Health and Climate Change in South America

A scoping review of the health co-benefits of climate mitigation strategies in South America

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Summary

The accelerated production of greenhouse gases (GHG) due to human activity has led to unprecedented global warming, making climate mitigation strategies crucial for minimizing its impacts. South America, a region highly vulnerable to climate change, stands to benefit from implementing such strategies to reduce future risks and generate health co-benefits. This scoping review, aimed to assess the existing evidence on the health benefits of climate mitigation strategies in South American countries. PubMed, Web of Science, and LILACS databases were searched until June 15, 2023. Nine studies published between 2001 and 2021 were analyzed, focusing on Brazil, Chile, and Bolivia. All the studies identified in this review used scenario modeling. They evaluated various GHG emission mitigation strategies, including land management, reducing livestock production, biofuel production, increased active transportation, renewable energy, and waste reduction. Only one study looked at GHG capture and sequestration through afforestation. Given the limited information available, there is a pressing need for more research on the region's potential health, environmental, and economic co-benefits. This review serves as a starting point and suggests that climate mitigation can offer a range of positive co-benefits, such as improved air quality and increased resilience to climate impacts, thereby advancing public health initiatives.

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Keywords: South America; Brazil; Chile; Bolivia; Climate change; Mitigation; Health

Introduction

Human activity has led to increased production of greenhouse gases (GHG) and consequently to global warming at an unprecedented rate in the last 200 years.[1–3] Global warming has generated disturbances in different ecosystems and human populations, with climate change amplifying these impacts.[1,2] Reducing GHG emissions and increasing their sequestration, known as climate mitigation, is a valuable tool to reduce the impacts of global warming and produce health co-benefits, such as reducing cardiovascular and respiratory diseases.[4] The Intergovernmental Panel on Climate Change (IPCC) agreed that limiting global warming to 1.5 °C requires a 45% reduction in GHG emissions by 2030 (relative to 2010 levels), followed by a net-zero emission by 2050.[5] However, GHG levels have continuously increased.[6]

In 2015, in the Paris Agreement, multiple nations worldwide agreed to implement climate change mitigation strategies.[7] However, research has primarily focused on the impact of these strategies on high-income countries and Global North countries, with realities vastly different from those in South America. Evidence shows that implementing national and multinational climate change mitigation strategies is crucial for the economy and human health.[8–10] In Europe and the United States of America (USA), for instance, increases in walking and cycling and improved agricultural and food practices have been reported as relevant mitigation strategies, also providing health co-

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benefits.[9,11] Such evidence highlights the need for further studies on the applicability of these strategies to South American contexts.

The need for countries to take significant action to mitigate climate change has been requested by the United Nations (UN), and several countries have already started to develop climate mitigation plans.[12] Mitigation strategies are cross-cutting and cover all sectors, from smart agricultural practices related to no-tilling practices,[13] precision livestock farming,[14] irrigation systems,[15] or afforestation and forest management[16]; to renewable energies, energy efficiency, waste management, transport management,[17,18] among others. According to the Climate Action Tracker report, in 2021,[19] climate actions implemented by countries in South America are currently rated between insufficient and highly insufficient in terms of achieving the UN Paris Agreement goals.[12]

South America stands out for its unique geographical and demographic characteristics, which set it apart from other regions. This vast landmass boasts diverse climates and ecosystems, from the tropical Caribbean coast and the Amazon rainforest to the Andes and Patagonia frigid glaciers. For that, it could be expected that emissions are controlled because of the carbon sequestration capacity of its ecosystems; however, South America's per capita GHG emissions surpass the global average.[20] South America remains highly vulnerable to climate change's impacts, largely due to population growth and density, inequality and poverty, land use changes, loss of biodiversity, and soil degradation, significantly impacting food security and people's health.[21] Additionally, social inequities are rampant in the region, creating disparities in how extreme weather events affect the economy and public health.[21] Furthermore, the region's heavy reliance on natural resources for national and local economies exacerbates these challenges. Unfortunately, climate research and monitoring have suffered from insufficient money investment in South American countries, especially for environmental and social objectives related to climate change research, projects and policies.[22]

Given the limited investment context in South American countries, implementing climate change mitigation strategies presents an opportunity to simultaneously address climate change and benefit public health. For example, promoting sustainable transportation reduces GHG emissions and increases physical activity, providing cardiovascular benefits to individuals.[23,24] Similarly, improving energy efficiency in buildings and housing can reduce GHG emissions, improve indoor air quality, and alleviate the burden of respiratory diseases.[25,26] The recent "2022 Global Lancet Countdown Report" focusing on mitigation strategies and potential health co-benefits mostly concentrated on developed countries,[4] and while The Lancet Countdown South America 2022 report provides valuable insights into the potential benefits of mitigation strategies for the region, it does not delve into the evidence generated within South America itself that could help us better understand the progress in addressing this issue.[27] This highlights the need for a more comprehensive literature review that examines the relationship between climate mitigation strategies and health co-benefits in South America. Therefore, this review aims to evaluate the available evidence on climate mitigation and health in South America and develop a framework for this area of research.

Methods

Study design

We performed a scoping review following the guidelines of the Preferred Reporting Items for Systematic and Meta-Analysis extension for Scoping Reviews (PRISMA-ScR) of 2020,[28] and the methodology described by the Joanna Briggs Institute.[29] In this scoping review, we aimed to collect evidence on climate mitigation and health in South America. This review focused on South America, defined as 12 countries: Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, and Venezuela. We considered only those studies referring to climate mitigation strategies. Climate mitigation was defined as interventions that allow communities and countries to reduce GHG emissions and/or increase GHG removal and sequestration.[30] Health co-benefits were defined as improved public health indicators resulting from climate change mitigation actions.[31] A conceptual framework encompassing the health co-benefits related to climate change mitigation strategies was developed to help design the search strategy (Fig. 1). We decided to include trials, quasi-experimental, comparative, observational, and modeling studies that reported results related to the health co-benefits of climate change mitigation strategies in South American countries. Case reports, editorials, commentaries, and reviews were excluded.

Search strategy and selection criteria

The search strategy was grouped into seven terms categories: Climate change, Climate mitigation, Mitigation sectors, Mitigation actions, Health determinants, Health outcomes, and Geography (the full search can be found in the Supplementary Material S1). The following databases were searched for articles: 1) PubMed, 2) Web of Science/Core collection, and 3) LILACS (Latin American and Caribbean Health Sciences Literature). The last search was performed on June 15, 2023. There were no restrictions on the publication date. However, it was limited to Spanish, English, and Portuguese within LILACS, as it is a region database and the most popular languages in the countries included.

Study selection

Duplicate articles were manually removed using Zotero software. Subsequently, studies were imported into

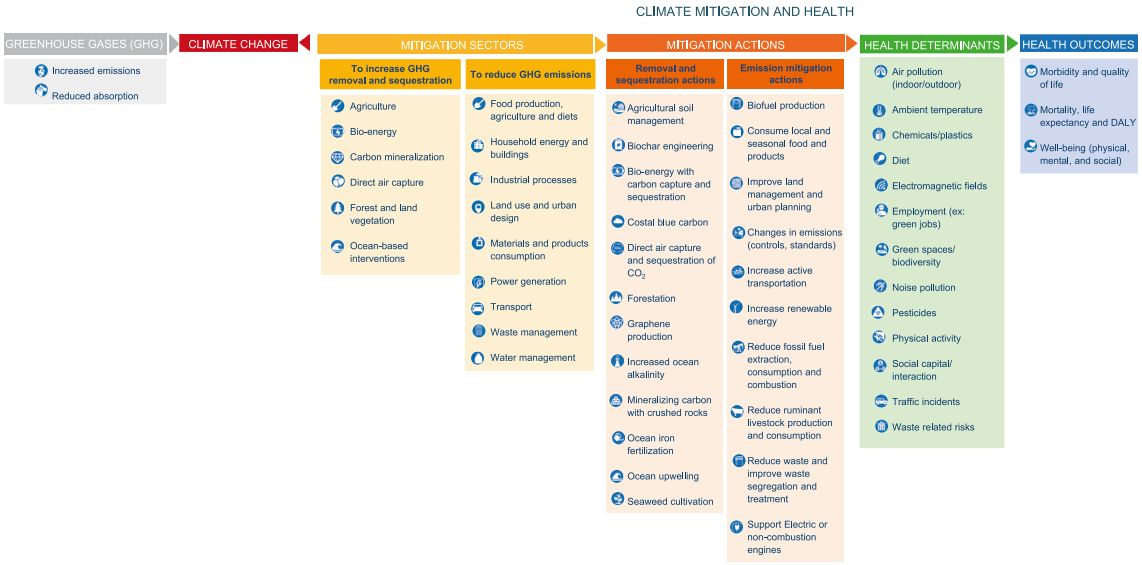

Fig. 1: **Climate mitigation and health framework.**

Rayyan software.[32] Two authors (DFG and RL) independently reviewed the titles and abstracts of the results to identify potentially relevant studies for inclusion. Similarly, two authors (DFG and RL) independently reviewed the full text of these studies. Any disagreement in selection was discussed with another author (DRR) and resolved by consensus. In addition, the reference list of all included studies was reviewed to supplement the search.

Charting and extraction

For included articles, we developed a chart on Google Sheets to extract data and confirm the relevance of full-text articles. We abstracted the following data from articles: title; abstract; authors' names; year of publication; country of the study population; study design; follow-up time, mitigation sector, mitigation strategy, health determinants, and health outcomes. Two authors (DFG and RL) independently extracted the data of interest. Discrepancies were resolved with a third author (DRR).

In order to properly classify the mitigation actions, we proposed to classify them into two sectors: 1) sectors where mitigation strategies could be implemented to remove and sequester GHG emissions and 2) sectors where mitigation strategies could be implemented to limit GHG emissions. Some examples of the removal and sequestration actions in the first sector are agricultural soil management, coastal blue carbon, forestation, and mineralizing carbon with crushed rocks, among others. Within the second sector, some examples of actions to reduce GHG are: biofuel production, consuming local and seasonal food and products, and increasing active transportation, among others. In addition, we proposed potential health outcomes which would be a direct or indirect consequence of implementing the mitigation actions. We classified these health benefits into those that 1) reduce morbidity and improve quality of life, 2) reduce mortality, increase life expectancy, and decrease disability-adjusted life years (DALYs), and 3) improve well-being (physical, mental, and social). Based on the literature, we proposed the following framework to integrate the sequence between mitigation sectors and health outcomes (see Fig. 1).

Methodological quality appraisal

Since this is a scoping review aiming to map available evidence, we did not conduct any risk of bias assessment or quality appraisal of included studies. This approach is consistent with the proposed scoping review methodology.[28,29]

Synthesis of results

The synthesis was focused on describing mitigation strategies and health outcomes assessment in South America as reported in the literature. Quantitative analysis was done using descriptive statistics (e.g., frequencies) using Microsoft Excel Software (2016). Additionally, tables were prepared to summarize the characteristics, mitigation actions, and health co-benefits reported in the studies.

Results

From a total of 1655 studies identified in the three databases with the search strategy, we excluded 98 studies for duplicity, and 1454 studies were excluded in the review of titles and abstracts. The remaining 103 studies were analyzed in full texts, of which we excluded 94 (24

because of the publication type, 11 for the design type, and 59 did not address health co-benefits and only focused on mitigation). Thus, we selected nine studies that met our selection criteria (Fig. 2).

Study characteristics

Although it was not a selection criteria, all the studies identified were scenario modeling studies (these studies are characterized by using mathematical models to simulate the potential effects of different scenarios on climate change and health outcomes).[33–41] The studies were published between 2001 and 2021. The studies modeled health impacts in a time range scenario of seven to 35 years. The South American countries included in those studies were Brazil, Chile, and Bolivia (Table 1).

Mitigation sectors and mitigation actions

Seven studies published actions on reducing fossil fuels use,[33–35,37,38,40,41] three evaluated actions on changes in emissions,[37,40,41] two evaluated actions on improving land management,[36,39] and two on reducing ruminant livestock-related GHG emissions.[33,38] In contrast, the actions of biofuel production,[38] increasing active transportation,[41] increasing renewable energy,[38] and reducing waste,[41] were evaluated by individual studies, one for each action. Only one study evaluated the sectors related to GHG capture and sequestration strategies.[36] This study evaluated afforestation as a climate change mitigation action (Fig. 3).

Health determinants and health co-benefits outcomes

In eight studies,[33–35,37–41] air pollution was the health determinant of mitigation actions. Other health determinants related to climate change mitigation included diet (two studies),[33,41] employment (two studies),[36,37] greenspace and biodiversity (two studies),[36,39] ambient temperature (one study),[37] physical activity (one study),[41] and social interaction (one study).[36] In terms of health outcomes, seven of the nine studies estimated mortality,[33–35,38–41] four estimated morbidity,[33–36] and well-being,[34,35,38,40] and two included DALYs,[33,37] or quality of life[34,35] (Fig. 3).

Discussion

Overall, we identified a limited number of studies incorporating South American countries in the evidence

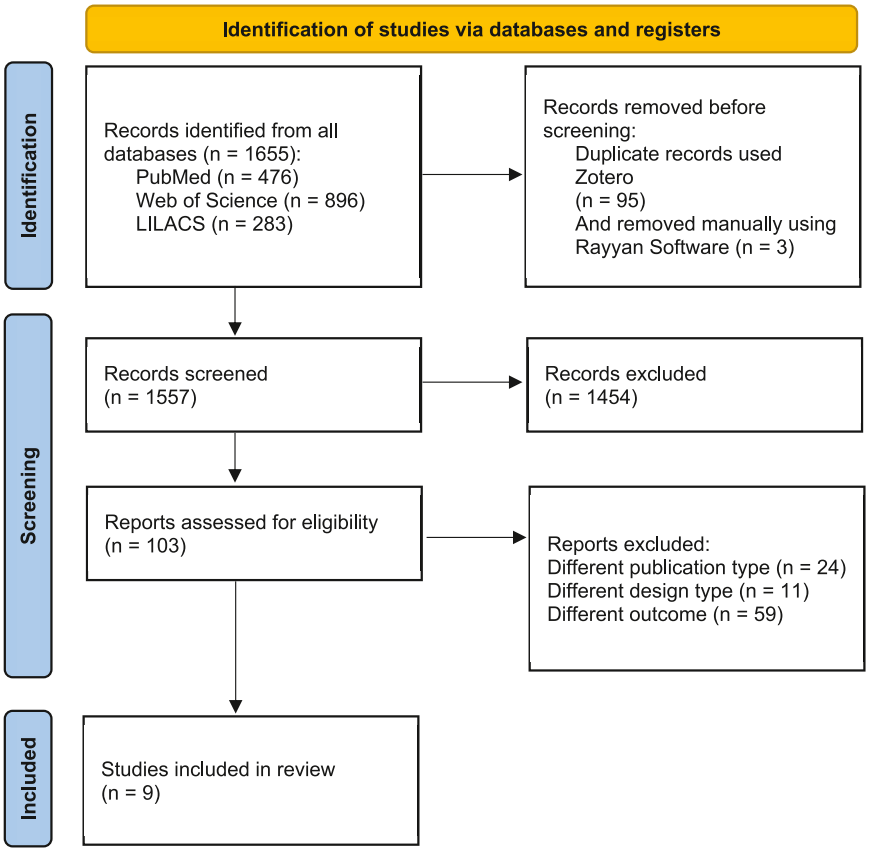

Fig. 2: **Flow diagram summarizing the process of literature search and selection.**

Study (Year)	City/Ies region	Follow up	Mitigation sector	Mitigation strategy	Health determinant	Health outcomes
Bell, M. L. et al. (2006)	Mexico City (Mexico), Santiago (Chile), Sao Paulo (Brazil)	20 years	Emission mitigation	• Control technologies to mitigate emissions in energy, transport, residential, and industrial emission sectors.	Air quality	Morbidity, Mortality, Quality of life, Physical well-being
Cifuentes, L. et al. (2001)	Santiago (Chile), São Paulo (Brazil), Mexico City (Mexico), and New York City (USA)	20 years	Emission mitigation	• Readily available technologies to lessen fossil fuel emissions	Air quality	Morbidity, Mortality, Quality of life, Physical well-being
Friel, S. et al. (2009)	Sao Paulo (Brazil)	20 years	Emission mitigation	• Improved efficiency of livestock farming • Reduced production and consumption of foods from animal sources in high-consumption populations • Decreased dependence on fossil-fuel input	Air quality, Diet	Morbidity, Mortality, Life expectancy, DALYs
Hamilton, I. et al. (2021)	Brazil, China, Germany, India, Indonesia, Nigeria, South Africa, the UK, and the USA	35 years	Emission mitigation	• IEA SDS fuels and energy system features • Active travel • Dietary changes (flexitarian and vegan diets) • Reduced food loss and waste by three quarters	Air quality, Diet, Physical activity	Mortality
Howard, D. B. et al. (2020)	Recife, Salvador and Fortaleza (Brazil)	15 years	Emission mitigation	• 30, 45 and 70% of variable renewable energy (wind and solar PV) • No new coal and oil generators added • Thermal generators decommissioned	Air quality	Mortality, Physical well-being
Pattanayak, S. et al. (2009)	Brazil	–	Emission mitigation GHG removal and sequestration	• Land management related to deforestation and climate change • FLONAS: 50 million hectare of national forests	Employment, Green spaces, biodiversity, and social interaction	Morbidity
Reddington, C. L. et al. (2015)	Brazil and Bolivia	12 years	Emission mitigation	• Reduction in deforestation	Air quality, Green spaces, and biodiversity	Mortality
Reyes, R. et al. (2015)	Valdivia City (Chile)	7 years	Emission mitigation	• Replace fossil fuel with biomass fuel • Firewood fuel and biomass fuel vs. LPG and kerosene	Air quality, Ambient temperature, Employment	DALYs
Vormittag, E. et al. (2018)	Sao Paulo and Rio de Janeiro (Brazil)	10 years	Emission mitigation	• Gradual biodiesel implementation (B7 and B20) vs actual B5	Air quality	Mortality, Life expectancy, Physical well-being

GHG: greenhouse gas; USA: United States of America; IEA SDS: International Energy Agency Sustainable Development Scenario; PV: photovoltaic; FLONAS: Brazilian policy to expand National Forests; LPG: liquefied petroleum gas; DALYs: disability-adjusted life years; B: Biodiesel.

Table 1: **Studies reporting health co-benefits of climate mitigation in South America.**

of health co-benefits of climate mitigation strategies. Among the 12 South American countries, the studies evaluated the situation only in three countries (Brazil, Bolivia, and Chile),[33–41] with eight of the nine studies focusing on Brazil.[33–36,38–41] All the studies included GHG emission-related mitigation strategies and air quality impacts,[33–41] and only one reported health co-benefits of GHG capture and sequestration strategies.[36]

The principal strategy studied among the publications was reducing fossil fuel extraction, consumption, and combustion. This relates to the energy sector, the largest emitter of GHG in South America,[42] and to fossil fuels use, which is the source of 70% of the energy in Central & South America.[43] Air pollution has been the most common health determinant reported among the included studies. Air pollution related to fossil fuels is an ongoing issue reported by regional stakeholders.[44,45] Furthermore, air pollution is the top environmental risk factor globally, and multiple studies have also quantified their health impacts in other regions.[46,47] Among the included studies, solutions related to changes in air pollution emission controls, standards, reduction in fossil fuel use, and increased use of renewable energy have been assessed. Among those, the solutions reported to provide greatest co-benefits in South America were reducing fossil fuel use and implementing technologies to control emissions, both of which apply to every sector. Some of the potential co-benefits listed on the studies were the avoidance of the following health impacts in Sao Paulo and Santiago: more than 70,000 cases of chronic and acute bronchitis, approximately 600,000 cases of asthma attacks and 16,206 adult and infant mortalities due to the reduction of PM_{10} in the atmosphere, that is emitted by the combustion of fossil fuels.[29] Also, other significant solutions reported were reducing ruminant livestock consumption (diet), land management, active transport, and agricultural soil management, although research results are more limited in these areas.

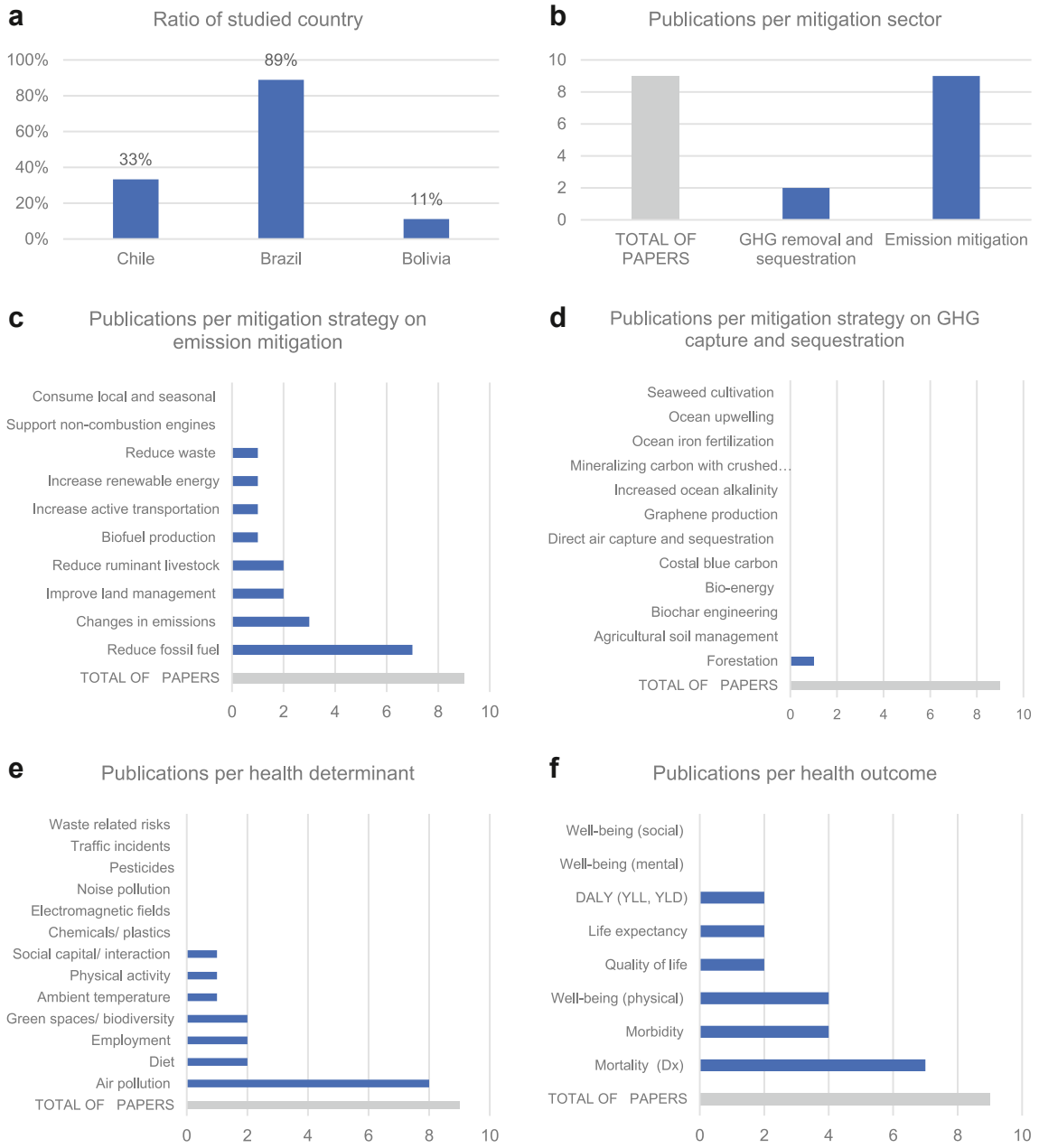

***Fig.* 3: Results panel describing publications by a) country, b) mitigation sector, c) strategy by emission mitigation, d) capture and sequestration strategy, e) health determinant, and f) health outcome.** GHG: greenhouse gas; DALY: disability-adjusted life years; YLL: years of life lost; YLD: years lived with disability; Dx: diagnosis.

Two studies considered the co-benefits of reducing ruminant livestock consumption associated with GHG emissions.[33,41] These studies found that reducing red meat consumption could prevent between 143 and 147 premature deaths per 100,000 population in Brazil.[41] However, it is important to note that the impact of meat consumption on health outcomes can vary depending on various factors, such as the type of meat and the production methods. Research has indicated that processed meats have a relative risk of 1.42 (95% confidence interval: 1.07–1.89) for coronary heart disease per 50 g/day consumed.[48] This is especially relevant because several countries in South America, like Paraguay, Brazil, and Argentina, are among the top countries regarding red meat consumption globally.[49] This regional context makes potential interventions to

reduce livestock consumption particularly relevant for improving public health outcomes. Therefore, a more comprehensive analysis considering the specific types of meat and their respective health implications would provide a clearer understanding of the potential benefits and risks associated with reducing ruminant livestock consumption in the region.

The studies also evaluated other mitigation strategies for reducing GHG emissions, such as biofuel production,[38] active transportation,[41] renewable energy,[38] and waste reduction.[41] One of those studies found that reducing motorized vehicles by encouraging active cycling and walking interventions could avoid 24 deaths per 100,000 population.[41] When combined with a healthy diet, this benefit could be increased to 167 premature deaths prevented.[41] This is particularly relevant for the region, given the constant increase in motorized trips in South American countries.[50] The potential of active transportation as a tool to attract the attention of local and national authorities cannot be overlooked. Examples like Bogota, Colombia, and São Paulo, Brazil, with important investments in bike lanes and open streets, illuistrate well interventions that are calling the attention of stakeholders in the region and globally.[51,52] Another emissions-related intervention is support for renewable energy, which in one study was estimated to reduce hospitalization and mortality costs in Brazil.[38] Latin America has one of the most dynamic renewable energy markets in the world, with more than a quarter of its primary energy coming from renewables, which is twice the global average and has great potential for further expansion.[53] However, it is important to mention that in South America, rural electrification is still a big concern, and where renewable energy and microgrids are also the perfect solutions for numerous areas in these countries.[54,55]

Carbon capture, utilization, and sequestration (CCUS) and the removal of other GHGs have been suggested as a part of the solution in the face of global warming and climate change.[56] Although in other regions of the world different carbon sequestration and renewal strategies have been proposed to reduce pollution, such as agricultural soil management,[57] biochar engineering,[58] bioenergy with carbon capture and sequestration,[59,60] coastal blue carbon,[61] direct air CO2 capture and sequestration,[62] afforestation,[63,64] graphene production,[65] ocean alkalinity enhancement,[66] carbon mineralization with crushed rocks,[67] ocean fertilization,[68] and algal cultivation,[69] in our review only one study focused on CCUS. We only found one study that evaluated the impact of afforestation (a CCUS intervention) on health. According to their analysis, reducing deforestation by 1 million hectares in Brazil could lead to a reduction of 2.7 malaria cases per 1000 persons and 0.1 dengue fever cases per 1000 persons in rural areas. In the best-case scenario, afforestation and forest conservation could reduce up to 50% of malaria cases, resulting in a maximum reduction of 14 cases per 1000 persons.[36]

Implementing new CCUS technologies and their potential social impacts are becoming increasingly disparate across different regions of the world.[70] Research on carbon sequestration is more scarce than on GHG emission interventions. Furthermore, the slow adoption of CCUS technologies in South America and the limited exchange of information between countries may account for the scant evidence on the health co-benefits of these strategies.[71] This highlights the necessity to strengthen and increase the assessment of CCUS strategies in the region and abroad.

Overall, mortality was the most common health outcome among the nine studies.[33–35,38–41] Mortality tends to capture the final stage of the natural history of disease and is often used because epidemiological data is more widely available in mortality than other health outcomes.[72] Currently, mortality is the primary health indicator used to assess the impact of mitigation strategies on human health.[73] However, this approach is limited because it only captures clinical and subclinical health indicators such as disease, signs, and symptoms, which may not provide a comprehensive understanding of the wide range of health co-benefits associated with mitigation strategies. Other crucial health outcomes, such as well-being and quality of life, have been overlooked in the studies conducted so far. For example, some studies have not included the measurement of DALYs, which aims to capture a more comprehensive estimation of health by taking into account the impact of both mortality and morbidity. Moving forward, it will be important to broaden the scope of the health indicators used in these studies to provide a more accurate and comprehensive assessment of the health co-benefits associated with mitigation strategies.

In South America, the energy sector is the largest contributor to GHG emissions,[42] and according to our review, it is also the area that has been most extensively studied to evaluate health co-benefits. As mentioned, South American countries are well-positioned to implement clean energy solutions, and most have enough potential for renewable energy to cover the projected energy demand.[74] However, despite this potential, oil and gas companies continue to dominate the market due to lower prices, government subsidies, state-owned industries, large oil and gas resources, and established infrastructure across the region.[75,76] Land use, land-use change, and forestry (LULUCF) are the second-largest contributors to GHG emissions in the region. South America contains one of the largest regions of forest in the world, but it also experiences one of the fastest rates of forest loss on the planet, with around 50% of forest loss in the last 30 years.[77] Strategies like forestation, land management, or agricultural practices have been suggested as key interventions by the 2019 IPCC Special Report to address climate change

mitigation.[78] Therefore, exploring and implementing these strategies to reduce GHG emissions and promote sustainable regional development is important.

Limitations and strengths

The limited number of studies and geographic scope should be considered when interpreting the results of this scoping review. Our search retrieved nine studies, all in English, despite including multiple languages and databases in the inclusion criteria. The prevalence of non-peer-reviewed journals in Spanish or Portuguese in the region could partly explain this fact.[79] Additionally, the limited number of studies may be due to regional limitations, such as the lack of researchers in South America.[80] The findings of this review cannot be extrapolated to the entire region, as the nine studies covered only three out of the 12 countries in South America. Additionally, all publications included are modeling studies that only estimate potential health impacts, not real effects that have occurred with certainty. Including primarily scenario modeling studies in the results reflects the current research availability and does not indicate a methodological bias. Furthermore, several mitigation sectors and actions described in our framework (Fig. 1) were absent from the evidence, and those should also be considered in future research. In addition, some studies found during the reporting process lacked information regarding data sources or a clear description of the methods used.

Despite these limitations, our study has several strengths. First, it is the first study to focus solely on South America, including climate change mitigation and its health co-benefits, and considers interventions related to GHG emissions and carbon removal and sequestration. Second, it is based on the methodology recommended by the JBI and the PRISMA guidelines.[28,29] In addition, the conceptual framework of the review and the synthesized overview of the evidence may guide the development of future research.

Recommendations and implications for decision-making

Based on our findings, we propose several recommendations. First, governments should support and prioritize studies of health co-benefits of climate mitigation areas in South America, with special attention to GHG removal and sequestration interventions. Second, more investments and research from diverse countries should be prioritized to provide a graphical representation of South American countries. Third, evidence from rural interventions should also be considered among stakeholders. Fourth, future publications should improve the reporting and publication processes to describe data sources and methods comprehensively. Fifth, there is a lack of climate mitigation indicators in South America, and more research is needed to track and compare such strategies and health co-benefits among different periods and countries in the region. Sixth, health practitioners should use and support research and evidence related to climate change in the region. Seventh, we recommend a Health in All Policies approach to integrate health considerations in other climate-related economic sectors. By prioritizing policies that have the greatest health co-benefits, such as those that reduce greenhouse gas emissions and improve air quality, governments can promote more coordinated and effective responses to complex public health challenges like climate change. Finally, stakeholders should prioritize economic or environmental solutions supporting health co-benefits of climate mitigation, such as those in Brazil, Venezuela, and Colombia, South America's biggest oil producers,[81] and Brazil and Argentina, the largest soybean producers.[82] By integrating these recommendations into decision-making processes, South America can contribute to global climate mitigation while improving public health outcomes.

Conclusion

The available evidence regarding the health co-benefits of climate change mitigation strategy in South America is limited and insufficient. The studies were primarily modeling studies, focusing on GHG emissions, and were concentrated in three out of the 12 South American countries, with a bias towards urban areas. In order to facilitate informed decision-making by health policymakers and community members, it is incumbent upon stakeholders and researchers to prioritize the production of scientifically robust evidence and indicators capable of tracking climate mitigation strategies across South American countries, identifying temporal trends and geographical variations.

Contributors

DRR and MYG generated the idea for the study. DFG, RL, DRR and MYG designed the analysis and methods. DFG, RL and DRR reviewed the literature. DFG, RL and DRR performed the analysis and DFG, RL and DRR wrote the first draft of the manuscript. DRR participated in the analysis. DRR, MYG and SMH made critical scientific contributions to the manuscript.

Data sharing statement

All data are available in the paper and supplementary materials. Protocol is available from the corresponding authors upon reasonable request. This scoping review was reported in accordance with the PRISMA-ScR checklist (Supplementary Material S2).

Declaration of interests

All authors declare no competing interests.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.lana.2023.100602.

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