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Access and opportunities for Peruvian women in STEM fields in the Latin American context: A systematic review

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Abstract: This article aimed to describe the authors' main results on the access and opportunities that Peruvian women have in STEM careers in the Latin American context. A systematic review of the literature was developed, complying with the PRISMA Protocol. In addition, the sources in the Scopus and Web of Science databases were filtered and reviewed using Boolean operators and combined descriptors until 24 articles that met the search criteria were found. Fundamental aspects such as Peruvian women scientists, access to scientific careers, their opportunities, and their scientific and academic productivity are presented. The results of the review demonstrated that the situation of university access for Peruvian women compared to women from other Latin American countries has improved in recent years; however, they occupy the last place in the gender opportunity gap, and less than half of women with STEM careers are dedicated to research, minimizing their role within the scientific field. Therefore, it is relevant to conduct research that allows obtaining relevant and in-depth information about the participation of Peruvian and Latin American women scientists and the impact on future generations.

Keywords: *Academic opportunities, Female scientists, Gender gaps, Scientific potential, Training of researchers.*

1. Introduction

According to the United Nations Educational Scientific and Cultural Organization [1] female researchers represent less than 30% Likewise, António Guterres, Secretary-General of the United Nations Organization [2] stated that, although in basic education girls and boys demonstrate equal performance in science and mathematics subjects, Only a minimum of female students will access scientific careers, so it is a challenge to dismantle the gender stereotypes rooted among young people and prevent gender equality in society. Likewise, although they represent half of the world's population, they are underrepresented, causing academic or labor disadvantage, exacerbated in the context of COVID-19 [3-7].

Although in recent decades there has also been an evolution of certain policies and institutional efforts to promote gender equality, influencing to avoid prejudice and trying to reduce the gap in different areas, these are still insufficient for women to be included in science, technology, engineering and mathematics (STEM or STEM) for its acronym in English. et al., 2021).

In 2014, University Law 30220 was enacted in Peru [8] and implemented in 2015. Where the National Superintendence of University Higher Education (Sunedu) was created, whose objective was to supervise the quality of the academic service and to supervise the resources in the public university environment. According to Sánchez and Singh [9] universities are responsible for making the necessary changes and improvements to consolidate the sociocultural and institutional structure, presenting and

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implementing plans and projects that consolidate educational development.

In this context, the Centrum of the Pontifical Catholic University of Peru [10] argued that in the country the gender gap is unfavorable for women, with an average of -12.1% and where 19 of the 26 Peruvian regions have a gap greater than 10%. In addition, Peru ranks last in the general index and in the opportunity dimension, compared to other Latin American countries, and in the aspects of education and health, Peruvians are in 6th place. Likewise, the results of the National Council of Science, Technology and Technological Innovation [11] maintained that 32.9% of students enrolled in careers are related to science, technology, and innovation (STI), and of that percentage, only 29.2% correspond to women; likewise, only 31.9% hold positions as researchers.

These inequalities that are observed in the scientific field are not due to inherited traits, but to the interaction of the girl within the family and educational bosom where learning conditions are not promoted for women in the same conditions as men, this social pressure and cultural role in the graduate of basic education leads her to put aside her vocation and her scientific or technological skills. to choose careers related to the areas of health and education, where there are greater opportunities for acceptance [12-17].

In addition, in recent years it has become evident that gender gaps persist both in scientific research centers and in scientific journals. In this regard, Barrutia, et al. [13] stated that for the international scientific community, it is necessary to publish articles in indexed scientific journals to obtain recognition as a researcher and that is where it is observed that most publications belong to male authors.

Due to the relevance of the topic, it is considered appropriate to conduct research from various sources on the problem of the entry and development of Peruvian women in the fields of science, technology, engineering, and mathematics (STEM). Therefore, the researchers posed the following question: How do Peruvian women do in terms of access and opportunities in STEM areas in the Latin American context? As it is a relevant topic, a systematic review of the literature was conducted, which is why it was proposed as an objective to describe the main results of the authors on the access and opportunities that Peruvian women have in STEM careers in the Latin American context.

2. Methodology

A systematic review of the literature was conducted to provide greater scientific clarity around the research question [18-20]. For the documentation, the guidelines established in the PRISMA statement: Preferred Reporting Items for Systematic Reviews and Meta-Analyses [21] were used regarding the access and opportunities of Peruvian women in STEM areas compared to their Latin American peers.

2.1. Eligibility Criteria

For the inclusion criteria, the following were established: studies in Spanish languages. English and Portuguese; articles from indexed journals were downloaded; the theme of the research on the opportunities that Peruvian women have in accessing scientific careers and the publications made between 2015 and 2024.

In addition, the inferential PICO strategy [22] was taken into consideration. This format included the selection of studies that have as population (P) Peruvian and Latin American university women of STEM careers, for this reason articles on undergraduate and graduate higher education were included, and research related to university women from other careers, and linked to basic education students, were excluded. Regarding the intervention (I), the search focused on studies with results where the various problems in terms of access, lack of opportunities and development of women students of science careers were addressed. For comparison (C), articles were analyzed and included with data to be collated in the national and Latin American context, the date of publication (2015-2024) was also limited for a better understanding of the changes established in the university system in Peru since the implementation of University Law 30220, and finally in the outcome phase (O) articles were found,

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reports, documentary works in Spanish, English and Portuguese, on the opportunities that women have in accessing scientific careers. On the other hand, articles written in languages other than Spanish, English or Portuguese, other documents that were not articles, duplicate results and grey literature were excluded.

2.2. Sources of Information

The main sources were the Scopus and Web of science databases. However, for the literature of methodological support, the research was conducted by the Scielo database and the Google Scholar search engine.

2.3. Search Strategies

The search strategies included keywords found in the Eric and Unesco thesauri. Spanish search descriptors were used with their English equivalents to access all articles in those languages. Subsequently, various combinations were made with the support of logical or Boolean operators (AND, OR, NOT) the syntax combinations used were three: ("gender inequality") AND ("scientific careers"), ("gender inequality") AND ("scientific careers*) AND ("gender inequality") AND (university*) OR (university*) OR (university*) NOT (schoolchildren), (researchers*) AND ("gender inequality") AND (university*) OR (university*) NOT (schoolchildren); ("Gender inequality in science") AND ("Peruvian female researchers") OR (Latin American researchers), ("gender inequality in science") AND ("Peruvian female researchers") OR (Latin American female researchers).

2.4. Selection procedure

To avoid bias in the study, the researchers established and adhered to the following screening and analysis protocol:

It began by developing search criteria, then the review of information in the Scopus databases, Web of Science, was carried out, filtering open access articles, published in indexed journals, also with the dates established from 2015 to 2024, considering the papers that were written in Spanish, English or Portuguese languages, the origin of the journals and study population will be located in Latin American countries, with different kinds of designs. As for the literature for the methodological support, the Scielo database and the Google Scholar search engine were consulted. All the processes were controlled by means of the available filters. Subsequently, the selected articles were downloaded and the titles and abstract of each one was read, verifying that they come from journals indexed in the Scopus and Web of science databases, with the theme of access and opportunities that Peruvian and Latin American women have in STEM areas and with studies where the Latin American context is considered. Assorted designs and approaches, both quantitative and qualitative, were included to have a broad view of the trends offered by systematic review research [23, 24].

In addition, with the selection of these articles, the researchers proceeded to examine each one completely and organized the information obtained in an excel table where the data of the author, title, doi, abstract, type of study, keywords, name of the journal, country of origin, impact of the journal were included. Subsequently, the paragraphs of the article were written, following the format: Introduction, Methodology, Results and Discussion (IMRD) the researchers' reviewed aspects of the scientific literature, following the format of the APA standards and with the due percentage of similarity, finally, the results of the selected studies were saved in a shared folder in the cloud.

As for the quantitative analysis, the bibliometric record was conducted with dynamic tables in excel and for data segmentation. Finally, and for the qualitative approach, the categories were established according to the patterns observed in the analyzed articles.

3. Results

Data collection was observed, and 519 results were initially obtained. From that moment on, the process of sifting the documents begins, which can be seen in Figure 1.

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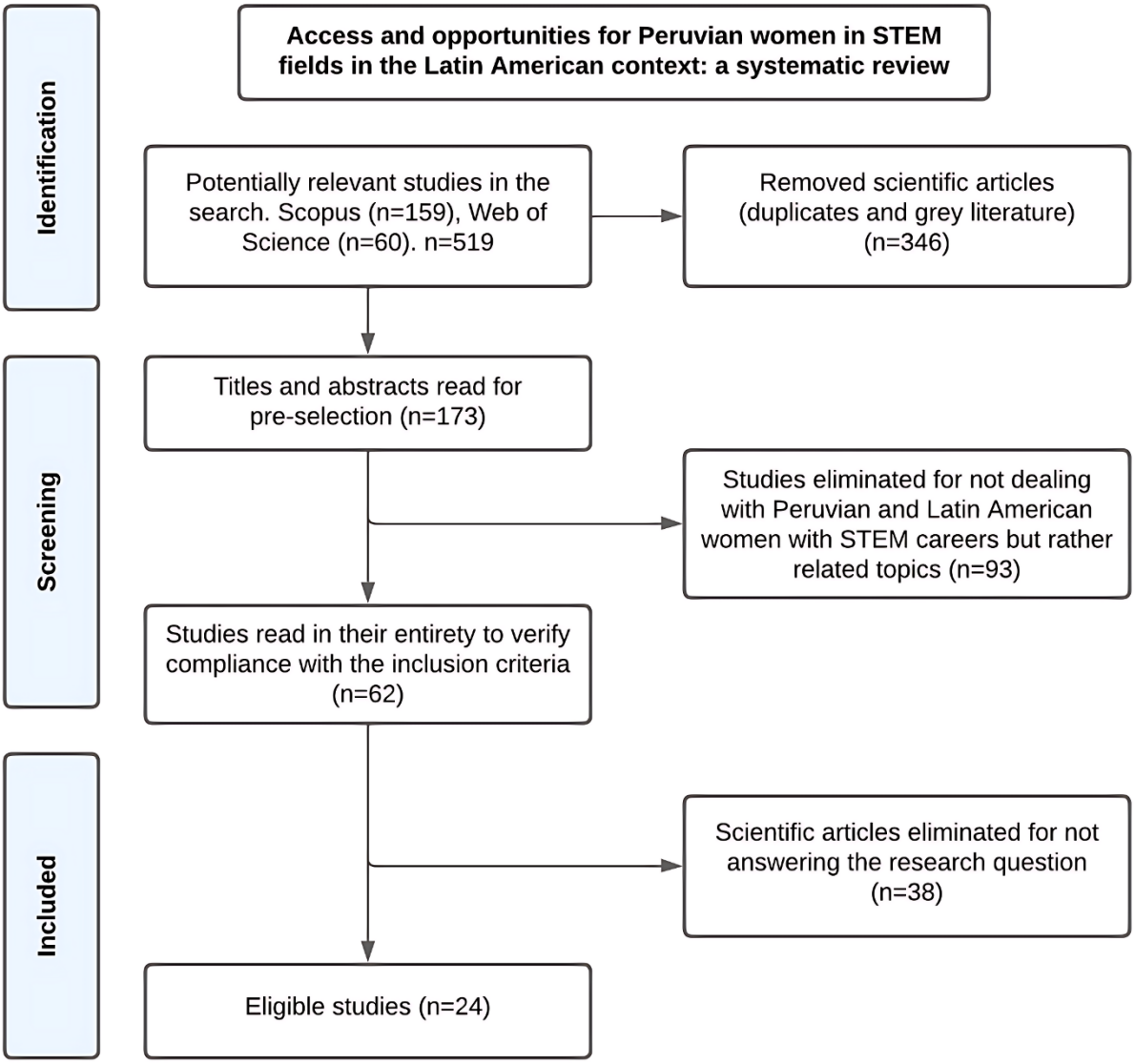

Figure 1.
Document screening process.
Source: Adapted from PRISMA [21].

24 articles were selected, and the quantitative analysis necessary to have a broader vision and to be able to have bibliometric information of interest continued. Next, the contents of each article were analyzed with respect to the topic developed.

3.1. Bibliometric Characteristics

Table 1 shows that the abstracts of the articles of interest were analyzed and then classified according to the dates of publication (2015-2024) and the language of the source, recognizing the trend. Most of the articles published in the Spanish language from 2019 to 2023 and in second place in English, from 2018 to 2024, finally in Portuguese from 2015 to 2021.

Table 1.
Distribution of the languages of the reviewed articles.

Year	Spanish	English	Portuguese	Total
2015			1	1
2016				0
2018		1		1
2019	2			2
2020	1	1	1	3
2021	4	1	1	6
2022	3	1		4
2023	4	2		6
2024		1		1
Total	15	7	3	24

Likewise, from the analysis carried out of the 24 articles, table 2 verifies the countries of origin of the articles, for the study research that included Latin American countries was considered, with Peru being the country where the greatest research on the subject was evidenced, later, Colombia, then Brazil, Chile and Mexico, finally Costa Rica and Ecuador.

Table 2.
Countries of origin of published articles.

Year	Peru	Brazil	Chile	Colombia	Mexico	Costa Rica	Ecuador	Total
2015		1						1
2016								0
2018	1							1
2019	1		1					2
2020	1							1
2021	1	2	1	2				6
2022	1	1		1	1		1	5
2023	1		2	2	1	1		7
2024					1			1
Total	6	4	4	5	4	1	1	24

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Table 3.
Journals consulted with publications on gender gaps (2016-2023).

Year	Brazilian Notebooks of Occupational Therapy	Biblios	Countertext	Soil Science	Culture & History Digital Journal	Medical Education	Front. Aging Neurosci	International journal of science education	Neotropical Entomology	Educational Thinking	Plos One	CES Law Magazine	Colombian Journal of Social Sciences	Colombian Journal of Education	Journal of Social Sciences	Journal of Latino Studies Journal of Latin American Studies	Interuniversity Electronic Journal of Teacher Training	Peruvian Journal of Health Sciences	JournalofSocial Sciences	World Development	Total
2015																			1		1
2016																					0
2017																					0
2018																				1	1
2019		1								1											2
2020						1															1
2021	1		1						1		1			1	1				1		7
2022												1					1	1			3
2023			1	1	1		1			1	1		1			1					8
2024								1													1
Total	1	1	2	1	1	1	1	1		2	2		1	1	1	1	1	1	2	1	24

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With regard to the sources consulted, Table 3 classified the various journals analyzed, with Contratexto, Pensamiento Educativo, PLoSONE and Revista de Ciências Sociais having the most articles of scientific literature that addressed the subject of study, opportunities and gender gap in the areas of science, and subsequently publications on the subject in the other journals are evidenced.

Finally, Table 4 shows the methodology used by the researchers in each article consulted, as can be seen that most of them were systemic reviews, then descriptive studies, then bibliometric and phenomenological studies, and finally quasi-experimental design, case studies and documentary reviews.

Table 4.
Methodologies used by researchers.

Year	Quasi-experimental design	Bibliometric study	Case Studies	Descriptive Study	Phenomenological	Document review	Systematic Review	Total
2016					1			1
2017								0
2018				1		1		2
2019							3	3
2020		1					2	3
2021				2	1		1	4
2022	1	1					2	4
2023		1	1	3	1		1	7
Total	1	3	1	6	3	1	9	24

3.2. Terminology and Regulatory Frameworks

As a result of the analysis of the sources on the issue of access and opportunities for Peruvian women for their development in the areas of science, technology, engineering and STEM mathematics in Latin America, three main aspects are presented: First, they correspond to the role of women scientists with social pressure and opportunities, secondly, access to scientific careers and their training, and academic productivity.

3.2.1. Woman Scientist

For Reinking and Martin (2018), the gender gap and the low representation of women in science can be justified through three theories: (a) socialization based on gender stereotypes, which creates inequality, where it is argued that men dominate and women submit, the family and the school reaffirm this idea, (b) referring to peer groups, where the influence of peers affects social behaviors and academic motivation and success (Van Hoorn et al., 2016) and (c) finally, the stereotypes of male professionals in STEM careers, known as introverts and isolated disseminated by the media, which differs from the behavior of most women who are more sociable.

Likewise, even in the 21st century it is observed that the lack of access to information and communication technologies in schools among adolescent students is not egalitarian, so the dialogue on gender inequality in science continues [25].

In addition, in Latin American universities, only 30% of women specialize in science, technology, engineering, and mathematics (STEM) and approximately only 25% of authors of research articles are women [26, 27]. Thus, in Mexico, only 31% of enrolled students are women [28]; in Colombia, 26% of engineering students are women [29]. The report of the Organization of Ibero-American States for Education Science and Culture [30] can support this where it is evident that less than 50% of women with STEM careers in Chile, Mexico and Peru are dedicated to research. However, in countries such as

Cuba, Argentina, Paraguay and Uruguay, women already exceed half of the people dedicated to research; the report also indicates these important advances in scientific parity (Figure 2).

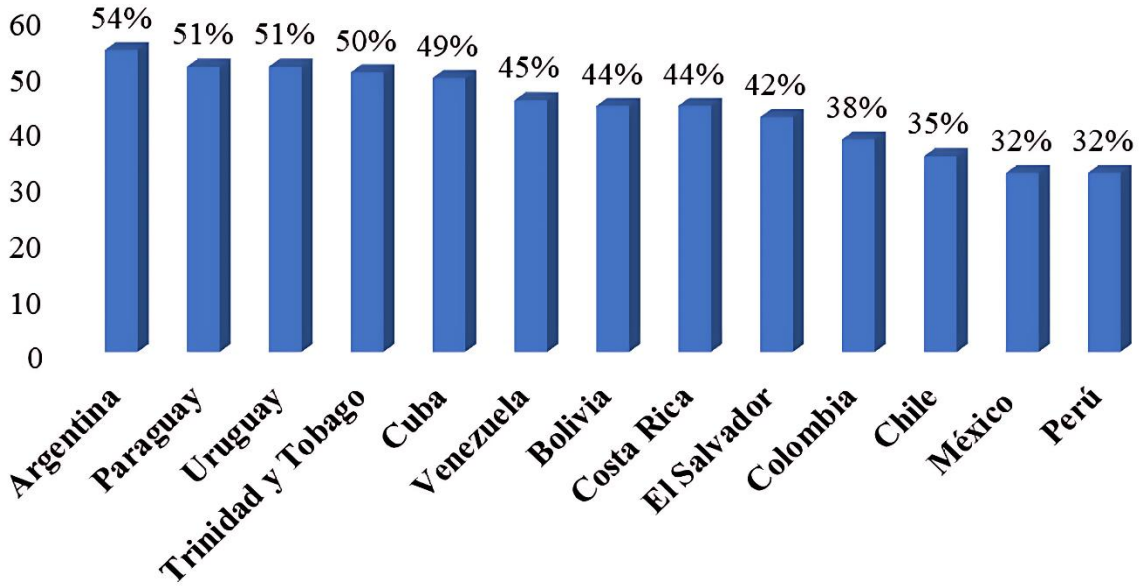

Figure 2.
Women researchers and/or fellows.
Source: Adapted from the report of the Organization of Ibero-American States for education, science and culture (OEI, 2023).

3.2.2. Access to Scientific Careers

At the end of the twentieth century, the entry of women into Latin American university environments became massive, but equal participation between women and men has not yet been achieved [31, 32]. In countries such as India, Peru and Vietnam, access to higher education is a function of gender disparity and socioeconomic aspects, and the average age of entry is 19 years old. At university, students can develop their training by conducting research, learning content from their programs and curricula [9, 33].

In the report of the International Institute for Higher Education in Latin America and the Caribbean [34] it stated that in recent years transcendental changes have arisen in the gender aspects of access for students, their teaching staff, and their government. Therefore, in Latin America, women represent 41% of students, 46% of teachers and 18% of their rectors. However, according to the [30] Chile obtained 52.8% of female entrants who access higher education careers, followed by Peru with 44.5%; while Honduras remains at the bottom of the list with only 17% of the female population eligible to enter (Figure 3).

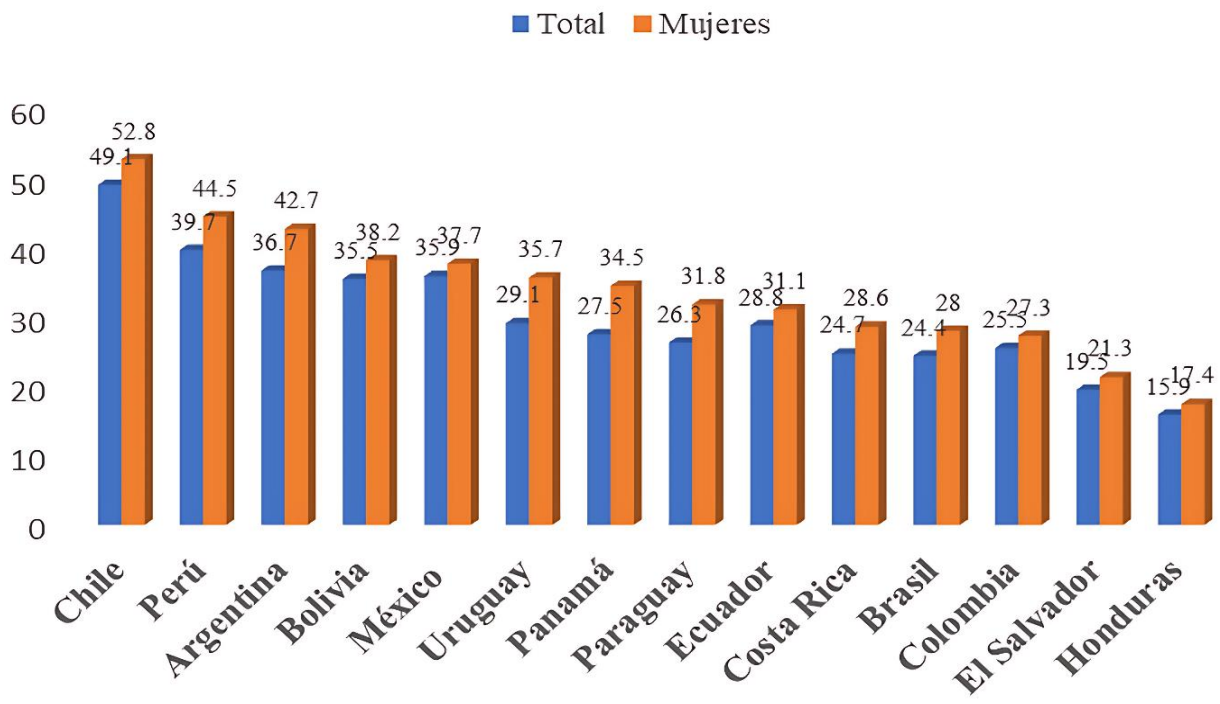

Figure 3.
Women's attendance at STEM university careers in 2020.
Source: Adapted from the Organization of Ibero-American States for Education Science and Culture [30].

This is reflected in the rise in admission to Peruvian universities, which have experienced a sustained process of admission of women: in 1980 female enrollment constituted 34.5% of students and by 1996 46%, by 2010 this was 49%, reaching almost 51% in 2017 [35]. Since 2015, university law 30220 has been implemented, which could be an important instrument for improving the gender gap situation and enhancing the quality of the Peruvian university service [36]. In this sense, in the decade 2008-2018, enrollment doubled, resulting in an average annual growth rate of 7.9% (Figure 4).

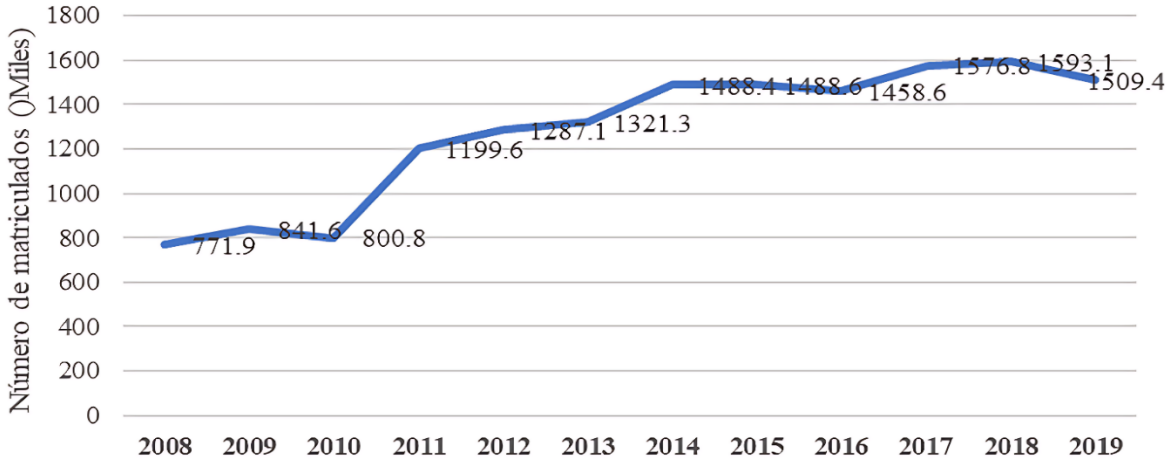

Figure 4.
Evolution of university enrolment (2008-2019).
Source: Adapted from the National Superintendence of University Higher Education Sunedu [35].

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In most Latin American countries, there is a gender disparity in the areas of Engineering and Technology, with male students and, on the other hand, most women are in the areas of Medical Sciences and Health. Likewise, the gap in the areas of Agricultural Sciences and Humanities is around 10 and 4 percentage points [35]. In addition, in the first cycles there is a higher proportion of women in STEM careers, which decreases in the higher stages [37, 38].

Women linked to research are relegated and underrepresented in the field of science, so it is necessary to promote compliance with policies and legislation in various scientific contexts, such as the 2030 Agenda whose Sustainable Development Goals (SDGs) focus on achieving gender equality and empowering women. It is quite common in Latin American countries to have difficulties due to low investment in scientific development, political instability, and patriarchal sociocultural norms, which only increase the gender gap [23, 39, 40].

Although the political agendas of Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, the Dominican Republic, Ecuador, El Salvador, Guatemala, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela have incorporated the issue of gender equality in STI from eight dimensions to promote transformations focused on achieving justice and manifesting the political decision of governments to address the persistent issue of gender equality in STEM, this is not reflected in the current context [41].

The publication of these legislations and the campaigns aimed at helping to raise awareness of the need for gender equality, where prejudices are no longer manifested, gender-sensitive educational policies are promoted to empower women in scientific careers [42]. The inequality of women in the scientific world generates and underrepresents, harming their scientific and technological development. Therefore, it is up to the governors, authorities, and directors of higher education institutions to propose careers free of prejudices that demystify the idea based on gender differences [5, 9, 13, 14, 43, 44].

3.2.3. Scientific Production

It has been evidenced that the elites of male scientists have achieved multiple publications and academic recognitions and are disproportionately represented in scientific fields, they maintain that women should prepare more to possess knowledge of their profession, avoiding discrimination, harassment and responsibilities such as motherhood, in their university stage as professional life, which decreases the presence of women in senior positions since they occupy only 26% of jobs in STEM careers, however; the quality and impact of their published articles are similar to their peers [13, 27, 39, 43, 45-50].

However, despite this discouraging panorama, Buenestado-Fernández, et al. [51] argued that there was a significant increase in the number of women in scientific publication and the positions within the groups of authors. In this sense, Perdomo [52] conducted research on 441 articles published in Scopus between 2020 and 2022 where he reported that 54% of authors are men and 46% women, stating that men had a greater presence as authors of individual articles, while women stand out in those of multiple authorship. Likewise, in the 0EI CTS report (2018) between 2014 and 2017, the countries with the lowest publication of women were Chile, Peru, Costa Rica, and Mexico. For this reason, 3,747 publications were produced in Peru, while after the University Law (2015-2019), production was improved with 6,590 scientific articles [35] (Figure 5).

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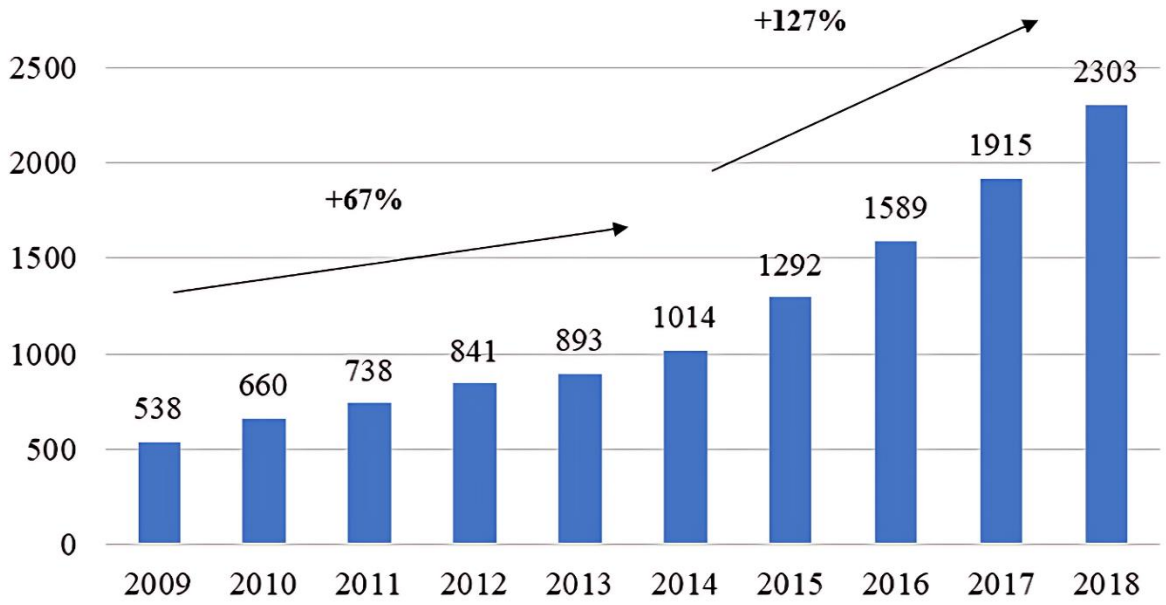

Figure 5.
Increase in research in Peruvian universities (2009-2018).
Source: Adapted from the report of the National Superintendence of University Higher Education Sunedu [35].

In addition, in the OEI report (2023) of Ibero-American scientific publications, 45% had women, being the nursing career that has the highest number of publications, while the percentage decreases in the so-called STEM careers. In this sense, women who study science careers, both at the university and postdoctoral level, are aware of gender imbalance, but make efforts to position themselves, combating prejudices and obsolete stereotypes and, on the contrary, demonstrating that their participation in the various scientific areas is important [51, 53-55].

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Table 4.
Analysis of the main contributions.

Authors	Contributions declared by the authors.
I. Gender equity	
Moschkovich and Almeida [3]	The social responsibilities imposed on women, discrimination and the burden in the workplace are the reasons why women are disadvantaged.
Reyes and Álvarez [46]	A fair change in university policy with gender equality would increase women's access to scientific fields and would imply working to eliminate violence in gender relations.
Salgado and Minotre [6]	The organized opposition to advances in gender equality and women's rights is clear, the objective is to weaken, fragment and discredit people, feminist movements, programs, and institutions that defend them.
Hipólito, et al. [27]	Women being half of the world's population, they are still underrepresented and have difficulty accessing the scientific sectors in most societies.
I. Access to a scientific career	
Sánchez and Singh [9]	In countries such as India, Peru and Vietnam, access focuses on gender and the socioeconomic and educational characteristics of parents.
Landaeta [14]	While women choose careers related to the areas of health and education, men choose those related to technology and basic sciences.
Ruiz-Ruiz, et al. [15]	In the family and educational environment of Peruvian women scientists, performance expectations for access and personal characteristics are very demanding, which are not required of all men.
Posso, et al. [17]	Deficiencies in the learning conditions of female students can affect their academic performance and subsequent professional success.
Cardona [33]	It is urgent to reevaluate the profiles of the professions to support them in the competencies and qualities that people must acquire from education as an engine for equitable development.
Ángel, et al. [40]	Women face limited opportunities for professional fulfilment in scientific disciplines.
Manzano-Sánchez [16]	The choice of a career is not related to personal abilities or skills, but to patriarchal social perceptions, gender-based discriminations.
Pacheco-Ladrón, et al. [50]	Female leadership is valued according to the characteristics assigned to women: lack of authority, submission, valuation of the body and not of talent and others, further developing gender discrimination.
II. Scientific opportunities	
Valério, et al. [56]	In the last ten years, black feminism has been strengthening and advancing in Brazil, which has led black intellectuals to occupy positions of social and academic prestige.
Ruiz-Ruiz, et al. [15]	Teachers recognize and value the abilities and competencies of their female students, as well as the development of traits that should place them in the labor market
Arroyo-Hernández [43]	It is important to continue researching to identify gender disparities in the areas of scientific work that women might encounter when starting or pursuing a scientific career in Peru.
Fittipaldi, et al. [44]	Pursuing an academic career in all disciplines remains a challenge for women, and progress in reducing gender inequality in science is still insufficient.
Zepeda Pérez and Villagómez [39]	In practice, the opportunities that women have in accessing scientific careers are still limited and unequal for their professional fulfillment
III. Scientific production	
Centeno-Leguía, et al. [54]	Peruvian medical students have managed to study, complete, and practice their profession, demonstrating that their dedication and efficiency are just like their male peers.
Barrutia, et al. [13]	To be recognized as a researcher within the international scientific community, one must have an extensive list of articles in scientific publications available in journals indexed in international databases.
Salerno, et al. [55]	Mixed teams of researchers can generate much more effective, innovative, impactful, and productive studies, avoiding the threats of stereotypes.
Hipólito, et al. [27]	Female researchers are no less productive than male researchers, as the relative numbers showed a similar number of publications and citations.
Arroyo-Hernández [43]	There is gender disparity in key areas for scientific research in Peru, such as research centers and publications in scientific journals
Perdomo [52]	The almost equal presence of female and male authors allows us to speak of a slight gender gap, in favour of the latter, in scientific production in the field of communications.
In Araneda-Guirriman, et al. [48]	Under current conditions, women experience structural inequality in academia, research, and scientific productivity; Therefore, equating men in the performance of these metrics only

	means intensifying efforts on their part

4. Discussion and Conclusions

Several factors were identified to take into consideration, firstly, although most of the journals have been Peruvian (6), these publications are insufficient to address the problem of access, opportunities and production of women in STEM scientific careers, this coincides with the findings of several Latin American and Peruvian researchers, who argued that it is necessary to continue conducting research to identify gender gaps in the scientific work observing the limitations that university women could encounter to start or continue with a scientific career and subsequent job of Peruvian and Latin American women [13, 39, 43, 54, 57].

Likewise, it can be stated that the origin of gender inequalities in science is not to be found in the innate biology of the human being and is not associated with gender; rather, it is rooted in cultural and social beliefs, especially in school and the family where women are minimized [7, 12]. In addition, these social constructs have greater weight in the conception of women themselves and in their role within the scientific field. It continues during the development of the scientific career chosen both at university and in the workplace, where there are several obstacles such as: mistreatment, discrimination, harassment, underrepresentation, biases in their publications, limitations in accessing management positions and wage inequality [5, 12, 39, 43, 51].

It is important to mention that the limiting factors in this study were the few scientific studies regarding the access of Latin American women who come from rural areas, also on the academic productivity of women with STEM careers in Peru and Latin America, which would allow a clearer and more precise vision of the problems of this research. since, according to the results obtained in the reported articles, women scientists are victims of discrimination in access and opportunities and biases in their participation [13, 52, 54].

In conclusion, according to the scientific literature analyzed, it can be argued that in recent decades Peruvian women in STEM careers have improved in terms of access to university, ranking second with 44.5% of enrollment in the Latin American context. However, the gender gap persists because in the opportunity dimension they are in a painful last place. About scientific production, it has doubled in the last ten years, but despite this improvement, less than 50% are dedicated to research and the publication of scientific articles compared to women scientists in other Latin American countries. It can also be said that the Peruvian and Latin American articles published on the access, opportunities and production of women in STEM scientific careers have been insufficient, which is why it is necessary to generate more research, to obtain relevant and in-depth information on the participation of women scientists and its impact on future generations.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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