



International collaboration among medical societies is an effective way to boost Latin American production of articles on tuberculosis

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Submitted: 27 December 2018.

Accepted: 10 January 2019.

Study carried out at the Centro de Investigación, Prevención y Tratamiento de Infecciones Respiratorias – CIPTIR – Monterrey, México, and the WHO Collaborating Centre For Tuberculosis and Lung Diseases, Tradate, Italia.

INTRODUCTION

The World Health Organization (WHO) has estimated that, in 2017, there were 9.0-11.1 million new cases of active tuberculosis and 1.2-1.4 million tuberculosis-related deaths, indicating that tuberculosis is now the leading cause of infection-related death worldwide and is among the ten leading causes of death from any cause.⁽¹⁾ The WHO Region of the Americas, which is managed by the Pan American Health Organization, includes the United States and Canada, both of which have a low incidence of tuberculosis, whereas the incidence of tuberculosis ranges from low to high in Latin American and Caribbean countries, which are mainly low- to middle-income countries with limited resources allocated to health care and research.^(1,2)

Scientific societies such as the *Asociación Latinoamericana de Tórax* (ALAT, Latin American Thoracic Association) and the *Sociedade Brasileira de Pneumologia*

e *Tisiologia* (SBPT, Brazilian Thoracic Association) are both active in promoting training, continued medical education, and research that is useful in the fight against tuberculosis. The influence of those societies reaches most of the countries in Latin America. Recently, they have joined forces with the European Respiratory Society (ERS) to develop initiatives against tuberculosis in several fields, including research.^(3,4) Such initiatives are collectively known as the ALAT/ERS/SBPT project. Because no specific funds were otherwise available for the task, the project included data collection, the creation of new databases, the ordering of existing databases, and the design of studies, as well as the writing/translation of the articles produced and the facilitation of their submission to peer-reviewed journals.

As clearly mentioned by the WHO and included in Pillar 3 of its "End TB Strategy",^(5,6) research is crucial to promoting better clinical and public health initiatives.

ABSTRACT

Objective: Most studies of tuberculosis originate from high-income countries with a low incidence of tuberculosis. A review of the scientific production on tuberculosis in Latin American countries, most of which are low- or middle-income countries (some with high or intermediate tuberculosis incidence rates), would improve the understanding of public health challenges, clinical needs, and research priorities. The aims of this systematic review were to determine what has been published recently in Latin America, to identify the leading authors involved, and to quantify the impact of international collaborations.

Methods: We used PubMed to identify relevant manuscripts on pulmonary tuberculosis (PTB), drug-resistant tuberculosis (DR-TB), or multidrug-resistant tuberculosis (MDR-TB), published between 2013 and 2018. We selected only studies conducted in countries with an annual tuberculosis incidence of $\geq 10,000$ reported cases and an annual MDR-TB incidence of ≥ 300 estimated cases, including Brazil, Peru, Mexico, Colombia, and Argentina. Articles were stratified by country, type, and topic. **Results:** We identified as eligible 395 studies on PTB and 188 studies on DR/MDR-TB—of which 96.4% and 96.8%, respectively, were original studies; 35.5% and 32.4%, respectively, had an epidemiological focus; and 52.7% and 36.2%, respectively, were conducted in Brazil. The recent Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project boosted the production of high-quality articles on PTB and DR/MDR-TB in Latin America. **Conclusions:** Most of the recent Latin American studies on tuberculosis were conducted in Brazil, Mexico, or Peru. Collaboration among medical societies facilitates the production of scientific papers on tuberculosis. Such initiatives are in support of the World Health Organization call for intensified research and innovation in tuberculosis.

Keywords: Tuberculosis, pulmonary; Tuberculosis, multidrug-resistant; Latin America.

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Declaration of interests: All authors declare no competing interests.

Financial support: None.

By reviewing who and what has recently been published in Latin America on the subject of active tuberculosis and measuring the impact of international collaboration on the production of scientific evidence, we could gain a better understanding of what aspects should be targeted in order to address the WHO recommendations.

For the purposes of this article, we included five of the six Latin American countries that report more than 10,000 cases of tuberculosis annually. Those countries are, in decreasing order of tuberculosis incidence, Brazil, Peru, Mexico, Colombia, and Argentina.⁽¹⁻⁴⁾ Collectively, they reported a total of 160,683 cases in 2016, as shown in Table S1 of the supplementary file (available online at http://jornaldepneumologia.com.br/detalhe_anexo.asp?id=60).

Countries approaching the goal of tuberculosis elimination (defined as less than 1 case per million population) need to focus on specific interventions such as managing latent tuberculosis infection, and countries with a higher tuberculosis incidence need tuberculosis control activities focused on active pulmonary tuberculosis (PTB).^(3,4,7-9) Therefore, we decided to limit our review to articles dealing with active tuberculosis.

The epidemiological diversity of Latin American countries was recently captured in two important documents related to the region, both published jointly by the Pan American Health Organization and the WHO: the 2013 Strategic Plan of the Pan American Health Organization⁽¹⁰⁾; and the 2014 Plan of Action for the Prevention and Control of Tuberculosis.⁽¹¹⁾ It is expected that research priorities will be aligned with the priorities and resources available in each country. The Brazilian National Plan to End Tuberculosis as a Public Health Problem is an example of that.⁽¹²⁾ Further new information emerging from local studies is needed in order to increase the overall scientific production in Latin America.

The primary aim of this review was to identify the main areas of tuberculosis research conducted in the Latin American countries with the highest rates of active PTB, drug resistant-tuberculosis (DR-TB), and multidrug-resistant tuberculosis (MDR-TB). Secondary aims were to identify the Latin American researchers leading the production of tuberculosis research and to evaluate the impact that recent international collaborations among medical societies have had on the overall scientific output in the region.

METHODS

This study focused on the local scientific contributions of Brazil, Peru, Mexico, Colombia, and Argentina related to PTB and MDR-TB. Those five countries, all of which are middle-income countries, have the highest scientific production rates in Latin America. In each of those countries, the annual tuberculosis incidence is $\geq 10,000$ reported cases and the annual MDR-TB incidence is ≥ 300 estimated cases, as shown

in Table S1 of the supplementary file (available online at http://jornaldepneumologia.com.br/detalhe_anexo.asp?id=60). Those are also the only countries that have participated in the ALAT/ERS/SBPT project.

Although Haiti ranks fourth in Latin America in terms of the incidence of tuberculosis, we decided not to include it in the regional analysis of this review, for a number of reasons. As a low-income country, Haiti receives long-term external financial support for research (mainly from United States government agencies). In addition, Haiti has not been involved in any studies related to the ALAT/ERS/SBPT project. Those two conditions would make it difficult to evaluate the spontaneous research contribution of the country.

Inclusion criteria

We selected peer-reviewed articles written in English, Spanish, or Portuguese by authors (corresponding authors or not) working in any of the five Latin American countries under study (Brazil, Peru, Mexico, Colombia, and Argentina). We used PubMed to identify any relevant manuscripts, published between January 1, 2013 and April 19, 2018, authored by Latin American researchers. To attribute a given article to a given country, the first selection criterion was the country of the corresponding author, followed by that of the first author and then that of each of the other authors, based on the affiliations as they appeared in the original manuscript. Manuscripts with authors whose main affiliation was in a high-income country (e.g., the United States, Canada, or a country in Europe) were not considered if no Latin American affiliations were listed.

We performed our searches in two steps, using the following search terms: "pulmonary tuberculosis" OR "pulmonary TB", to retrieve articles related to PTB (step 1); and "multidrug-resistant tuberculosis" OR "multidrug-resistant TB" OR "MDR-TB" OR "drug-resistant tuberculosis" OR "drug-resistant TB", to retrieve articles specifically focused on DR/MDR-TB (step 2). Most of the MDR-TB-related manuscripts were retrieved in the first step. Articles related to extrapulmonary tuberculosis were excluded, because the focus of this review was to identify the scientific production related to the transmissible form of tuberculosis (drug-susceptible or drug-resistant PTB).

We included full-text original articles, review articles, editorials, letters, correspondence containing original data, and case reports containing new information. To ensure the quality of the publication, we included only articles that were published in journals that had an impact factor in the year of publication. Basic research studies were included if they involved patients with PTB. Case reports containing no new information were excluded, as were editorials/letters containing no original data.

Studies that were not related to the ALAT/ERS/SBPT collaborative project were analyzed separately. We then drew comparisons between the articles that were related to the project and those that were not,

those comparisons being limited to articles published in 2016, 2017, or the first quarter of 2018.

Data analysis

The articles were first separated into two groups: those related to PTB; and those related to DR/MDR-TB. They were then stratified by country and type of manuscript—articles containing original data (full manuscripts, short reports, or letters), editorials, and review articles—as well as by topic (epidemiology/research, biochemistry/diagnosis, treatment/outcomes, or genetics/immunology/vaccines). Two of the authors, working independently, evaluated the manuscripts. Any disagreements were resolved by consensus.

For each country, the authors publishing the most articles, either on PTB or on DR/MDR-TB, were identified. For each of those authors, a complete bibliometric analysis was performed, including the overall number of publications, the h-index, and the number of citations. The articles related to the ALAT/ERS/SBPT project (and therefore their authors) were not considered in the main analysis, although they were considered in the comparative analysis. The study was conducted in accordance with the 2009 Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.⁽¹³⁾

RESULTS

For the period from January 2013 to April 2018, a total of 803 manuscripts were identified (Figure 1): 532 on PTB and 271 on DR/MDR-TB. Of those 803 manuscripts, 583 were deemed eligible for further analysis: 395 on PTB and 188 on DR/MDR-TB.

Of the 395 articles on PTB, 137 were excluded, for the following reasons (Figure 1A): being a case report or letter containing no new information ($n = 45$); being authored by individuals not working in one of the Latin American countries specified ($n = 34$); not focusing on tuberculosis ($n = 25$); and having been published in a journal that had no impact factor in the year of publication ($n = 33$). The annual number of articles on PTB unrelated to the ALAT/ERS/SBPT project was rather stable (Table 1): 60 in 2016; 90 in 2017; and 17 in the first quarter of 2018.

As can be seen in Figure 2A, the country contributing the greatest number of articles on PTB was Brazil, which accounted for 208 (52.7%) of the 395 articles, followed by Mexico, with 79 (20.0%), Peru, with 57 (14.4%), Colombia, with 29 (7.3%), and Argentina, with 22 (5.6%). Table 2 describes the types of articles published in Latin America, the largest proportion being original studies, which accounted for 96.4% (381 articles). The most common topic studied in those articles was epidemiology/research (in 35.5%), followed by genetics/immunology/vaccines (in 29.9%), biochemistry/diagnosis (in 23.5%), and treatment/outcomes (in 11.1%).

Of the 188 articles on DR/MDR-TB, 82 were excluded, for the following reasons (Figure 1B): being a duplicate

or a case report/letter containing no new information ($n = 11$); being authored by individuals not working in one of the Latin American countries specified ($n = 28$); not focusing on DR/MDR-TB or focusing on animal tuberculosis ($n = 32$); and having been published in a journal that had no impact factor in the year of publication ($n = 12$). The annual number of articles on DR/MDR-TB unrelated to the ALAT/ERS/SBPT project was rather stable (Table 1): 32 in 2016; 41 in 2017; and 10 in the first quarter of 2018. As can be seen in Figure 2B, Brazil was the country contributing the greatest number of articles on DR/MDR-TB, accounting for 68 (36.2%) of the 188 articles, followed by Peru, with 53 (28.2%), Mexico, with 33 (17.6%), Argentina, with 20 (10.6%), and Colombia, with 14 (7.4%). Table 2 shows that the largest proportion of articles on DR/MDR-TB were original studies, which accounted for 96.8% (182 articles). In terms of topics, the most common was epidemiology/research (in 32.4%), followed by treatment/outcomes (in 30.9%), biochemistry/diagnosis (in 27.1%), and genetics/immunology/vaccines (in 9.6%).

The bibliometric analysis of the top authors per country for the PTB and DR/MDR-TB categories are summarized in Table 3. For both categories, it is evident that the Brazilian Tuberculosis Research Network plays a leading role in Brazil,⁽¹⁴⁻¹⁹⁾ whereas the Peruvian Partners in Health Research Network and Harvard University play major roles in Peru.⁽²⁰⁻²³⁾ In Argentina, Mexico, and Colombia, most of the basic research studies are conducted at a few high-level institutions, often in collaboration with other countries within and outside of Latin America.

Table 4 presents the comparative analysis of studies related and unrelated to the ALAT/ERS/SBPT project. A total of 289 articles were published in the comparison period (2016-2018). Studies related to the ALAT/ERS/SBPT project accounted for 13.5% of those articles overall, specifically accounting for 9.7% of the articles on PTB and 20.1% of the articles on DR/MDR-TB (Figure 3). All of those articles were published in journals with an impact factor. The contributions of the authors who published within the ALAT/ERS/SBPT project are summarized in Table 5.

DISCUSSION

The aims of this systematic review were to determine which were the main areas of research on PTB and DR/MDR-TB conducted recently in Brazil, Peru, Mexico, Colombia, and Argentina, to identify the Latin American authors involved in that research, and to quantify the impact of collaboration among international medical societies. It is difficult to evaluate the quantity and quality of the scientific production of the selected countries, because there is no benchmark or gold standard comparator.

In a recent bibliometric analysis, Sweileh et al.⁽²⁴⁾ evaluated the studies on MDR-TB published worldwide

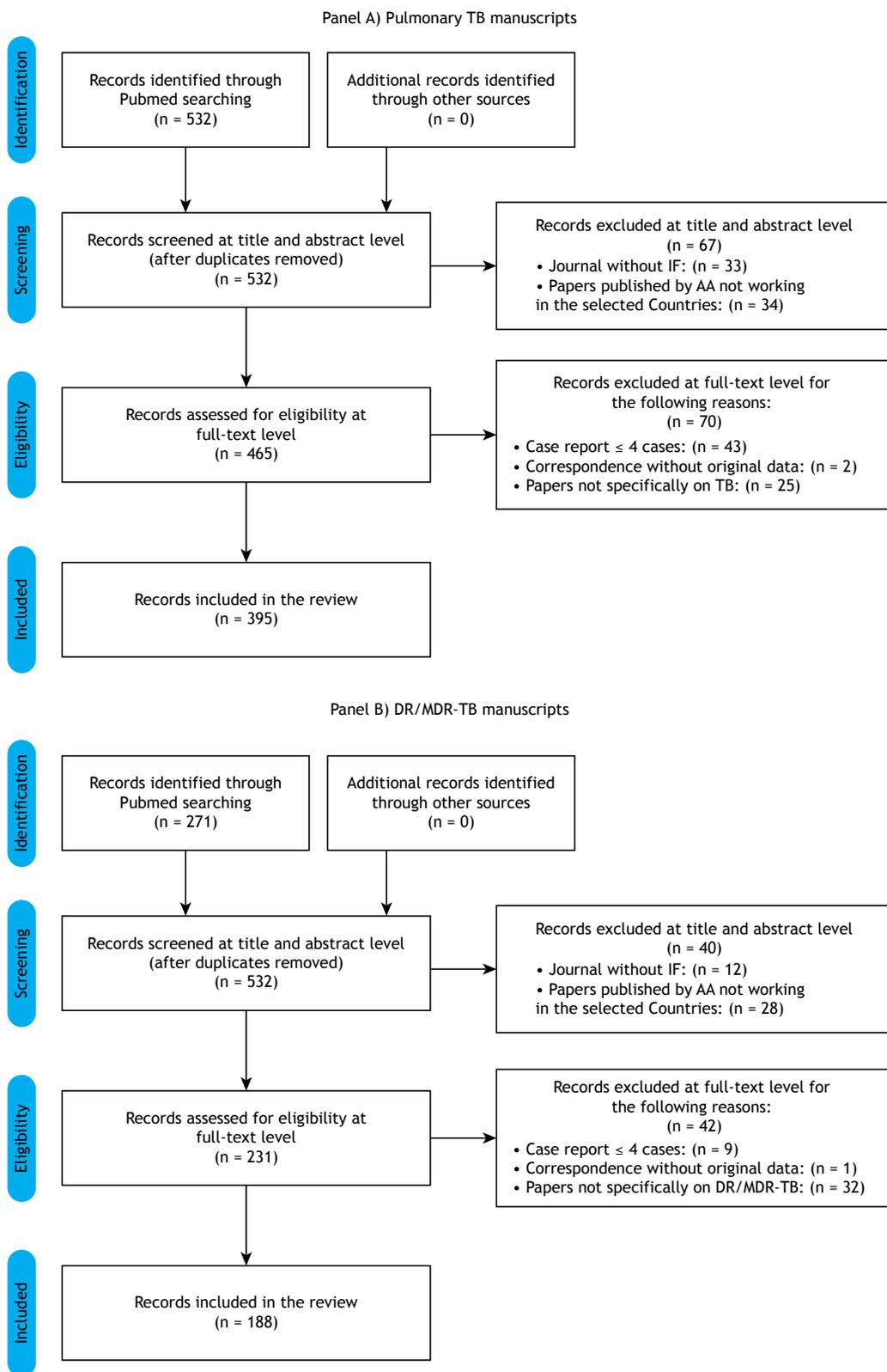


Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2009 flow diagram of the process of selecting manuscripts on pulmonary tuberculosis (TB, panel A) and on drug-resistant/multidrug-resistant tuberculosis (DR/MDR-TB, panel B) unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project and authored by researchers working in Brazil, Mexico, Peru, Colombia, or Argentina. IF: impact factor.

between 2006 and 2015. The authors found that the number of studies on tuberculosis and MDR-TB increased from 4,460 and 279, respectively, in 2013 to 4,711 and 342, respectively, in 2016. They also ranked countries by their level of scientific production on the topic of MDR-TB: Peru ranked 13th, with 69 articles; Brazil ranked 18th, with 51; Mexico ranked 24th, with 36; Argentina ranked 31st, with 29; and Colombia ranked 37th, with 14. In the worldwide bibliometric analysis, original articles accounted for 71.3% of the articles, whereas review articles accounted for 9.6% and editorials accounted for 3.8%. Despite the methodological differences between that study and ours (the former having used the Scopus database, having focused on MDR-TB, and not having limited the searches to journals with an impact factor), the overall production in the Latin American countries included in our study is quantitatively consistent with that reported by those authors. Given

Table 1. Articles unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project, 2013-2018.

Year	Pulmonary TB	DR/MDR-TB	Total
2013	75	33	108
2014	86	32	118
2015	67	40	107
2016	90	32	132
2017	60	41	114
2018 ^a	17	10	44
Total	395	188	583

TB: tuberculosis; and DR/MDR-TB: drug-resistant/multidrug-resistant tuberculosis. ^aOnly articles published in the first quarter of 2018.

the continuous increase in the number of articles published over time, the number of articles published per year is comparable between the two studies. In terms of the types of articles, our findings were also similar: original articles were the most common type of articles, followed by review articles and editorials. One difference was related to the proportional distribution of the article types, original articles accounting for 96.5% of the articles identified in our study, compared with only 71.3% in the study conducted by Sweileh et al.⁽²⁴⁾ In the latter study, one Latin American author (Becerra MC, from Peru) was among the top 20 authors publishing research on MDR-TB, having authored 29 articles during the period evaluated. That same author also ranked highly in our study. Nine of the top-ranked authors from the five countries we studied had an h-index ≥ 20 (50 being the highest), confirming that high-quality research groups are active in the region. However, it should be borne in mind that some of the most highly ranked authors conduct research on a wide spectrum of tropical diseases other than tuberculosis and that their h-indices therefore reflect their overall scientific production.

In the present study, we considered the articles in which at least one of the authors had an affiliation in one of the five Latin American countries selected. Therefore, articles in which the affiliation was outside those countries (e.g., Harvard University rather than the Peruvian Partners in Health Research Network for studies conducted in Peru) were not counted. As previously mentioned, we did not consider studies conducted in Haiti, because research projects in

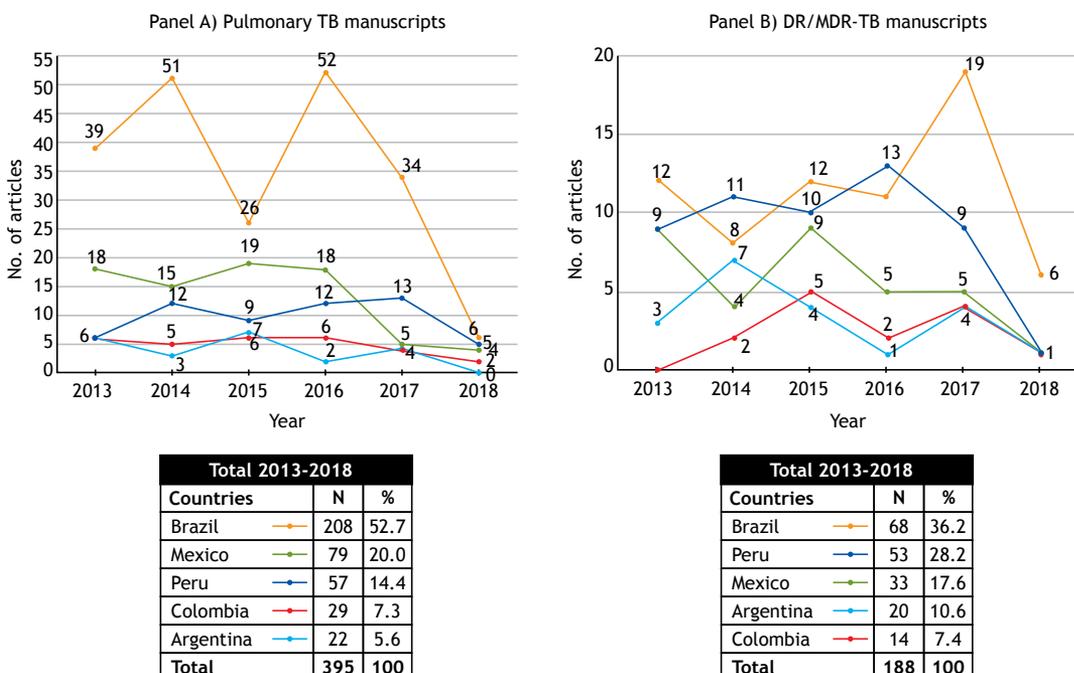


Figure 2. Results of the searches for manuscripts on pulmonary tuberculosis (TB, panel A) and on drug-resistant/multidrug-resistant tuberculosis (DR/MDR-TB, panel B) unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project, by country.

Table 2. Manuscript types and topics of the articles unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project, 2013-2018.^a

Manuscript characteristic	Pulmonary TB		DR/MDR-TB	
	n	%	n	%
Type				
Original article ^b	381	96.5	182	96.8
Review article	11	2.8	4	2.1
Editorial	3	0.8	2	1.1
Total	395	100	188	100
Topic	n	%	n	%
Epidemiology/research	140	35.4	61	32.4
Biochemistry/diagnosis	93	23.5	51	27.1
Treatment/outcomes	44	11.1	58	30.9
Genetics/immunology/vaccines	118	29.9	18	9.6
Total	395	100	188	100

TB: tuberculosis; and DR/MDR-TB: drug-resistant/multidrug-resistant tuberculosis. ^aIncluded only the first quarter of 2018. ^bIncluded all articles containing original data (full manuscripts, short reports, and letters).

Table 3. Top authors, in each country, of articles on pulmonary tuberculosis or drug-resistant/multidrug-resistant tuberculosis that were unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project, as determined in the bibliometric analysis.

Country Author	Articles on pulmonary TB or DR/MDR-TB	H-index ^a	Cited documents ^a
Argentina			
Bottasso, Oscar A	11	22	158
Ritacco, Viviana	11	26	94
López, Beatriz	10	15	43
Sasiain, María del Carmen	9	17	68
Bay, María Luisa	8	14	40
Brazil			
Kritski, Afrânio Lineu	27	28	186
Maciel, Ethel Leonor Noia	16	17	98
Rossetti, Maria Lúcia Rosa	15	20	86
Dietze, Reynaldo	14	35	133
Trajman, Anete	14	17	77
Colombia			
Marín, Diana	8	4	17
Robledo, Jaime	8	18	70
Arbeláez, María Patricia	6	11	34
Barrera, Luis Fernando	5	15	32
García, Luis Fernando	5	28	108
Mexico			
Hernández-Pando, Rogelio	32	50	312
Mata-Espinosa, Dulce	20	9	32
Marquina-Castillo, Brenda	14	9	27
Barrios-Payán, Jorge	12	8	26
García-García, Lourdes	11	28	115
Zenteno-Cuevas, Roberto	11	8	32
Peru			
Contreras, Carmen	20	12	46
Lecca, Leonid	19	8	38
Becerra, Mercedes C	18	31	112
Coronel, Jorge	16	12	39
Calderon, Roger	12	6	18
Gotuzzo, Eduardo	12	52	401
Seas, Ramos Carlos	12	22	117

TB: tuberculosis; and DR/MDR-TB: drug-resistant/multidrug-resistant tuberculosis. ^aData from the Scopus citation database.

Table 4. Comparative table showing studies related and unrelated to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project.

Year	PTB			DR/MDR-TB			PTB and DR/MDR-TB	
	Total	ALAT/ERS/SBPT		Total	ALAT/ERS/SBPT		Total	ALAT/ERS/SBPT
		Unrelated	Related		Unrelated	Related		
2016	92	90	2	40	32	8	132	10 (7.5%)
2017	63	60	3	50	41	9	113	12 (10.6%)
2018 ^a	30	17	13	14	10	4	44	17 (38.6%)
Total	185	167	18 (9.7%)	104	83	21 (20.1%)	289	39 (13.5%)

PTB: pulmonary tuberculosis; DR/MDR-TB: drug-resistant/multidrug-resistant tuberculosis; ALAT: *Asociación Latinoamericana de Tórax* (Latin American Thoracic Association); ERS: European Respiratory Society; and SBPT: *Sociedade Brasileira de Pneumologia e Tisiologia* (Brazilian Thoracic Association). ^aOnly articles published in the first quarter of 2018.

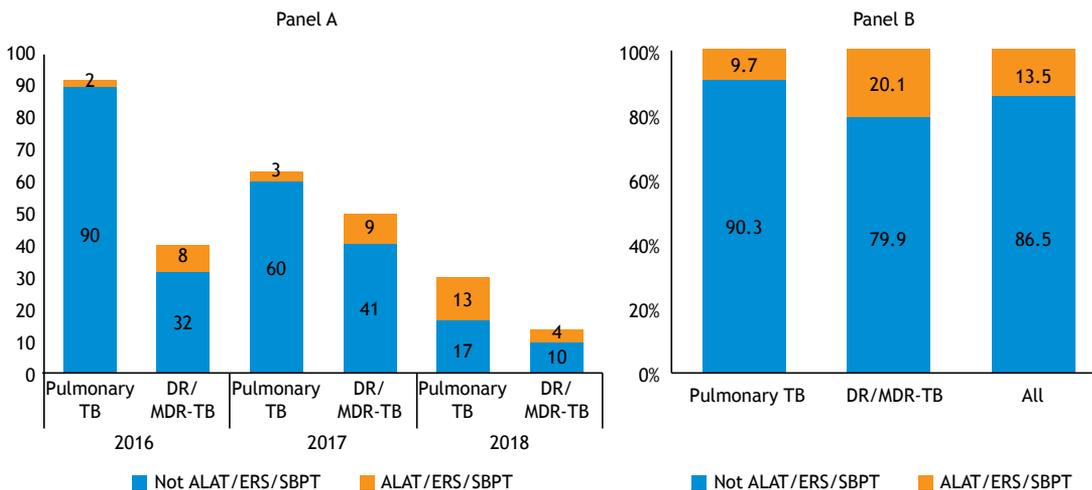


Figure 3. Impact of a collaborative project on the production of articles on pulmonary tuberculosis (TB) and drug-resistant/multidrug-resistant tuberculosis (DR/MDR-TB) published in the 2016-2018 period*. Panel A compares the number of articles per year, and panel B presents the overall contribution of the project. ALAT: *Asociación Latinoamericana de Tórax* (Latin American Thoracic Association); ERS: European Respiratory Society; and SBPT: *Sociedade Brasileira de Pneumologia e Tisiologia* (Brazilian Thoracic Association). *Included only the first quarter of 2018.

that country are mainly funded by the United States government and because Haiti has not yet participated in any of the studies published as part of the ALAT/ERS/SBPT project.

An indirect way of evaluating the quality of studies is by looking at the number and proportion of articles accepted in peer-reviewed journals with an impact factor. In the present study, articles were excluded if they were published in journals without an impact factor, as was the case for only 33 (7.7%) of 428 articles on PTB and only 12 (6.0%) of 200 articles on DR/MDR-TB. That suggests that the vast majority of such articles produced in Latin America have been published in high-quality journals.

The results of our study show how international collaborations are able to boost the quality and quantity of scientific production in Latin America. Examples of such collaborations are that between the Partners in Health initiative of Harvard University and the Peruvian National TB Program consortium,⁽²⁰⁻²³⁾ as well as the internal collaboration in Brazil within the Brazilian Tuberculosis Research Network, which has allowed several international collaborations to

be developed on the foundation of a well-designed national research plan.⁽¹⁴⁻¹⁹⁾

The ALAT/ERS/SBPT project allowed a research network involving five Latin American countries and Italy to be established in collaboration with the Maugeri Scientific Institute (Tradate, Italy). Particularly relevant are the scientific collaborations within this project involving four institutions in Mexico—the National Institute of Respiratory Diseases, in Mexico City; the Center for the Investigation, Prevention, and Treatment of Respiratory Infections, at the University Hospital of Monterrey; the Autonomous University of Nuevo León, in San Nicolás de los Garza; and the Mexican National TB Program—as well as four institutions in Brazil—the Oswaldo Cruz Foundation, in the city of Rio de Janeiro; the Federal University of Rio Grande do Sul, in Porto Alegre; the Brazilian Tuberculosis Research Network; and the Brazilian National Tuberculosis Control Program. Thus, the ALAT/ERS/SBPT project not only involved three scientific medical associations but also worked with three universities and two national tuberculosis programs, with no funding at all.

Table 5. Summary of all of the authors publishing studies related to the Latin American Thoracic Association/European Respiratory Society/Brazilian Thoracic Association collaborative project between 2016 and 2018.^a

Country	Author(s)	n
Argentina	Palmero DJ	2
	González Montaner P	1
Brazil	Arbex MA, Dalcolmo M	8
	Silva DR	7
	Mello FCQ	6
	Bonini EH, Carvalho ACC	5
	Kritski AL	3
	Alves TG, Borge L, Braga JU, Dockhorn F, Fandinho F, Rabahi MF, Rocha JL	2
	Arakaki-Sanchez D, Arbex FF, Augusto VM, Barbosa MS, Beraldi-Magalhães F, Cardoso CAA, Cordeiro-Santos M, Dias NJD, Ferreira MD, Galesi VM, Kawakame Pirolla G, Martire TM, Neves CPD, Pereira GR, Sant'Anna CC, Sanchez DA, Souza AB	1
Colombia	Torres-Duque CA	4
	Fuentes Z	2
Mexico	Rendon A	12
	Muñoz-Torrico M	11
	Salazar-Lezama MA	6
	Pérez-Padilla R	3
	Carrillo-Alduenda JL, Flores-Vergara H, García-Sancho C, Gayoso R, Martínez-Mendoza D, Torres-Cruz A, Villareal-Velarde H	2
	Martínez-Orozco JA, Millán MJM, Narváez-Díaz LA, Saavedra Herrera N, Segura-Del Pilar M	1
Peru	Alarcón VA	4
	Alarcón E, Manga S, Varga-Vasquez D	3
	Bayona J, Becerra MC, Perales R, Reaño M	1

^aIncluded only the first quarter of 2018.

According to Sweileh et al.,⁽²⁴⁾ the Harvard University Partners in Health initiative and the Maugeri Scientific Institute are both in the top 10 most active institutions worldwide in terms of the number of published articles on MDR-TB.^(3-6,25-59) Additional examples of scientific collaboration identified in our study are those on basic research involving leading institutions in Mexico, Argentina, and Colombia, which are often funded by other international partners.⁽⁶⁰⁻⁶⁴⁾

It is noteworthy that the ALAT/ERS/SBPT project not only boosted the quality and quantity of scientific production in Latin America but also encouraged young investigators to publish for the first time (improving their academic records) while consolidating the publication records of several senior experts (Table 4). In addition, as previously mentioned, the collaboration did not receive any specific funding from any group or medical society.

Although comprehensive in its design, our study has several limitations. First, it covered only five Latin American countries, all with a high incidence of tuberculosis, notably excluding Haiti and thus not covering the whole WHO Region of the Americas. Therefore, the total scientific production in the region was not covered in this study. In addition, we chose to use "pulmonary TB" rather than "TB" as a search term, thus omitting a certain number of potentially relevant publications. However, that approach was useful in order to limit the number of papers dealing with extrapulmonary cases and including tuberculosis in absence of a main focus on the disease (there were several articles on animal tuberculosis or in which

tuberculosis was mentioned only in the discussion without any data being provided). Nevertheless, the overall scientific production on tuberculosis in the region was likely underestimated. Furthermore, a direct comparison between the manuscripts that were related to the ALAT/ERS/SBPT project and those that were not was formally possible only for those dealing with DR/MDR-TB. Moreover, although the main collaborations were described and the essential bibliometric analysis was performed, a detailed analysis of the scientific collaborations and of the citation counts of the articles identified was outside the scope of our study.

In conclusion, although we have shown that the scientific production in Latin America is of high quality, the number of publications seems low in comparison with that reported for other regions.⁽²⁴⁾ We find it surprising that the national tuberculosis programs in the countries evaluated, despite having access to a large amount of data, have sponsored few published articles. More support is necessary in order to scale-up the existing research efforts in Latin America, which would strengthen the capacity of national tuberculosis programs to use their data to improve the prevention, diagnosis, and treatment of drug-susceptible and drug-resistant PTB in the respective countries, as well as to overcome the funding limitations and the language barriers.⁽²⁴⁾

International collaboration among medical societies should be promoted as a proven effective way to boost scientific production in the field of tuberculosis in Latin America. Despite a lack of funding, such collaborations

could support Pillar 3 (the intensified research and innovation portion) of the WHO "End TB Strategy".

ACKNOWLEDGMENTS

This study was conducted under the auspices of the ERS/ALAT and ERS/SBPT collaborative projects

and the operational research plan of the WHO Collaborating Centre for Tuberculosis and Lung Diseases (Tradate, ITA-80, 2017-2020-GBM/RC/LDA), as well as those of the Global TB Network, hosted by the World Association for Infectious Diseases and Immunological Disorders.

REFERENCES

- World Health Organization. Global tuberculosis report 2018. Geneva: World Health Organization; 2018.
- World Health Organization [homepage on the Internet]. Geneva: World Health Organization; c2018 [cited 2018 Apr 19]. Tuberculosis data and statistics. Available from: <http://www.who.int/tb/data/en/>
- Rendon A, Fuentes Z, Torres-Duque CA, Granado MD, Victoria J, Duarte R, et al. Roadmap for tuberculosis elimination in Latin American and Caribbean countries: a strategic alliance. *Eur Respir J*. 2016;48(5):1282-1287. <https://doi.org/10.1183/13993003.01549-2016>
- Torres-Duque CA, Fuentes Alcalá ZM, Rendón A, Migliori GB. Roadmap for Tuberculosis Elimination in Latin America and the Caribbean. *Arch Bronconeumol*. 2018;54(1):7-9. <https://doi.org/10.1016/j.arbres.2017.07.004>
- Duarte R, Silva DR, Rendon A, Alves TG, Rabahi MF, Centis R, et al. Eliminating tuberculosis in Latin America: making it the point. *J Bras Pneumol*. 2018;44(2):73-76. <https://doi.org/10.1590/s1806-37562017000000449>
- Duarte R, Migliori GB, Zumla A, Cordeiro CR. Strengthening tuberculosis control to advance towards elimination: The 2018 Rev. Port. Pneumol. (RPP) TB Series. *Pulmonology*. 2018;24(2):67-68. <https://doi.org/10.1016/j.pulmoe.2018.01.002>
- Lönnroth K, Migliori GB, Abubakar I, D'Ambrosio L, de Vries G, Diel R, et al. Towards tuberculosis elimination: an action framework for low-incidence countries. *Eur Respir J*. 2015;45(4):928-52. <https://doi.org/10.1183/09031936.00214014>
- Voniatis C, Migliori GB, Voniatis M, Georgiou A, D'Ambrosio L, Centis R, et al. Tuberculosis elimination: dream or reality? The case of Cyprus. *Eur Respir J*. 2014;44(2):543-6. <https://doi.org/10.1183/09031936.00044314>
- Al Yaqubi F, Al-Abri S, Al-Abri B, Al-Abaidani I, Al-Jardani A, D'Ambrosio L, et al. Tuberculosis elimination: a dream or a reality? The case of Oman. *Eur Respir J*. 2018;51(1). pii: 1702027. <https://doi.org/10.1183/13993003.02027-2017>
- Pan American Health Organization [homepage on the Internet]. Washington, DC: Pan American Health Organization. 52nd Directing Council. 65th session of the Regional Committee for the Americas [updated 2013 Sep 1; cited 2018 Jun 22]. Strategic Plan of the Pan American Health Organization 2014-2019. [Adobe Acrobat document; 147p.]. Available from: <https://www.paho.org/hq/dmdocuments/2014/OD345-e.pdf>
- Pan American Health Organization [homepage on the Internet]. Washington, DC: Pan American Health Organization. 54th Directing Council. 67th session of the Regional Committee for the Americas [updated 2015 Oct 2; cited 2018 Jun 22]. Plan of action for the prevention and control of tuberculosis. [Adobe Acrobat document; 24p.]. Available from: <https://www.paho.org/hq/dmdocuments/2015/CD54-11-e.pdf>
- Brasil. Ministério da Saúde. [homepage on the Internet]. Brasília: Ministério da Saúde. Secretaria de Vigilância em Saúde. Departamento de Vigilância das Doenças Transmissíveis [cited 2018 Jun 22]. Brasil Livre da Tuberculose: Plano Nacional pelo Fim da Tuberculose como Problema de Saúde Pública 2017. [Adobe Acrobat document; 54p.]. Available from: http://portalarquivos2.saude.gov.br/images/pdf/2017/junho/29/plano_nacional_tb_web.pdf
- Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6(7): e1000097. <https://doi.org/10.1371/journal.pmed.1000097>
- David SG, Lovero KL, Pombo March MFB, Abreu TG, Ruffino Netto A, Kritski AL, et al. A comparison of tuberculosis diagnostic systems in a retrospective cohort of HIV-infected children in Rio de Janeiro, Brazil. *Int J Infect Dis*. 2017;59:150-155. <https://doi.org/10.1016/j.ijid.2017.01.038>
- de O Souza Filho JB, de Seixas JM, Galliez R, de Bragança Pereira B, de Q Mello FC, Dos Santos AM, et al. A screening system for smear-negative pulmonary tuberculosis using artificial neural networks. *Int J Infect Dis*. 2016;49:33-9. <https://doi.org/10.1016/j.ijid.2016.05.019>
- Mesquita ED, Gil-Santana L, Ramalho D, Tonomura E, Silva EC, Oliveira MM, et al. Associations between systemic inflammation, mycobacterial loads in sputum and radiological improvement after treatment initiation in pulmonary TB patients from Brazil: a prospective cohort study. *BMC Infect Dis*. 2016;16:368. <https://doi.org/10.1186/s12879-016-1736-3>
- de Assunção TM, Batista EL Jr, Deves C, Villela AD, Pagnussatti VE, de Oliveira Dias AC, et al. Real time PCR quantification of viable Mycobacterium tuberculosis from sputum samples treated with propidium monoazide. *Tuberculosis (Edinb)*. 2014;94(4):421-7. <https://doi.org/10.1016/j.tube.2014.04.008>
- Bastos ML, Cosme LB, Fregona G, do Prado TN, Bertolde AI, Zandonade E, et al. Treatment outcomes of MDR-tuberculosis patients in Brazil: a retrospective cohort analysis. *BMC Infect Dis*. 2017;17(1):718. <https://doi.org/10.1186/s12879-017-2810-1>
- Vasconcelos KA, Frota SMMC, Ruffino-Netto A, Kritski AL. Sequential analysis as a tool for detection of amikacin ototoxicity in the treatment of multidrug-resistant tuberculosis. *J Bras Pneumol*. 2018;44(2):85-92. <https://doi.org/10.1590/s1806-37562016000000312>
- Odone A, Calderon R, Becerra MC, Zhang Z, Contreras CC, Yataco R, et al. Acquired and Transmitted Multidrug Resistant Tuberculosis: The Role of Social Determinants. *PLoS One*. 2016;11(1):e0146642. <https://doi.org/10.1371/journal.pone.0146642>
- Kurbatova EV, Cegielski JP, Lienhardt C, Akksilp R, Bayona J, Becerra MC, et al. Sputum culture conversion as a prognostic marker for end-of-treatment outcome in patients with multidrug-resistant tuberculosis: a secondary analysis of data from two observational cohort studies. *Lancet Respir Med*. 2015;3(3):201-9. [https://doi.org/10.1016/S2213-2600\(15\)00036-3](https://doi.org/10.1016/S2213-2600(15)00036-3)
- Franke MF, Appleton SC, Mitnick CD, Furin JJ, Bayona J, Chalco K, et al. Aggressive regimens for multidrug-resistant tuberculosis reduce recurrence. *Clin Infect Dis*. 2013;56(6):770-6. <https://doi.org/10.1093/cid/cis1008>
- Chiang SS, Starke JR, Miller AC, Cruz AT, Del Castillo H, Valdivia WJ, et al. Baseline Predictors of Treatment Outcomes in Children With Multidrug-Resistant Tuberculosis: A Retrospective Cohort Study. *Clin Infect Dis*. 2016;63(8):1063-71. <https://doi.org/10.1093/cid/ciw489>
- Sweileh WM, AbuTaha AS, Sawalha AF, Al-Khalil S, Al-Jabi SW, Zyoud SH. Bibliometric analysis of worldwide publications on multi-, extensively, and totally drug - resistant tuberculosis (2006-2015). *Multidiscip Respir Med*. 2017;11:45. <https://doi.org/10.1186/s40248-016-0081-0>
- Silva DR, de Queiroz Mello FC, Kritski A, Dalcolmo M, Zumla A, Migliori GB. Tuberculosis series. *J Bras Pneumol*. 2018;44(2):71-72. <https://doi.org/10.1590/s1806-37562018000020001>
- Ferreira MD, Neves CPD, Souza AB, Beraldi-Magalhães F, Migliori GB, Kritski AL, et al. Predictors of mortality among intensive care unit patients coinfecting with tuberculosis and HIV. *J Bras Pneumol*. 2018;44(2):118-124. <https://doi.org/10.1590/s1806-37562017000000316>
- Carvalho AC, Cardoso CAA, Martire TM, Migliori GB, Couto Sant'Anna CC. Epidemiological aspects, clinical manifestations, and prevention of pediatric tuberculosis from the perspective of the End TB Strategy. *J Bras Pneumol*. 2018;44(2):134-144. <https://doi.org/10.1590/s1806-37562017000000461>
- Silva DR, Dalcolmo M, Tiberi S, Arbex MA, Munoz-Torrico M, Duarte R, et al. New and repurposed drugs to treat multidrug- and extensively drug-resistant tuberculosis. *J Bras*

- Pneumol. 2018;44(2):153-160. <https://doi.org/10.1590/s1806-37562017000000436>
29. Silva DR, Muñoz-Torrico M, Duarte R, Galvão T, Bonini EH, Arbex FF, et al. Risk factors for tuberculosis: diabetes, smoking, alcohol use, and the use of other drugs. *J Bras Pneumol.* 2018;44(2):145-152. <https://doi.org/10.1590/s1806-37562017000000443>
 30. Chalmers JD, Aksamit T, Carvalho ACC, Rendon A, Franco I. Non-tuberculous mycobacterial pulmonary infections. *Pulmonology.* 2018;24(2):120-131. <https://doi.org/10.1016/j.pulmoe.2017.12.005>
 31. Carvalho I, Goletti D, Manga S, Silva DR, Manissero D, Migliori GB. Managing latent tuberculosis infection and tuberculosis in children. *Pulmonology.* 2018;24(2):106-114. <https://doi.org/10.1016/j.rppnen.2017.10.007>
 32. Munoz-Torrico M, Salazar MA, Millán MJM, Martínez Orozco JA, Narvaez Diaz LA, Segura Del Pilar M, et al. Eligibility for the shorter regimen for multidrug-resistant tuberculosis in Mexico. *Eur Respir J.* 2018;51(3). pii: 1702267. <https://doi.org/10.1183/13993003.02267-2017>
 33. Tiberi S, Muñoz-Torrico M, Duarte R, Dalcolmo M, D'Ambrosio L, Migliori GB. New drugs and perspectives for new anti-tuberculosis regimens. *Pulmonology.* 2018;24(2):86-98. <https://doi.org/10.1016/j.rppnen.2017.10.009>
 34. Garcia-Basteiro AL, DiNardo A, Saavedra B, Silva DR, Palmero D, Gegia M, et al. Point of care diagnostics for tuberculosis. *Pulmonology.* 2018;24(2):73-85. <https://doi.org/10.1016/j.rppnen.2017.12.002>
 35. Silva DR, Sotgiu G, D'Ambrosio L, Pereira GR, Barbosa MS, Dias NJD, et al. Diagnostic performances of the Xpert MTB/RIF in Brazil. *Respir Med.* 2018;134:12-15. <https://doi.org/10.1016/j.rmed.2017.11.012>
 36. Rendon A, Centis R, Zellweger JP, Solovic I, Torres-Duque CA, Robalo Cordeiro C, et al. Migration, TB control and elimination: Whom to screen and treat. *Pulmonology.* 2018;24(2):99-105. <https://doi.org/10.1016/j.rppnen.2017.11.007>
 37. Duarte R, Lönnroth K, Carvalho C, Lima F, Carvalho ACC, Muñoz-Torrico M, et al. Tuberculosis, social determinants and comorbidities (including HIV). *Pulmonology.* 2018;24(2):115-119. <https://doi.org/10.1016/j.rppnen.2017.11.003>
 38. D'Ambrosio L, Bothamley G, Caminero Luna JA, Duarte R, Gugliemetti L, Muñoz Torrico M, et al. Team approach to manage difficult-to-treat TB cases: Experiences in Europe and beyond. *Pulmonology.* 2018;24(2):132-141. <https://doi.org/10.1016/j.rppnen.2017.10.005>
 39. Amicosante M, D'Ambrosio L, Munoz M, Mello FCQ, Tebruegge M, Chegou NN, et al. Current use and acceptability of novel diagnostic tests for active tuberculosis: a worldwide survey. *Bras Pneumol.* 2017;43(5):380-392. <https://doi.org/10.1590/s1806-37562017000000219>
 40. D'Ambrosio L, Centis R, Tiberi S, Tadolini M, Dalcolmo M, Rendon A, et al. Delamanid and bedaquiline to treat multidrug-resistant and extensively drug-resistant tuberculosis in children: a systematic review. *J Thorac Dis.* 2017;9(7):2093-2101. <https://doi.org/10.21037/jtd.2017.06.16>
 41. Borisov SE, Dheda K, Enwerem M, Romero Leyet R, D'Ambrosio L, Centis R, et al. Effectiveness and safety of bedaquiline-containing regimens in the treatment of MDR- and XDR-TB: a multicentre study. *Eur Respir J.* 2017;49(5). pii: 1700387. <https://doi.org/10.1183/13993003.00387-2017>
 42. Dalcolmo M, Gayoso R, Sotgiu G, D'Ambrosio L, Rocha JL, Borga L, et al. Resistance profile of drugs composing the "shorter" regimen for multidrug-resistant tuberculosis in Brazil, 2000-2015. *Eur Respir J.* 2017;49(4). pii: 1602309. <https://doi.org/10.1183/13993003.02309-2016>
 43. Dalcolmo M, Gayoso R, Sotgiu G, D'Ambrosio L, Rocha JL, Borga L, et al. Effectiveness and safety of clofazimine in multidrug-resistant tuberculosis: a nationwide report from Brazil. *Eur Respir J.* 2017;49(3). pii: 1602445.
 44. Tiberi S, Buchanan R, Caminero JA, Centis R, Arbex MA, Salazar M, et al. The challenge of the new tuberculosis drugs. *Presse Med.* 2017;46(2 Pt 2):e41-e51.
 45. Sotgiu G, Dara M, Centis R, Matteelli A, Solovic I, Gratzou C, et al. Breaking the barriers: Migrants and tuberculosis. *Presse Med.* 2017;46(2 Pt 2):e5-e11. <https://doi.org/10.1016/j.lpm.2017.01.013>
 46. Tiberi S, Carvalho AC, Sulis G, Vaghela D, Rendon A, Mello FC, et al. The curved duet today: Tuberculosis and HIV-coinfection. *Presse Med.* 2017;46(2 Pt 2):e23-e39. <https://doi.org/10.1016/j.lpm.2017.01.017>
 47. Muñoz-Torrico M, Caminero-Luna J, Migliori GB, D'Ambrosio L, Carrillo-Alduenda JL, Villareal-Velarde H, et al. Diabetes is Associated with Severe Adverse Events in Multidrug-Resistant Tuberculosis. *Arch Bronconeumol.* 2017;53(5):245-250. <https://doi.org/10.1016/j.arbr.2016.10.003>
 48. Muñoz-Torrico M, Caminero Luna J, Migliori GB, D'Ambrosio L, Carrillo-Alduenda JL, Villareal-Velarde H, et al. Comparison of bacteriological conversion and treatment outcomes among MDR-TB patients with and without diabetes in Mexico: Preliminary data. *Rev Port Pneumol* (2006). 2017;23(1):27-30.
 49. Tiberi S, Scardigli A, Centis R, D'Ambrosio L, Muñoz-Torrico M, Salazar-Lezama MA, et al. Classifying new anti-tuberculosis drugs: rationale and future perspectives. *Int J Infect Dis.* 2017;56:181-184. <https://doi.org/10.1016/j.ijid.2016.10.026>
 50. Rendon A, Centis R, D'Ambrosio L, Migliori GB. WHO strategies for the management of drug-resistant tuberculosis. *Arch Bronconeumol.* 2017;53(3):95-97. <https://doi.org/10.1016/j.arbres.2016.07.015>
 51. Manga S, Perales R, Rea-o M, D'Ambrosio L, Migliori GB, Amicosante M. Performance of a lateral flow immunochromatography test for the rapid diagnosis of active tuberculosis in a large multicentre study in areas with different clinical settings and tuberculosis exposure levels. *J Thorac Dis.* 2016;8(11):3307-3313. <https://doi.org/10.21037/jtd.2016.11.51>
 52. Rendon A, Tiberi S, Scardigli A, D'Ambrosio L, Centis R, Caminero JA, et al. Classification of drugs to treat multidrug-resistant tuberculosis (MDR-TB): evidence and perspectives. *J Thorac Dis.* 2016;8(10):2666-2671. <https://doi.org/10.21037/jtd.2016.10.14>
 53. Muñoz-Torrico M, Rendon A, Centis R, D'Ambrosio L, Fuentes Z, Torres-Duque C, et al. Is there a rationale for pulmonary rehabilitation following successful chemotherapy for tuberculosis? *J Bras Pneumol.* 2016;42(5):374-385. <https://doi.org/10.1590/S1806-37562016000000226>
 54. Sotgiu G, Tiberi S, D'Ambrosio L, Centis R, Alffenaar JW, Caminero JA, et al. Faster for less: the new "shorter" regimen for multidrug-resistant tuberculosis. *Eur Respir J.* 2016;48(5):1503-1507. <https://doi.org/10.1183/13993003.01249-2016>
 55. Mitnick CD, White RA, Lu C, Rodriguez CA, Bayona J, Becerra MC, et al. Multidrug-resistant tuberculosis treatment failure detection depends on monitoring interval and microbiological method. *Eur Respir J.* 2016;48(4):1160-1170. <https://doi.org/10.1183/13993003.00462-2016>
 56. Arbex MA, Bonini EH, Kawakame Pirola G, D'Ambrosio L, Centis R, Migliori GB. Effectiveness and safety of imipenem/clavulanate and linezolid to treat multidrug and extensively drug-resistant tuberculosis at a referral hospital in Brazil. *Rev Port Pneumol* (2006). 2016;22(6):337-341. <https://doi.org/10.1016/j.rppnen.2016.06.006>
 57. Tiberi S, Sotgiu G, D'Ambrosio L, Centis R, Abdo Arbex M, Alarcon Arrascaue E, et al. Comparison of effectiveness and safety of imipenem/clavulanate- versus meropenem/clavulanate-containing regimens in the treatment of MDR- and XDR-TB. *Eur Respir J.* 2016;47(6):1758-66. <https://doi.org/10.1183/13993003.00214-2016>
 58. Tiberi S, Payen MC, Sotgiu G, D'Ambrosio L, Alarcon Guizado V, Alffenaar JW, et al. Effectiveness and safety of meropenem/clavulanate-containing regimens in the treatment of MDR- and XDR-TB. *Eur Respir J.* 2016;47(4):1235-43. <https://doi.org/10.1183/13993003.02146-2015>
 59. Tiberi S, Sotgiu G, D'Ambrosio L, Centis R, Arbex MA, Alarcon Arrascaue E, et al. Effectiveness and Safety of Imipenem-Clavulanate Added to an Optimized Background Regimen (OBR) Versus OBR Control Regimens in the Treatment of Multidrug-Resistant and Extensively Drug-Resistant Tuberculosis. *Clin Infect Dis.* 2016;62(9):1188-90. <https://doi.org/10.1093/cid/ciw088>
 60. Balboa L, Barrios-Payan J, González-Domínguez E, Lastrucci C, Lugo-Villarino G, Mata-Espinoza D, et al. Diverging biological roles among human monocyte subsets in the context of tuberculosis infection. *Clin Sci (Lond).* 2015;129(4):319-30. <https://doi.org/10.1042/CS20150021>
 61. Bini EI, D'Attilio L, Marquina-Castillo B, Mata-Espinoza D, Díaz A, Marquez-Velasco R, et al. The implication of pro-inflammatory cytokines in the impaired production of gonadal androgens by patients with pulmonary tuberculosis. *Tuberculosis (Edinb).* 2015;95(6):701-706. <https://doi.org/10.1016/j.tube.2015.06.002>
 62. Bini EI, Mata Espinoza D, Marquina Castillo B, Barrios Payán J, Colucci D, Cruz AF, et al. The influence of sex steroid hormones in the immunopathology of experimental pulmonary tuberculosis.

- PLoS One. 2014;9(4):e93831. <https://doi.org/10.1371/journal.pone.0093831>
63. Hernández-Pando R, Barrios-Payán J, Mata-Espinosa D, Marquina-Castillo B, Hernández-Ramírez D, Bottasso OA, et al. The Role of High Mobility Group Box 1 Protein (HMGB1) in the Immunopathology of Experimental Pulmonary Tuberculosis. PLoS One. 2015;10(7):e0133200. <https://doi.org/10.1371/journal.pone.0133200>
64. Rodríguez JE, Ramírez AS, Salas LP, Helguera-Repetto C, Gonzalez-Merchand J, Soto CY, et al. Transcription of genes involved in sulfolipid and polyacyltrehalose biosynthesis of Mycobacterium tuberculosis in experimental latent tuberculosis infection. PLoS One. 2013;8(3):e58378. <https://doi.org/10.1371/journal.pone.0058378>