, wind, precipitation), vegetation and phenology patterns (including urban plantings and invasive weeds), land-use data, and other open environmental signals to estimate relative exposure risk. Importantly, proxies should be framed transparently as modeled estimates rather than direct pollen counts, and they perform best when calibrated against high-quality morphologic counting from sentinel volumetric stations. This blended approach may extend clinical relevance beyond the footprint of existing samplers, supporting patient counseling, timing of therapy, and prioritization of where future stations would yield the greatest public-health benefit (Table 3).

Table 3. Summary of regional monitoring networks and emerging digital/computational tools that support translation of pollen data into decision support [1,3,24,54].

Platform/Network	Geographic Scope	Primary Outputs	Notes and Access
REMA (Red Mexicana de Aerobiología)	Mexico (multi-locality)	Weekly 'semaphore' risk reporting; station-specific updates; taxon-level counts.	Public-facing platform with routine updates; accessed 4 January 2026. [4]
RLA/LAAN (Red/Latin American Aerobiology Network)	Multi-country Latin America	Network coordination; station list; education/outreach.	Facilitates collaboration and capacity building; accessed 4 January 2026. [1]
PollenSense/Pollen Wise App	Mexico City and Monterrey (reported)	AI-assisted pollen identification and user-facing exposure reporting.	Computational model-based pollen recognition integrated with mobile reporting; accessed 4 January 2026. [24]

Experience from the historical development of the North American National Allergy Bureau illustrates that sustained, standardized counting combined with clinician engagement is essential for converting aerobiology from descriptive monitoring into actionable

clinical infrastructure [54]. Establishing comparable frameworks in Latin America will require investment in continuity, harmonization, and professional integration across aerobiologists and allergists.

Finally, climate change and urbanization are likely modulating pollen exposure in Latin America through altered flowering phenology, longer seasons, and shifts in dominant taxa, particularly for introduced ornamentals and invasive weeds. Long-term monitoring in representative ecoregions (temperate, tropical, Andean, and arid) is essential to quantify these impacts and to inform adaptation strategies [55]. A practical translational framework linking sampling, standardized products, communication, and decision support is summarized in Figure 3.

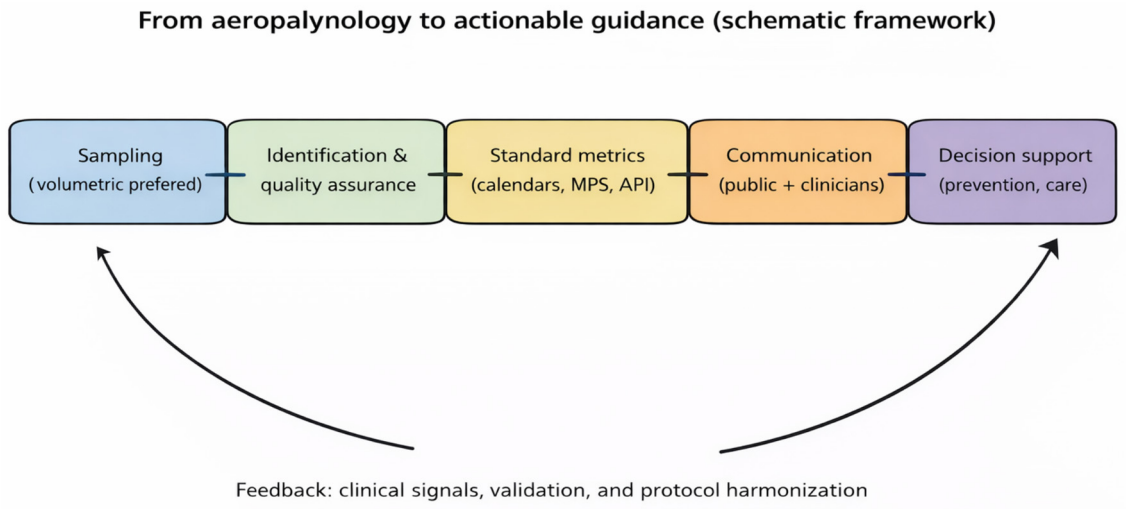


Figure 3. Translational framework for Latin American aeropalynology, emphasizing harmonized sampling, standardized data products, communication, and emerging computational tools. The curved arrow represents the feedback loop from clinical outcomes and validation processes back to the sampling and monitoring stages, supporting protocol harmonization and continuous improvement of aeropalynological surveillance.

6. Conclusions and Future Directions

Aeropalynology in Latin America is progressing toward greater clinical relevance, but substantial gaps persist in geographic coverage, methodological harmonization, and translation of exposure data into health action. Mexico currently offers the most complete ecosystem, combining multi-site monitoring, public reporting, multiple regional calendars, and emerging computational identification approaches.

Regional priorities include (i) stabilizing continuous volumetric monitoring in major cities and representative ecoregions; (ii) harmonizing protocols, taxonomy, and reporting metrics; (iii) publishing locally validated pollen calendars and thresholds; (iv) integrating monitoring with meteorological models for forecasting; and (v) expanding digital tools and open data practices through networks such as RLA/LAAN.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/aerobiology4020008/s1. Figure S1: PRISMA flow diagram summarizing the screening process.

Author Contributions: Conceptualization, G.G.-F.; Methodology, G.G.-F. and O.C.L.; Formal analysis, G.G.-F. and A.A.V.M.; Investigation, G.G.-F., A.A.V.M., D.S., M.U.P., O.C.L. and I.C.-O.; Resources, O.C.L. and I.C.-O.; Data curation, A.A.V.M., I.Y.S.P., D.D. and G.V.S.; Writing—original draft preparation, G.G.-F.; Writing—review and editing, all authors; Visualization, G.G.-F. and I.Y.S.P.; Supervision,

G.V.S. and I.C.-O.; Project administration, G.G.-F. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Data Availability Statement: No new data were created or analyzed in this study.

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

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