RESEARCH ARTICLE

Factors associated with producing a scientific publication during medical training: evidence from a cross-sectional study of 40 medical schools surveyed in Latin America

[version 1; peer review: 1 approved]

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⁶Facultad de Medicina, Universidad Ricardo Palma, Lima, Peru

Abstract

**Background:** Scientific publication during medical training is key to promote enduring cutting-edge knowledge. The promotion of science among medical students in Latin America is a multi-sphere issue hampered by the unawareness of governments to invest in national research, as well as a lack of support from local universities. This study aims to determine the factors associated with producing a scientific publication during medical training among Latin American medical students of local scientific societies.

**Methods:** This is a secondary data analysis of a cross-sectional study initially conducted in 2016 to evaluate the use of information and communications technologies (TICs) among medical students of 40 local scientific societies of medical students affiliated to the Latin American Federation of Medical Students Scientific Societies (FELSOCEM, in Spanish). Teams in each local scientific society surveyed self-reported scientific publications and explored its association with socioeconomic, academic, and research training conditions. We included medical students enrolled in the 2016-I term and excluded medical interns. We implemented nested models to identify covariates associated with self-reported scientific publication until reaching a parsimonious mixed-effect multilevel model clustered by medical scientific society.

**Results:** We surveyed 11,587 medical students. The prevalence of
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Author roles: Valladares-Garrido MJ: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing; Mejia CR: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Rojas-Alvarado AB: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Araujo-Chumacero MM: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Córdova-Agurto JS: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Fiestas J: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Rojas-Vilar FJ: Conceptualization, Data Curation, Investigation, Methodology, Validation, Writing – Original Draft Preparation, Writing – Review & Editing; Culquichicón C: Conceptualization, Data Curation, Formal Analysis, Funding Acquisition, Investigation, Methodology, Project Administration, Supervision, Writing – Original Draft Preparation, Writing – Review & Editing

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Introduction

Producing a scientific publication during medical training is key to promote the constant medical training and to encourage students to create cutting-edge knowledge; in this way, students will build-up research skills and critical thinking, and conduct evidence-based practice and patient-centered care with an endured vision to follow a scientific career. Latin American universities are progressively recognizing the critical importance of fostering science in the early onset of undergraduate, and are implementing research-oriented courses such as research design methods, biostatistics, epidemiology, and a final research-centered thesis. However, there are still gaps in Latin America when comparing to research university systems from developed countries in terms of the number of publications, the quality of articles published, the outreach of the studies, and funding opportunities. Studies in Colombia and Brazil show that medical students consider scientific research as an important issue of their training and the low scientific production is influenced by the lack of inspirational and committed mentors as role models for the beginning of a scientific career. Between 1997 and 2010, there was an increase of 8.4% in student participation in manuscripts published on journals indexed in Scielo-Peru, of whom 42% reported being affiliated to a scientific society of medical students.

In Peru, the progress of research in medical undergraduate has been strongly promoted by the Peruvian Scientific Society of Medical Students (SOCIMEP, by its acronym in Spanish), an organization that has been improving the research training of medical students for 27 years. SOCIMEP stands scientific and academic committees in their central and 38 local scientific societies throughout local medical schools of Peru, and held international, national, and local scientific conferences. The SOCIMEP also foster societies to actively participate and integrate them into a nation-wide research network, and provide connections with experienced research mentors. Being affiliated to the SOCIMEP’s local scientific society is associated with increased scientific production (PR: 2.41; 95% CI: 1.55-3.74). However, only 10% of the projects conducted in local scientific societies are published in indexed journals due to deficient methods implemented in the studies, lack of knowledge about editorial processes, few local mentors and a lack of financial support from public agencies and institutions. The funding opportunities for medical students are poor in the local medical schools of Peru and in much of Latin America; overall government investment is disproportionately granted to attend medical schools of Peru and in much of Latin America; overall government investment is disproportionately granted to attend medical schools of Peru and in much of Latin America; overall government investment is disproportionately granted to attend medical schools of Peru and in much of Latin America; overall government investment is disproportionately granted to attend medical schools of Peru and in much of Latin America; overall government investment is disproportionately granted to attend medical schools of Peru and in much of Latin America.

Methods

Study design

This is a secondary data analysis of a cross-sectional study initially conducted in 2016 to evaluate the use of information and communications technologies (TICs) in medical students along Latin America. This study evaluated 40 scientific societies of medical students from Latin America. We primarily evaluated the self-report of scientific publications and used the following variables to explore its associated factors: gender, age, university, current year of career, affiliated to a scientific medical student society, English proficiency, studied previous career, courses in scientific databases including PubMed, Scopus and Scielo, courses in scientific writing skills, courses in scientific browsing, courses in Zotero, use of Sci-Hub, access and provider of pirated academic accounts.

Population and sampling

The primary study surveyed 11,587 students from 40 medical schools, including two from Ecuador, two from Panama, four from Paraguay, three from Bolivia, 18 from Peru, two from Mexico, two from Venezuela, one from Honduras, three from Colombia, one from Chile, and two from Argentina. This study included medical students enrolled in the term 2016-I and excluded who were doing the internship.

We made a stratified sampling using the academic year in the medical school as a stratum. The estimated sample size for each investigation site was 289 medical students, we also added 10% to anticipate withdraws. Thus, we aimed to survey 318 medical students in each university. We consider a sample size calculation with an 80% of power, and 5% of significance for an infinite sample size. Regarding participant selection, the interviewer team entered the course with greatest credits in each academic year and picked the students who were sat in an odd numbered location per row. In three universities, the sample size was not enough large to reach the minimum required, so we conducted a census-type sampling.

Operational procedures

In 2015, the ICTs project was awarded on the category of multi-center projects by the XXX International Congress of the Latin American Federation of Medical Students Scientific Societies (FELSOCEM, by its acronym in Spanish). This award let connect the researchers within the FELSOCEM’s international collaboration network and carry out the study. We could enroll teams from 40 out of 69 Scientific Medical Students Society (SOCEMs, by its acronym in Spanish) along Latin American. Each scientific society had at least one team with three medical students who were trained on scientific integrity, standardized methods for survey participants, data entry procedures, and quality control of datasets.
In each medical school, every team of interviewers surveyed at the beginning or the end of the lectures, prioritizing that the students had long time enough for their convenience. The surveys were self-reported and last approximately 15 minutes per participant. An English translation of the survey is available as Extended data7.

Measures
We analysed the self-reported manuscript publication as a binary outcome. Multinomial variables included gender, age, current year of career, English proficiency, courses in PubMed, courses in Scopus, courses in Scielo and provider of pirated academic accounts. Binary variables included university, affiliation to a Scientific Medical Student Society, studied previous career, courses in scientific data bases, courses in scientific writing, courses in scientific browsing, courses in Zotero, use of Sci-hub, use of pirated academic accounts. All of these variables were assessed with a self-administered survey.

Data analysis
We evaluated the association between self-reported manuscript publication and its covariates using chi-squared tests for categorical variables and Mann-Whitney U-test for numerical variables. Poisson family regressions were performed using a log link function and mixed effects multilevel models. We estimated nested models following a manual forward selection method to identify covariates associated with self-reported manuscript publication until reaching a parsimonious multivariable model. These covariates were selected using likelihood ratio tests. Crude and adjusted prevalence ratios (PR) were estimated with 95% confidence intervals (CI 95%). All hypotheses were contrasted using 5% significance. The analysis was performed using Stata 15.1, and the analysis code is openly available on GitHub and Zenodo.

Ethical considerations
This study was classified as minimal risk for participants by the San Bartolome Hospital’s Institutional Review Board (CIE15325-15) and issued its approval. Trained interviewers verbally consent participants, provided them an anonymized self-administered survey. Also, each survey was assigned a numeric ID to protect the privacy of the participants.

Results
We interviewed 11,587 medical students, of whom the mean age was 21±2.9 years and 53% were female. In total, 22.2% (n=2,575) of medical students were in the first year of career. There were 12.5% (n=1,449) affiliated to a Scientific Medical Student Society and 14.1% (n=1,618) reported advanced English skills. The individual-level responses are available as Underlying data.

A total of 65.1% (n=3,989) had attended a scientific writing course, and 7.9% (n=893) published at least one scientific article during his medical training. There were 22.6% (n=2,514) with a pirated academic account, and from a total of 6,632 medical students, 19.2% (n=1,273) used Sci-Hub at a certain point of their careers (Table 1).

There were differences on the prevalence of scientific publications among first-year and last-year medical students (13% vs 4.3%, respectively), being affiliated to a Scientific Medical Student Society (12.43% vs 7.24%), the advanced and elementary proficiency of English (11.2% vs 6.4%), took a scientific writing course (14.6% vs 4.3%), use Sci-Hub (19.3% vs 4.7%) and having pirated academic accounts (15.3% vs 5.5%) (Table 2).

The nested models progressively selected the following covariates: courses in scientific writing, pirated academic accounts, universities, courses in Zotero, courses in scientific databases, year of study, previous career, English proficiency, and affiliation to a scientific medical student society. The prevalence of having a scientific publication were 36% (PRp=1.36, 95% CI=1.16–1.59, p<0.001) higher if a medical student was affiliated to a Scientific Medical Student Society, 51% (PRp=1.51, 95% CI=1.21–1.87, p<0.001) higher among the medical students with advanced English proficiency, 85% (PRp=1.85, 95% CI=1.59–2.15, p<0.001) higher in medical students who took a scientific writing course, 81% (PRp=1.81, 95% CI=1.50–2.20, p<0.001) higher in medical students who used Sci-Hub, and 108% (PRp=2.08, 95% CI=1.83–2.36, p<0.001) higher among medical students who have a pirated academic account (Table 3). The information about medical schools in Latin America is available as Extended data.

Discussion
Pirated academic accounts and use of Sci-Hub
The use of Sci-Hub was reported by 19.2% (n=1,273) of the students surveyed, of whom 19.3% (n=243) published a manuscript during their medical training. The awareness and use of Sci-Hub may be due to the high need to access top-level scientific evidence behind a paywall. However, medical students have reported difficulties to access Sci-Hub because it is considered an illegal service in many regions, meaning the web domain is often blocked.

The use of Sci-Hub was associated with higher prevalence of scientific publications among medical students (PR: 1.81; CI95%: 1.50–2.20). Students feel the great need to obtain access to payed articles, leading them to seek free access throughout Sci-Hub. However, even those students who do not face a paywall, found using Sci-Hub reduced the time and increased simplicity of browsing. In addition, many researchers and students identify Sci-Hub as a faster option that is not limited to their institution’s catalogue. This is likely homogeneous between high- and low-income countries worldwide. More than 56,000 article downloads via Sci-Hub came from different east coast cities of the United States, especially from cities where large universities have subscriptions to different publishers.

The use of pirated academic accounts was associated with higher prevalence of scientific publications (PR: 2.08; CI95%: 1.83–2.36). The institutional licenses let access to journals, books, or specialized databases such as Scopus or Web of Science. These paid services are funded by government institutions in low- or middle-income countries (LMIC); however,
Table 1. Characteristics of medical students from 40 schools of medicine in Latin America.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>N=11,587</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
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<tr>
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<td>885</td>
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<td>Courses in scientific databases</td>
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Characteristics | N=11,587 | n  | %  |
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</table>

* Mean ± standard deviation.

These are not widely distributed or have not been implemented in LMIC. Alternatives such as HINARI allow access to paid articles in LMIC, and is available to the academic and research community only from certified institutions who achieved certain milestones defined by local science systems. All this complex context leads users to exchange, loan or acquire access accounts or proxy links to journal catalogs of institutions by non-legal terms.

Courses in scientific writing
A total of 34.9% of students who had produced a scientific publication attended a course in scientific writing skills.
Table 2. Characteristics of medical students among scientific publication from 40 schools of medicine in Latin America.

<table>
<thead>
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<th>P value</th>
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</tr>
<tr>
<td></td>
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<td>%</td>
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<tr>
<td>Gender</td>
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<td>4,823</td>
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<td>Age (years)*&lt;sup&gt;a&lt;/sup&gt;</td>
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<td>Advanced</td>
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<td>Studied previous career</td>
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### Scientific publication

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(1) Poisson’s regression model with robust variance.
(2) Poisson’s regression model with robust variance and multilevel analysis.
* Multiple regression parsimonious model was independently adjusted by each variable below.

Abbreviations: PRc, Crude prevalence ratio; PRp, Parsimonious model prevalence ratio; PRa, adjusted parsimonious' prevalence ratio.

Attending a scientific writing skills course increased the prevalence of scientific publications by 85% (PRp=1.85, 95%CI=1.59–2.15, p<0.001). This is likely because of the great need of medical students to improve their skills to effectively communicate scientific findings, make a relevant academic reflection, and enhance the chances of acceptance into a scientific journal. New medical students in research training are eager to be trained in scientific writing skills and seek an experienced mentor to train them. In addition, medical students actively seek for courses of scientific writing and communication, for instance, the Brazilian DivulgaMicro initiative was a course funded by the Fundação de Amparo a Pesquisa do Estado de São Paulo (FAPESP, by its acronym in Portuguese) to train early career researchers to translate complex scientific messages to understandable pieces of information to community members. At 30 days after launch, the website registered 1,026 users from different regions worldwide, including Latin American, United Kingdom, Pakistan, Germany and Canada. This was one of the most visited free and open scientific communication workshops, which trained over 600 novel medical student researchers.

### English proficiency

An advanced English proficiency was reported in 14.1% of the students, of whom 11.2% published a scientific manuscript during medical training. In addition, the prevalence of scientific publications increased by 51% among students with advanced English proficiency (PRp=1.51, 95%CI=1.21–1.87, p<0.001). Students are encouraged to understand a scientific publication comparing to non-English natives. Medical students from second to sixth year who attended an English scientific writing skills training reported 53% of them perceived that they were not proficient enough at English to publish a manuscript in English-language journals.

The association between scientific publications and advanced English proficiency could be likely because of students’ desire to pursue an academic training abroad offered by institutions requiring academic excellence and a great potential. In 2016, the Peruvian Program of Educational Grants and Credits (PRONA-BEC, by its acronym in Spanish) jointly funded the Fulbright, FONDECYT, and Chevening scholarships in Peru which benefited 14, 6, and 15 Peruvian graduate applicants, respectively. In this way, the scholars could be trained by outstanding foreign universities producing a generation of researchers with masters and doctoral degrees who upon returning to their home countries seek to improve the science and technology system. During 2004–2012, the Fogarty International Clinical Research Fellows Program funded promising initiatives of highly competitive English-dominant students from LMIC whose scientific discoveries can address long-term global health needs. This approach has become Fogarty’s hallmark: bringing great science to solve local problem of global outreach and building local research capacities. During 2014–2015, Fogarty has contributed substantially to the training of more than 6,100 global health leaders, 140 of whom have earned doctorates in epidemiology and 96 in public health.

The Fogarty International Center builds a bridge between the US National Institutes of Health and the global health research community; 85–90% of trained fellows return to LMICs and obtain research positions into academia, government agencies, and institutes. However, young Latin American scholars and...
postdoctoral researchers trained abroad find it difficult because of an unfavourable science system. For instance, the investment of the Peruvian administration to progress in science and research is still insufficient, it is only 0.12% of the gross domestic product compared to 0.36% in Chile, 1.3% in Brazil and 2.8% in the United States.

Affiliated to a scientific medical student society

Our findings showed that being affiliated to a medical student scientific society increased the prevalence of scientific publication in 36% (PRP:1.36, CI95%=1.16-1.59, p<0.01). Student scientific societies, such as the Peruvian Medical Student Scientific Society (SOCIMEP, by its acronym in Spanish) tries to fill the gaps of research training and provide students the mentors, courses, and scientific opportunities to pursue a research career.

With over 30 years of operations with local-level scientific societies across Peru, SOCIMEP promotes research events at a regional, national, and local level multidisciplinary university research and service camps (CUMIS, by its acronym in Spanish), the annual scientific conferences, and foundation courses in epidemiology, research design, and biostatistics. The outreach the SOCIMEP achieved overall was reflected in the 242 published articles by scientific societies, of which 11% (n=67) were published in Q1 journals, under the mentorship of highly experienced national researchers.

Limitations

We must understand our findings have limitations, described in the following statements. First, several parameters of the questionnaire were self-reported which may cause an undifferentiated classification of the outcome, and may increase the residual confusion of confounding parameters, indicating potential information bias. However, we tried to control this situation by motivating the students to answer the questionnaire truthfully and not to rush their answers; in this sense, our outcome is consistent with reality. Second, all 40 medical schools were affiliated with FELSOCSEM, indicating potential selection bias, so our findings are useful for these schools and similar studies should be extended to understand local and regional scientific realities from different countries.

Conclusion

Factors associated with producing a publication among medical students during their medical training in Latin America include being affiliated to a local Scientific Society of Medical Students, having an advanced English proficiency, attended a course of scientific writing skills, the use of Sci-Hub, and having pirated accounts. The promotion of science among medical students in Latin America is a multi-sphere issue which needs to be addressed as part of multilevel strategies coming from high government authorities, to empower universities and build-up a committed science system in each nation.

Data availability

Underlying data


This project contains the underlying data in DTA and CSV formats.

Extended data


This project contains an English-language copy of the questionnaire used for data collection.


This project contains a list of the medical schools surveyed for this study.

Analysis code used in this study is available at: https://github.com/culquichic/Scientific_writing.

Archived code at time of publication: https://doi.org/10.5281/zenodo.3730359.

Analysis code license: GNU General Public License v3.0.

Unless otherwise indicated, data are available under the terms of the Creative Commons Attribution 4.0 International license (CC-BY 4.0).

References


5. Machado-Alba J, Machado-Duque M: The Role of Research Incubators in...


This study brings a broad view of the current efforts of local Scientific Societies of Medical Students on promoting research among medical students. The authors found relevant factors associated with producing a scientific manuscript during medical school including the use of pirated academic accounts, training in basic research skills, English proficiency, and ultimately being affiliated to a scientific medical student society. All of these conditions are validated by the faculties of medical schools across Latin America, and are linked between them. The outreach of this study is to give us a sight of factors to continue promoting research capacities among medical students and take advantage of the Medical Students Scientific Society as an ally in this mission.

Is the work clearly and accurately presented and does it cite the current literature?  
Yes

Is the study design appropriate and is the work technically sound?  
Yes

Are sufficient details of methods and analysis provided to allow replication by others?  
Yes

If applicable, is the statistical analysis and its interpretation appropriate?  
Yes

Are all the source data underlying the results available to ensure full reproducibility?  
Yes

Are the conclusions drawn adequately supported by the results?
Yes

**Competing Interests:** No competing interests were disclosed.

**Reviewer Expertise:** Infectious diseases, Health interventions, Systematic Reviews and meta-analysis, Medical education.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

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