Are the greatest professors those who publish the most? Aspects related to scientific research production of professors from Medicine programs at a Peruvian university during the Covid-19 pandemic*

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Abstract

Scientific production is an essential activity in universities, and this may have been compromised by the Covid-19 pandemic. Therefore, it is important to explore the aspects related to scientific research production during the pandemic, such as teaching performance, hours dedicated to research, academic degree, and gender. In this article, this analysis is conducted at a private university in Lima, on undergraduate professors of the Medicine program. Documentary analysis was applied to gather data on professors for later submission to logistic and gamma regression. A correlation was found among research hours, male researchers, academic degree, and scientific production. However, there is no connection between teaching performance and scientific production in both genders. Certainly, the connection between the research dynamics and gender disparities must be the focus of the discussion, especially in a pandemic context that strengthens domestic tasks and the gender roles attached to them. It is remarkable how the bibliography devoted to the analysis of the aspects related to production, usually avoids the gender variable in their research.

Keywords

Teaching – Publications – Gender – Academic Curriculum – Covid-19 pandemic.

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Introduction

Scientific production in Latin America represents only 3% of international production (RÍOS GÓMEZ; HERRERO SOLANA, 2005). Despite this, from 1996 to 2007, scientific production in Latin America increased by 137% (SANTA; HERRERO SOLANA, 2010b, p. 384). Likewise, according to other studies, from 2010 to 2015, Latin American production increased by 37%, according to articles published in *Scopus (ALBORNOZ;* BARRERE; SOKIL, 2017). This indicates that there is an upward trend.

However, during the first time period, Peru ranked last in terms of scientific production among ten countries, representing only 0.03% of the total international production. (SANTA; HERRERO SOLANA; 2010b, p. 387). Furthermore, in Peru, there are only 29 indexed journals (in *Scopus, Emerging Sources Citation Index* (ESCI) or SciELO), which belong to 14 Peruvian universities (ESTRADA-CUZCANO; BARRIONUEVO-FLORES; ALHUAY-QUISPE, 2018), out of a total of 143 higher education institutions in the country (SUNEDU, 2019). This data reveals the challenging situation prevailing in scientific research production in Peru. Therefore, it is important to investigate the aspects that are related to the results of scientific research in the country.

This research addresses the problem of scientific research production in professors teaching in a particular program at Universidad Científica del Sur[2] (Southern Scientific University) (UCSUR) in Peru. The following aspects are analyzed: teaching performance, hours dedicated to teaching, hours dedicated to research, researcher status recognized by the institution, gender, and academic degree of the professor. The main objective is to determine the aspects related to scientific research production in *Google Scholar* and *Scopus*. These variables have been considered because, first, it is necessary to ask whether a higher teaching performance is related to a higher scientific research production, according to different authors (ARTÉS; PEDRAJA-CHAPARRO; SALINAS-JIMENÉZ, 2017; COATE; BARNETT; WILLIAMS, 2001; HATTIE; MARSH, 1996; PALALI *et al.*, 2018; UZ ZAMAN, 2004). Second, it may be possible that a professor, who spends more time on research and is recognized as a researcher, may have a higher number of research studies. Third, a similar point applies to the relation between academic degree and scientific production-as demonstrated, for example, by the research of Mejía, Valladares-Garrido and Valladares-Garrido (2018), regarding physicians registered with the Peruvian Physician Association.

These aspects, mentioned above, shall be analyzed in the context of a human historical period caused by the outbreak of the Covid-19 pandemic and the consequent changes in social habits (AYALA-COLQUI, 2020, 2022).

Health restrictions forced researchers and university professors to work from home, which had significant personal, social, and academic repercussions that affected scientific production (LAUDA-RODRIGUEZ *et al.*, 2020), especially for female researchers due to gender inequalities in the distribution of household and childcare responsibilities (INNO;

2 - This university excels in research. For instance, according to the Scimago Institutions Rankings (2020), it is ranked 7th among Peruvian universities; while, according to the Webometrics ranking (2021), it is ranked 9th. On the other hand, according to the Biennial Report on University Reality – 2018 by SUNEDU (2018), it is ranked 8th among Peruvian universities. In addition, it is a licensed university with several programs accredited by the Peruvian Accreditation Organization (SINEACE), in which it is included the human medicine program (ANDINA, 2020).

ROTUNDI; PICCIALLI, 2020). In most cases, this has implied implementing a distance and virtual teaching practice model. In this sense, the main research question is: What are the aspects related to scientific research production in *Google Scholar* and *Scopus* of professors from a private university in Lima, Peru, during the pandemic caused by Covid-19?

The variable “teaching performance” is defined as the set of competencies of the professor that allows the development of the teaching-learning process (MONTES DE OCA; MACHADO, 2011; RUEDA, 2009). This is generally approached in relation to the evaluation of teaching performance, which is a complex process that, by involving cognitive, instrumental, and axiological aspects, (TEJEDOR; GARCÍA-VARCÁRCEL, 2010), allows to evaluate teaching performance (ELIZALDE; REYES, 2008; RUEDA, 2009; VAILLANT, 2008). This evaluation may be conducted using different models or strategies such as the evaluation based on the opinion of professors, academic supervisors, students, standardized instruments or rubrics, student achievements, and a skills-based model (TEJEDOR, 2012). In this study, teaching performance is determined through a “teacher satisfaction survey” completed by students, who grade their professors according to their teaching skills performance.

The variables: hours dedicated to teaching, hours dedicated to research, researcher status recognized by the institution, gender, and academic degree of the professor, do not require further explanation. These variables have been considered due to previous research focused on aspects related to scientific research publication (ANGULO- GIRALDO, 2020; MEJÍA; VALLADARES-GARRIDO; VALLADARES-GARRIDO, 2018; PEREYRA-ELÍAS *et al.*, 2014). Researcher status is an internal category of the university where professors of our institution teach: It is possible to become an associate researcher (and enjoy a few restricted hours for research), a part-time senior researcher (whose hours dedicated to research amount to an average of 20), and a full-time senior researcher (whose hours dedicated to research tend to be 40).

The variable “scientific publication” is understood in this study, exclusively, as the sum of publications in *Scopus* and *Google Scholar* (discounting, of course, research in the first database that is repeated in the second one). However, as discussed further below, the analyses will unbundle both databases in order to closely analyze the articles only published in *Scopus*, in *Google Scholar versus* the articles published in both databases. Theoretically, it is important to distinguish between scientific production and scientific publication since they are empirically different phenomena. Scientific production involves both the outcome material of the acquired scientific output, as well as the activities related to research (CHÚA; OROZCO, 2016). In contrast, the scientific publication refers to the process by which scientific production is exposed, made visible and shared (MONTCUSÍ; TORMO, 2017). Both are studied by scientometrics and bibliometrics, the former being the quantitative analysis of the development of scientific knowledge and, the latter, involves statistical studies of scientific activity (ARAUJO; ARENCIBIA, 2002; SPINAK, 2001). Moreover, the publications may be made on different media. However, journals are the main and substantive means of scientific production dissemination (AGUADO-LÓPEZ *et al.*, 2014; MENDOZA; PARAVIC, 2006; MIGUEL, 2011; PATALANO, 2005).

Journal indexing, understood as the publication of journals in a renowned database, is "the most significant indicator of the production capacity of a researcher and, therefore, it is an essential factor in the overall scientific evaluation" (AGUADO-LÓPEZ *et al.*, 2014, p. 571). The two most widely used multidisciplinary databases, both of which are indexed, are *Web of Science* (under the domain of *Thomson Reuters*) and *Scopus* (under the domain of *Elsevier*). This is due to their relatively wide coverage, accessibility, and utility (AGUADO-LÓPEZ *et al.*, 2014; CORTÉS, 2008; SANTA; HERRERO SOLANA, 2010b; SANTA; HERRERO SOLANA, 2010a; PATALANO, 2005).

However, these databases do not cover the entire scientific production of a researcher. In contrast, *Google Scholar* offers an alternative that brings together the production of several databases, as it has the advantage of being free of charge, greater coverage, and access to a wide range of documents such as books, articles, conference papers, theses or any other publication with an abstract (TORRES-SALINAS; RUIZ-PÉREZ; DELGADO-LÓPEZ-CÓZAR, 2009). That is why our scientific production variable includes *Google Scholar*, in addition to *Scopus*, because it is wider and more inclusive.

In terms of background, in Peru, there is a number of research studies that address the factors related to the scientific research production of professors from human medicine program. First, Parra (2010) focuses specifically on gastroenterologists. In this study, a qualitative methodology is employed, in which interviews with physicians are included, who provide their perceptions of the aspects related to publication. The multivariate analysis performed by the author allows concluding that the relevant aspects are divided into categories such as "personal" (belonging to a scientific society), "work" (support for research in the workplace and number of jobs) and "academic" (type of bibliographic research and comprehension level of authentic articles) (PARRA, 2010, p. 4). Second, an article by Pereyra-Elías *et al.* (2014) was found. This paper focuses on Peruvian medical program professors (32 schools) in 2011, especially, those who teach academic courses related to research, in order to determine the aspects related to publication. Among these aspects are age (under 40 years old), to be a university professor with a compulsory thesis, and to work in a university with a high level of research production. Third, the paper by Atamari-Anahui, Sucasaca-Rodríguez and Marroquín- Santa Cruz (2016), addresses scientific production of thesis advisors from a university in Cuzco. However, the text simply provides publication statistics (indicating a low level of publications) without explaining the reasons for this situation based on a statistical test. Fourth, the article by Merino-Soto and Salas-Blas (2016) analyzes, qualitatively, the motivations and difficulties for conducting research in Peru; from the sample results, it was found that the main motivations are social and individual, and the most important hindrances are difficulties of a personal, instrumental, and environmental nature. Fifth, the publication by Atamari-Anahui *et al.* (2016) identified that physicians from Cusco, who teach in medical schools, are more likely to publish compared to those who do not teach in universities. Sixth, the article by Mejía, Valladares-Garrido and Valladares- Garrido (2018) focuses on the publication of physicians by determining the academic degree as a variable. As a result, it was found that those who have a higher chance to publish are those who have both a master's degree and a doctorate. Seventh, Chachaima- Mar, Fernández-Guzmán and

Atamari-Anahui (2019) in their paper, highlight that “being a coordinator of an academic course increased the possibilities to publish” (p. 9).

Finally, regarding research that addresses the pandemic scenario and the fact that many journals allowed free access to their papers with the aim to foster medical research on Covid-19, Torres-Salinas (2020) mentions that there was an exponential increase in publications on the pandemic (R2 =0.92), especially, in medical journals. Gregorio- Chaviano, Limaymanta and López-Mesa (2020) agree on the exponential increase in articles and add that, in Latin America, the countries that published the most were Mexico, Brazil and Colombia. Ortiz-Núñez (2020) adds that, in the case of *Scopus*, publications on Covid-19 were mostly in English, with multiple authorship, a high number of collaborations, a high visibility in social networks and publications in first quartiles. The author refers to medical publications, which mainly dealt with three fields: the description of the new disease, clinical studies, and possible treatments. Peru has not been the exception and the enormous effort in medical research is reflected, for example, in its participation in the *Solidaridad* (Solidarity) project, a massive global clinical trial to seek treatment for Covid-19 (SOTO *et al.*, 2020). Likewise, the impact of the pandemic on the Peruvian academic community is reflected in two Peruvian medical journals that greatly increased their research on the subject of the pandemic: *Acta Médica Peruana* (Peruvian Medical Journal) (ISSN 1728-5917) and *Revista Peruana de Medicina Experimental y Salud Pública* (Peruvian Journal on Experimental Medicine and Public Health) (ISSN 1726-4634) (RODRÍGUEZ-MORALES *et al.*, 2020; ROMANI, 2020).

These documents clearly show a great number of publications regarding Covid- 19; however, they do not focus on the specific and tangible aspects that, within the pandemic context, are related to publications. Therefore, these papers are highly descriptive and merely report on the increase in research in the context of the disease without investigating the observable and measurable reasons behind it, beyond the need to understand the causes and treatments of this new viral outbreak. On the other hand, the aim of this research is precisely to address the latter: to identify the internal institutional aspects related to scientific research production in the context of the Covid-19 pandemic.

Methodology

Design and population

The research was based on a non-experimental design and had a cross-sectional and analytical nature, since the variables were measured in a limited time period, specifically, during 2020, when the Covid-19 pandemic took place. The research approach was quantitative, the technique was documentary review and the population consisted of professors from the School of Medicine of Universidad Científica del Sur (Lima, Peru), who were included in the C9 format in force in 2020[3]; this is a format required by the National Superintendence of Higher University Education of Peru (SUNEDU) for auditing purposes,

3 - The 2020 “C9 format ”is available on the website of the Peruvian university: https://www.cientifica.edu.pe/node/1903.

which contains information on their academic degrees, details of working hours, hours dedicated to research, researcher status and gender.

Search processes

During August and September 2020, a list of all the professors from the School of Medicine of Universidad Científica del Sur, who were registered in the C9 format of the university, was collected. Simultaneously, the evaluation regarding the teaching performance of each professor was obtained using the information provided by the Teaching Management department of this university. The reliability of the instrument used by this department was determined using Cronbach's Alpha coefficient, which resulted in a score of 0.985.

During October and November, a search regarding the publications of each professor was made in *Scopus* and *Google Scholar*. The search strategy used consisted of combining possible variations of the names of each professor, following the approach used in previous research (ATAMARI-ANAHUI *et al*., 2016; MEJÍA; VALLADARES- GARRIDO; VALLADARES-GARRIDO, 2018; PEREYRA-ELÍAS *et al*., 2014). It is important to note that "publication" was considered to be any text published in a scientific journal, which includes authentic research articles, reviews, case reports, summaries, and letters to the editor. Therefore, theses, books, posters, technical reports, abstracts, and syllabuses were explicitly excluded. The documents published up to the year 2020 were registered in this search, which was performed twice, achieving a matching level of more than 90%. Quality control was performed by the second investigator to address any discrepancies. It is important to mention that other databases, such as *Web of Science*, were not considered due to three reasons: the low number of publications of the professors who were analyzed in said database; access to this database is not free but is available on a paid subscription basis; and mainly because previous research, which is our local background, was based exclusively on *Google Scholar* and *Scopus*. Therefore, the non- inclusion of other databases is one of the limitations of this study.

Study variables

The variables considered for the professors were: teaching performance, academic degree, sex, hours dedicated to teaching, hours dedicated to research, researcher status (none, associate, part-time or full-time) and the number of articles published in both *Google Scholar* and *Scopus*.

Data analysis[4]

Following a first data browsing, the large number of unpublished professors biased the sample by zero data (or zero-skewed data in the Anglo-Saxon literature). Although

4 - The data used in the research may be found on Figshare: https://figshare.com/s/3a68b879d0e5394dded4 there are different solutions to this problem (see, for different fields, BORHAN *et al.*; 2020; CHAI; BAILEY; 2008; YANG; SIMPSON; 2010), a strategy similar to the one used by Fletcher *et al.* (2005) was applied; however, instead of ordinary regression, gamma regression was used. This happened due to issues related to normality, data dispersion and by dealing with natural numbers versus decimals.

Fletcher *et al.* (2005) propose to divide a zero-biased database into two databases: one including the biased variable converted to a *dummy* variable (in his particular case, as in this one, the dependent variable) and another, smaller, database containing only the unconverted positive cases. Logistic and linear models should be designed with these variables. However, this perspective was changed in this study. The reason for this is that the number of publications per author (the dependent variable in this study) does not follow a continuous normal distribution, nor do the simple regression residuals. Thus, by performing the first collinearity tests, linear regressions and the corresponding Q-Q plots of the residuals, it was decided that logistic regressions and the generalized linear gamma model would be the most appropriate alternatives for our data.

It was found that only “Teaching performance score”, out of all independent variables, followed a normal distribution. However, it lacked data for 43 cases. Therefore, and due to its tendency to normality, an imputation of the cases following the SPSS (v.24) TREND (Average) method was performed. Nonetheless, the missing data were cases with significant differences in the remaining independent variables in contrast with the other 119 cases. For this reason, four databases were created in SPSS from the original database in Excel. Two of them (n=162 and n=64) included the cases with the imputed values for said variable, and the remaining two (n=119 and n=37) lacked those cases. All results are comparatively presented in order to assess the effect of the addition of the cases with the imputed values.

The dependent variables (total amount of publications, publications in *Google Scholar*, and publications in *Scopus*) were transformed into *dummies* in the larger databases, where 0 indicated no publications and 1 indicated at least one. Given the dispersion of continuous data, said variables were transformed in the two databases with positive numbers through natural logarithms plus three (in avoidance of the existence of ceros, with which the gamma regressions would be impossible). After the deletion of cases with exaggeratedly high values, the variables “research hours” and “teaching” did not show problems in the regressions, although they had a zero bias (the logarithmic transformations were inefficient). Finally, in the smaller databases, the “Academic degree” variable had to be transformed into a *dummy* due to a low presence of positive cases. Conversely, the “Researcher status” initial variable was discarded as it included an extremely small number of positive cases.

Models

The logistic regression follows the formula:

$$\frac{p_y}{1-p_y} = e^{\beta_0+\beta_1 x_1+\cdots\, \beta_n x_n} = \exp(\beta_0) * \exp\,(\,\beta_n x_n)$$

Where p_y is the probability of an event happening, e is a constant equal to 2.718, β_0 is the model constant and $\beta_1 x_1$ +... $\beta_n x_n$ represents the predictor or independent variables multiplied by their coefficients β_n. In this model, $\frac{p_y}{1-p_y}$ represent the odds of occurrence of event y=1 versus the odds of occurrence of y=0. The odds ratio $\exp\left(\frac{p_y}{1-p_y}\right)$ has a logistic distribution. Moreover, on one hand, logistic regression requires calculating the odds of values of a variable and binary (of 0 and 1). On the other, this model lacks an error term.

Furthermore, the gamma regression that uses our transformed dependent variable is represented by:

$$\ln(\ln(y+2)) = \ln(\mu) = x^T\beta$$

Where $\ln(\mu)$ is the link function, x^T is the transposed matrix of the values of x predictors, and β is the coefficient matrix of the predictors in the model. This model is similar to the exponential regression because it measures the logarithmic increase in the mean μ of a variable y. It is necessary to clarify that, in this model, $\ln(y + 2)$ has an approximate distribution to the gamma distribution (Γ). Finally, after trying different alternatives, a doble logistic transformation was used as it was decided that this was the appropriate transformation for the porosity of the data of the smaller bases.

Assumptions review

The multiple linear regressions must generally follow a series of assumptions. Two common features in every regression model are multicollinearity and overfitting (PITUCH; STEVENS, 2016). However, there are models that relax several of the other assumptions, such as normality, linearity, and independence of residuals. This is also the case for logistic and gamma regressions. In both cases, multicollinearity tests were conducted using the variance inflation factor (VIF). In the case of logistic regressions, this was done through linear regressions with an additional weighting of $w = Pred*(1 - Pred)$ (ALLISON, 2012). Also, in both cases, the presence of influential cases was iteratively addressed. For logistic regressions, this was done using graphs of equivalents to Cook's distances and studentized squared residuals against predicted values, and PfBetas(x) against the number of observations. For gamma regressions, Cook's distances and influence values were used.

The tests were performed for each model variant (*i.e.*, after removing or adding a variable). The remaining assumptions indicated by the bibliography were also tested in the more refined models.

- For logistic regression: Linearity assumptions were tested by adding interactions $X*\log(X)$ for all continuous values, in addition to adjusting cut-off values using ROC curves, checking the relationship between residuals and the logistic distribution through Q-Q plots, and assessing the presence of perfect or imperfect separation through iterations with different cut-off points (ALLISON, 2012; GARSON, 2014).
- For gamma regression: Independence of predictors and residuals was tested using scatter plots with standardized Pearson residuals, fit test for transformations of

dependent variables by comparing Q-Q plot results of deviance residuals from models with original and transformed variables, testing the link function by adding squared predicted values to the model, and assessing overdispersion through the division of deviance by degrees of freedom (BRESLOW, 1996; HARDIN; HILBE, 2018).

Goodness of fit

The adjustment of logistic models was comparatively evaluated using the percentages explained by ROC curves, as well as the log-likelihood minus two (LL-2) and the inefficiency of the Hosmer-Lemeshow goodness of fit test. Conditional stepwise logistic regressions were also used to compare our results with those obtained through maximum likelihood estimator (MLE) algorithm.

In the case of gamma models, this adjustment was assessed by comparing Akaike's information criterion (AIC), Bayesian information criterion (BIC), and the relationship between the value of deviance and the degrees of freedom of each model. Stepwise regressions (what SPSS calls "robust estimate") were also compared when necessary. It should be noted that MLE in this case is even more reliable as it involves a generalized linear model.

Interpretation

The results of the regressions are usually expressed in terms of coefficients. To make the results more intuitive, the odds ratios (also known as exp(β)) of the logistic models and the β coefficients of the gamma models were transformed. For this reason, tables 3 and 4 present the results of p_y and $E(y)$, so that: $p_y = \frac{\exp(\beta)*1000}{1000+(\exp(\beta)*1000)}$ while $E(y) = \exp(median(\ln(y)) * \exp(\beta * Unit\ change\ in\ x)) - 2$.

Ethical aspects

The research was reviewed and approved by the University Ethics Committee (Registration Code: 545-2020-POS99; Approval Certificate from the Ethics Committee: No. 295-CIEI-CIENTÍFICA-2020), as well as all relevant official administrative bodies. The university authorities, following appropriate requests, provided the databases for the analysis, including the mentioned C9 format and the teachers' performance ratings. Once the data for each professor was collected, their names were removed, ensuring the use of an anonymous list in the analysis.

Results

Table 1 presents a summary of the variables used in Models 1, 2, and 3, while Table 2 does the same for Models 4, 5, and 6, respectively. It was noted that imputing values had significant consequences for Model 3 (*Scopus).* Moreover, it appears to severely modify the coefficients of all predictor variables in Models 4, 5, and 6, except for gender. In other words, the expansion of the sample generated considerable changes in the estimations of the final adjusted models (see Tables 3 and 4).

Table 1- Descriptive statistics of the variables used in the logistic regressions

	With no imputed values (n=119)		With imputed values (n=162)	
	Average	Range	Average	Range
Scientific publication				
Have or do not havepublications	0.353	1	0.395	1
Have publications in *GoogleScholar*	0.328	1	0.377	1
Have publications in *Scopus*	0.76	1	0.185	1
Research hours	0.91	35	0.85	35
Teaching hours	7.61	37	7.52	38
Teaching performance score	4.37	2	4.17	2
Gender				
Female	0.40	1	0.41	1
Academic degree				
Undergraduate	0.84	1	0.77	1
Postgraduate: Master's degree	0.10	1	0.15	1
Postgraduate: Doctorate	0.06	1	0.07	1

Source: Author's elaboration.

Table 2- Descriptive statistics of the variables used in the gamma regressions.

	Whith no imputed values (n=37)		Whith imputed values (n=64)	
	Average	Range	Average	Range
Scientific publication				
Total number of publications	22.81	325	20.67	325
Publications in *Google Scholar*	12.78	131	11.89	131
Publications in *Scopus*	10.03	195	8.78	195
Research hours	2.65	35	2.03	35
Teaching hours	6.57	17	6.77	29
Teaching performance score	4.40	1.2	4.10	2
Gender				
Female	40.5	1	43.8	1
Academic degree				
Undergraduate	0.89	1	0.72	1
Postgraduate: Master's degree	0.03	1	0.13	1
Postgraduate: Doctorate	0.08	1	0.16	1

Source: Author's elaboration.

Some patterns in the model fit shown in Tables 3 and 4 should be mentioned. Using imputed values, the models with the best fit, both in logistic and gamma regressions, were models 2 and 5 (*Google Scholar*). Those with the worst fit were models 3 and 6 (*Scopus*). This relationship was not found among the models with no imputed values, due to the changes introduced by the added case values. However, in all cases, only results with models showing optimal fit will be discussed.

Table 3- Goodness of fit statistics for the logistic regression models.

	LL-2	R2N	Sig. of H-L test
Model 1: Do not have vs. Have			
With no imputed values	122.694	0.307	0.777
With imputed values	167.43	0.35	0.249
Model 2: Have in *Google Scholar*			
With no imputed values	127.871	0.261	0.222
With imputed values	161.69	0.362	0.194
Model 3: Have in *Scopus*			
With no imputed values	124.391	0.257	0.56
With imputed values	194.096	0.247	0.831

Source: Author's elaboration.

Table 4- Goodness of fit statistics for the gamma regression models

	Deviancevalue/gl	AIC	BIC
Model 4: All publications			
With no imputed values	0.124	69.331	76.963
With imputed values	0.115	45.778	56.08
Model 5: Publications in *Google Scholar*			
With no imputed values	0.135	63.206	70.837
With imputed values	0.106	35.259	46.36
Model 6: Publications in *Scopus*			
With no imputed values	0.157	43.648	54.137
With imputed values	0.176	66.258	78.517

Source: Author's elaboration.

1) Logistic regressions (Models 1, 2, and 3)

In Table 5, the logarithm of odds ratio of the logistic regressions was transformed into probabilities using the databases with and without imputed values for each of the tested models. Additionally, the significance of the chi-square tests and confidence intervals were added. Here, a value close to 1 indicates the absence of a relationship (a value lower than 1 indicates an inverse relationship, and vice versa). In the second case, a value close to 0.5 replaces the cut-off value of 1.

As seen in Table 5, in all logistic models, the variables most related to the likelihood of having publications (or having them either in *Google Scholar or Scopus*) compared to those who do not publish are the increase in research hours (with an average of p=0.723, C.I.: [0.591, 0.824] for models without imputed values, and p=0.727, C.I.: [0.605, 0.821] in models with imputed values), the decrease in average teaching performance (respectively, p=0.398, C.I.: [0.160, 0.692] and p=0.284, C.I.: [0.129, 0.518]), and especially holding a doctorate (average of p=0.831, C.I.: [0.493, 0.963], only in models with imputed values). However, Model 3 (*Scopus*) shows low significance for all independent variables except the first one, although the average teaching performance offers p=0.259 (Sig.=0.192; C.I.=[0.128, 0.603]) in the model without imputed values and p=0.273 (Sig.=0.128; C.I.=[0.096, 0.569]) in the alternative model.

The models converge on the importance of research hours (an additional hour increases the probability of p=0.5, indicating no relationship, to nearly p=0.7). They also agree on the limited importance of teaching hours (odds ratios hover around 1, or p=0.5, indicating a lack of relationship) as determinants of scientific publication. The other variables indicate generally negative relationships that become more significant when using imputed values, except for the academic degree, where the opposite occurs. Table 5 also confirms that these results gain more significance with imputed values.

Table 5- Transformed p-values of the odds ratios for logistic regressions and confidence intervals

Result: Have or do not have publications	Model 1: Have vs. Do not have publications			
	With no imputed values(n=115)		With imputed values (n=160)	
	p(0-1) (sig.)	I.C.	p(0-1) (sig.)	I.C.
Teaching performancescore (+1)	0.321 (0.21)	(0.128, 0.603)	0.284 (0.038)*	(0.143, 0.487)
Teaching hours (+1h)	0.479 (0.104)	(0.455, 0.504)	0.482 (0.097)*	(0.460, 0.503)
Research hours (+1h)	0.724 (0.002)**	(0.586, 0.830)	0.738 (0.001)**	(0.599, 0.841)
Gender (Female)	0.479 (0.104)	(0.455, 0.504)	0.374 (0.186)	(0.218, 0.561)
Academic degree (Postgraduate)[a]	0.374 (0.489)	(0.122, 0.719)	0.564 (0.594)	(0.333, 0.770)
Academic degree (Postgraduate: Master's degree)	-	-	0.368 (0.38)	(0.148, 0.660)
Academic degree (Postgraduate: Doctorate)	-	-	0.875 (0.027)**	(0.555, 0.975)
	Model 2: Have publications in *Google Scholar*			
	With no imputed values(n=116)		With imputed values (n=159)	
Teaching performance score (+1)	0.487 (0.938)	(0.200, 0.781)	0.292 (0.048)*	(0.146, 0.498)

Teaching hours (+1h)	0.451 (0.019)**	(0.410, 0.491)	0.474 (0.042)*	(0.450, 0.498)
Research hours (+1h)	0.715 (0.001)**	(0.595, 0.810)	0.742 (0.002)**	(0.599, 0.847)
Gender (Female)	0.465 (0.773)	(0.250, 0.692)	0.412 (0.372)	(0.245, 0.603)
Academic degree (Postgraduate)[a]	0.397 (0.613)	(0.115, 0.769)	0.383 (0.336)	(0.190, 0.620)
Academic degree (Postgraduate: Master's degree)	-	-	0.432 (0.66)	(0.185, 0.718)
Academic degree (Postgraduate: Doctorate)	-	-	0.888 (0.02)**	(0.582, 0.978)
	Model 3: Have publications in *Scopus*			
	With no imputed values(n=115)		With imputed values (n=159)	
Teaching performance score (+1)	0.259 (0.192)	(0.128, 0.603)	0.273 (0.128)	(0.096, 0.569)
Teaching hours (+1h)	0.496 (0.802)	(0.455, 0.504)	0.503 (0.745)	(0.482, 0.524)
Research hours (+1h)	0.691 (0)**	(0.586, 0.830)	0.701 (0)**	(0.615, 0.774)
Gender (Female)	0.356 (0.325)	(0.285, 0.697)	0.412 (0.506)	(0.199, 0.665)
Academic degree (Postgraduate)[a]	-	-	0.524 (0.873)	(0.246, 0.788)
Academic degree (Postgraduate: Master's degree)	-	-	0.374 (0.522)	(0.111, 0.741)
Academic degree (Postgraduate: Doctorate)	-	-	0.731 (0.237)	(0.341, 0.934)

[a] [a] All the coefficients calculated for Academic degree (Postgraduate) in the logistic regressions with imputed values are based on unfitted models with the addition of this variable, which is a binary transformation of the original. These models lacked residual tests (the model configuration without this variable was used). The other results for Academic degree were calculated in reference to the value indicated by Undergraduate (Baccalaureate).

Source: Author's elaboration.

2- Gamma regressions (Models 4, 5 and 6)

Table 6 displays the changes in the means of the dependent variable operated by increases in fixed values relative to the independent variables by the aforementioned conversion of logistic coefficients. Finally, consider that Table 6 presents the coefficients as predictive values in relation to the parameters of the median of the dependent variable and units of the independent variable.

Despite some differences between the regressions, both confirm the significance of research hours as a determinant of the number of publications per author. Although hours devoted to teaching emerge as a positive determinant, they exhibit high variance and weak coefficients in most models (Table 6). Finally, a decrease of 0.5 on the teaching performance scale leads to an increase of nearly 4 articles in *Google Scholar*, albeit the results are not highly significant. This aligns with the results of the logistic regressions.

In addition, it is confirmed that the determinants of publication in Scopus turn out to be very specific. Model 6 (*Scopus*) expresses a significant correlation with teaching performance hours. However, this contradicts the value close to the significance of the teaching performance score with a negative trend in the logistic regressions (Models 1 and 2). The explanation could lie in the fact that those who report more research hours at a single university are precisely those who work there exclusively, while the others work at several universities. Otherwise, the gamma models related to *Scopus* exhibit lower overall fit. This may be due to the lack of other variables (e.g., being able to write in academic English, a requirement that does not affect presence in *Google Scholar*).

Finally, the significance of the male gender of the researcher remains an intriguing pattern as a determinant of the total number of publications and those in *Google Scholar* (Table 6). Males publish between 3 to 9 more articles in Models 4 and 5 with no imputed values, and between 1 to 5 more articles using imputed values (Table 6). Consider that the variance decreases significantly with the use of imputed values, which makes these relationships stronger.

Table 6- Estimated values transformed from the gamma regressions and confidence intervals.

Result: Number of publications	Model 4: All publications (median=1.7)			
	No imputed values (n=34)		Imputed values (n=58)	
	E(y) (Sig.)	I.C.	E(y) (Sig.)	I.C.
Teaching performance score (+0.5)	3.533 (0.949)	(2.124, 5.899)	2.765 (0.135)	(2.113, 3.606)
Teaching hours (+1h)	-	-	-	-
Research hours (+1h)	5.044 (0)**	(4.252, 5.998)	5.410 (0)**	(4.645, 6.370)
Gender (Female)	-5.284 (0.176)	(-9.992, -2.890)	-1.788 (0.005)**	(-2.871, -1.072)
	Model 5: Publications in Google Scholar (median=2)			
	No imputed values (n=34)		**Imputed values (n=58)**	
Teaching performance score (+0.5)	5.861 (0.764)	(3.409, 10.40)	-4.075 (0.054)*	(-5.411, -3.075)
Teaching hours (+1h)	-	-	-	-
Research hours (+1h)	8.072 (0)**	(6.709, 9.791)	7.428 (0)**	(6.238, 8.883)
Gender (Female)	-3.405 (0.155)	(-6.433, -1.801)	-3.193 (0.032)*	(-5.158, -1.969)
	Model 6: Publications in *Scopus* (median=1.06)			
	No imputed values (n=34)		**Imputed values (n=58)**	
Teaching performance score (+0.5)	-	-	-	-
Teaching hours (+1h)	0.923 (0.454)	(0.829, 1.037)	0.977 (0.026)**	(0.895, 1.061)
Research hours (+1h)	1.352 (0)**	(1.127, 1.621)	1.557 (0)**	(1.268, 1.895)
Gender (Female)	1.249(0.41)	(0.485, 2.625)	-0.650 (0.422)	(-1.311, -0.208)

Source: Author's elaboration.

Discussion

The models which relate the number of publications and those appearing in *Google Scholar* exhibit higher levels of significance compared to the models regressing publications in *Scopus*. Additionally, the first models demonstrate significant associations with a broader range of variables. These findings substantiate the low efficacy of predictors commonly identified in the bibliography as determinants of scientific productivity (RØRSTAD; AKSNES, 2015).

Considering that university professors in Peru can hold either a master's degree or doctorate, the academic degree has shown to be highly favorable and statistically significant for scientific production in the conducted logistic regressions. Previous research conducted by Mejía, Valladares-Garrido, and Valladares-Garrido (2018) found that a higher academic degree is related to higher scientific production. However, these findings contrast with those reported by Castro-Rodríguez *et al.* (2020), who did not find a significant relationship between these variables among dental professors at the Universidad Nacional Mayor de San Marcos. Needless to say, in the country, only 18% of the professors hold a doctorate, while 49% possess a master's degree (SUNEDU, 2020).

The second variable whose importance permeated all the models was research hours. This variable has received limited attention in the academic bibliography on the subject. A study by Spanish authors measured "research intensity" through path analysis models (BERBEGAL-MIRABENT *et al*., 2018) and found that it acts as a moderator between teaching quality and student satisfaction with the professor. The authors examined all possible relationships among the three variables, including research hours as a result. In the context of the pandemic, this variable may have been favored by the fact that, as Torres-Salinas (2020) demonstrates, in several places in the world, special attention and research care was devoted to the issue of Covid-19: considering that these professors already had hours reserved for research, the pandemic may have concentrated their research efforts on such topics, driven by the urgency of the new disease.

However, it should be noted research hours were measured "intramurally", i.e., only within a university, while research hours in other institutions were left aside. In terms of academic degrees, only postgraduates have on average more than 0 hours of research (master's degree=1, doctorate=5, n=162). The reason for this is due to the internal policies of the institution. In fact, institutional characteristics such as university funding (BARLETTA *et al*., 2017; RHAIEM, 2017), optimal human capital utilization by the university, and optimal working environment for research (KANNEBLEY *et al*., 2018; WAY *et al*., 2019) are crucial in scientific productivity. Furthermore, the increase of research hours in the university would theoretically facilitate local and intramural scientific collaboration, as well as its presence (and a less individualistic and more egalitarian or hierarchical culture) seems to facilitate the increase of scientific articles and their quality (ABRAMO *et al*., 2017; CHEN; MA, 2015).

A relevant issue is related to the gender variable. Research reveals that women produce fewer articles in general and in Google Scholar. Moreover, five of the six regressions show that gender is negatively related to the scientific productivity variables. Despite greater scientific production in the context of Covid-19, the gender gap has widened, so that men have been rewarded while women, who have taken on more responsibilities in their own households (MYERS *et al.*, 2020; VINCENT-LAMARRE *et al.*, 2020), who have had to bear more of this domestic "unpaid work" (FEDERICI, 2018), have been penalized. Regarding this, an analysis of articles submitted for review in Elsevier journals between February and May 2020 showed that women submitted fewer Covid-19-related manuscripts in 2020, especially in health and medical journals, with significant values for the areas of life sciences, physical sciences, and engineering (SQUAZZONI *et al.*, 2020).

This research, however, also finds a significant increase commensurate with the degree. Although gender inequalities are common in academia and also in health-related disciplines (BEAUDRY; LARIVIÈRE, 2016), women with doctorates tend to match their male peers over time (RØRSTAD; AKSNER, 2015). Our larger base confirms that assumption (the ratio of total publications per person progresses from 7/2 for bachelors, 5/2 for masters, and 6/4 for doctors).

One finding of this study was the low importance of teaching quality factors, such as hours and performance scores. Many international studies confirm that the relationship between teaching quality and scientific publication is ambiguous and rather depends on each local context (TIGHT, 2016), and some authors find different relationships depending on the quality and productivity measures used (PALALI *et al.*, 2018). However, even the latest aforementioned authors have not found any relationships between the presence or quantity of publications and teaching quality. The same applies to technology transfer, which highlights the requirement of full dedication to research (BEAUDRY; LARIVIÈRE, 2016). Nevertheless, consider that the teaching quality score was an average derived from several variables. Among these variables, the professor proficiency in the use of the virtual platform was the one that showed a slight increase in significance in the models. Regarding other matters, it is important to mention that the "scientific publication" variable is a factor that inevitably has an impact and influence in the classroom. For instance, previous studies have shown that a research-oriented professor is perceived to be better in terms of their teaching practice (ROSE; MCKINLEY, 2020). And, in some cases, a positive correlation has been found between being a researcher and being a good professor (ARTÉS; PEDRAJA-CHAPARRO; SALINAS-JIMENÉZ, 2017; PALALI *et al.*, 2018). For this reason, Boyer (1990) stated that "great professors" have as a necessary condition the possession of knowledge acquired both through experience and teaching practice, as well as through research. Hence, although our research shows results on scientific productivity, the knowledge of the factors that determine it can indirectly help to improve teaching practice in the classroom since researching professors will have a better self-perception of their teaching practice, as well as updated and first-hand knowledge.

Returning to the question of factors related to productivity, other factors must also be considered. Latin America is known to produce fewer scientific papers than other regions in the world, although this trend is expected to change in the coming years (JAVED; LIU, 2018). However, there is a scarcity of publications on methods to improve academic efficiency in the health academic areas of developing countries (OBUKU *et* *al.*, 2018). Despite this, some reviews of interventions focused on literacy for university professors have been found with excellent results (FRANTZ; AMOSUN, 2011; HAVNAER *et al.*, 2017).

Regarding general recommendations, the model of scientific effectiveness of Rhaiem (2017) indicates that institutional decisions are fundamental for the increase of scientific publications. Recommendations include an emphasis on gender and academic degree differences, as well as the creation of ideal work environments to encourage and retain highly research-performing professors. This recommendation is important because teaching activities interfere with research activities. Finally, the United Way model seems appropriate to the needs of health career professors in order to level knowledge inequalities, albeit it is not the subject of this study (HAVNAER *et al.*, 2017).

Limitations

This study stands out from others because it divides scientific productivity into the presence or absence of research and its quantity (PALALI *et al.*, 2018) The combined use of gamma and logistic regressions is an adequate innovation to our variables; other studies use OLS regressions or a mixture of linear and logistic regressions. This is because many studies measure both quality and quantity of publications as dependent variables. Furthermore, it was crucial to differentiate between publications in Google Scholar and Scopus, thereby identifying the differences between these repositories. Finally, this research takes into account academic degree and research hours in the regressions, which is uncommon in the bibliography.

However, there are several limitations to be acknowledged. The first limitation is related to the small size of our sample, whereas other studies have samples that consist of thousands of researchers. The second limitation is the relative scarcity of independent variables. Future studies should incorporate variables related to scientific collaboration, funding, age, informal strategies (e.g., participation) or formal strategies (e.g., being a lead author) for positioning of professors (RODRÍGUEZ; RUBIO, 2016; VUONG *et al.*, 2018), as well as the literacy skills of professors. Thirdly, future studies should consider both the quantity and quality of publications and differentiate the individual contribution of professors (VUONG *et al.*, 2018).

The academic degree variable exhibited a significantly positive association with scientific productivity in our logistic regressions. However, this variable was not included in the gamma regressions due to the limited number of positive cases, which resulted in biased estimates and multicollinearity issues.

Another limitation was the presence of extreme values and data dispersion, which decreased the quality of the regressions. Future research is necessary to account for unexplained residuals. It is recommended to strike a balance between the available data and theoretically relevant variables. Finally, it is recommended to have access to the data repository and to documents detailing the procedures used to collect the data (a final limitation of this study).

Conclusions

This study had the following findings: the main factors associated with scientific production in a private university in Lima, Peru, are the academic degree. This determines the presence of publications, and research hours, which are associated with both publications and their increase. It is important to note that in the Peruvian context, according to SUNEDU (2020), only 18% of professors hold a doctorate, while 49% have a master's degree. This fact has a direct impact on the studied scientific productivity. In addition to the findings, it should be noted that in Peru, postgraduate studies are not free of charge in any case. Therefore, individuals who aspire to obtain a higher academic degree must invest both additional time (beyond their working hours) and money (as the Peruvian government does not provide scholarships for national studies). This situation poses challenges to the training of doctoral professors and their future relevance in scientific production. Despite this, it is important to mention that in this research, the quality and dedication of teaching are null or negatively related to the presence of publications.

Furthermore, it is concerning to note another finding that reinforces the gender gap in academia: being male is associated with a greater presence of scientific publications. This finding is consistent with other Latin American studies. For instance, Alarco *et al.* (2021) emphazise that only 17.3% out of 1750 Latin American researchers listed in Webometrics are women, which indicates their underrepresentation. The research conducted by Colther, Rojas-Mora, and Wong identifies that the gender of female students and professors in Chilean universities has an impact on the scientific productivity of their institutions.

Additionally, it is important to highlight the gender gap in academia on a global scale. For instance, in France, Mairesse and Pezzoni (2015) found that male researchers have a scientific productivity that is 2/3 higher than that of their female counterparts in French universities. Similarly, in Italy, Filandri and Pasqua (2021) discovered that female researchers have fewer publications compared to male colleagues, which directly impacts their career advancement in academia.

The latter finding is significant because, although there is a demonstrated correlation between research hours and scientific productivity, the gender gap may be hindering women researchers' access to dedicated research time. Therefore, it remains to influence policies specifically aimed at addressing the gender gap in a transversal manner in the promotion of research in all its dimensions.

It is recognized that the increased family burdens faced by women compared to men make it challenging to meet criteria of excellence. In the field of science, these domestic work hours are not taken into consideration (CABALLERO-VILLALOBOS *et al.*). In particular, during the pandemic, the personal, social, and academic disruptions that affected scientific productivity were accentuated in the case of women researchers due to gender inequity in the distribution of household and childcare responsibilities (INNO; ROTUNDI; PICCIALLI, 2020).

These findings confirm trends explained in the existing bibliography. In the context of the pandemic, we observed that the scientific production of professors accumulated disparate numbers whose main factors were only grade, hours of research, and male gender.

In general, findings showed that the determinants of publication in *Google Scholar* are not the same as those of publication in *Scopus*. In fact, the models related to *Scholar* are more robust in relation to the other variables, indicating that publication in *Scopus* is very scarce and limited to professionals who only work at the university studied. The adoption of modern scientific effectiveness models is recommended to increase the collaboration and quality of researchers, as well as a literacy intervention model to shorten the cognitive distances between them.

Regarding the limitations, the study focused on a very small sample size of professors, which contrasts with the cited background studies that examined thousands of professors. Furthermore, the study only considered a specific school and did not consider all schools within the studied university. Moreover, other potentially relevant independent variables were not considered in the study, such as scientific collaboration, funding, age, informal strategies (e.g., participation), formal strategies (e.g., being the lead author), and others. Indeed, future research can be expected to work with larger samples, comparing results among different schools within the same university, and even across different universities. In addition, future research should incorporate the aforementioned unaddressed independent variables and include variables related to the quantity and the quality of publications. This includes considering traditional scientometric standards such as author H-index and citation count, as well as exploring alternative metrics (altimetric).

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