

Exploring gender differences in Physiotherapy research in Italy: a cross-sectional analysis

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ABSTRACT

Introduction: Gender equity in scientific research, especially in Physiotherapy, reveals significant underrepresentation of women, affecting career advancement, salary, and research recognition. This study aims to examine the characteristics, knowledge, attitudes, and productivity of Physiotherapy researchers in Italy, focusing on gender distribution.

Methods: This cross-sectional study was conducted on Italian Physiotherapists who either have a PhD or are currently enrolled in PhD programs.

We used a survey consisting of 62 items that explored demographic and educational characteristics, research experience, work-life balance, attitude and social norms, and career-related factors. Performance metrics included H-index, number of publications (during PhD and in the whole career), and awards.

Results: Of the 167 Physiotherapists surveyed, 102 participated. Female participants reported worse attitudes and social norms perception, and during their PhD, were less satisfied with work conditions compared to males. Females reported a median of 3 publications during their PhD, and males 5. However, after adjusting for age, time invested in research, and whether the interviewee lives with a partner, age remains the only associated factor. There is no evidence of an association between gender and H-index or awards.

Conclusion: Gender-based disparities in research attitudes exist in Physiotherapy, particularly during the PhD phase, favoring males. Further research is needed to promote gender equity.

Keywords: Academic productivity, Gender, Physiotherapy, PhD, Research career.

What's already known about this topic?

Women face challenges in achieving gender equity in medical research, encountering underrepresentation in high-level positions, lower chances to obtain grants, and insufficient recognition of their research contributions, despite their extensive expertise and qualifications.

What does the study add?

The study highlights significant gender-related differences in perceptions of social norms and work satisfaction among Physiotherapy researchers in Italy. This could inform policy changes to promote gender equity in this field.

Introduction

Gender equity in medical research involves ensuring that all researchers receive equal representation, recognition,

and valuation, irrespective of their gender (1). However, the representation of women in science has often been underestimated (2).

Currently, the United Nations reports that 33% of researchers worldwide are women (3). Similar percentages are found within the field of Science (4). Since the 2000s, Italian Physiotherapists have significantly invested in postgraduate university education across various scientific fields, resulting in 83 PhD awarded to date, 36% of whom are women (4).

Women in Physiotherapy science enrich the field with diverse PhD backgrounds, including Biomedical Engineering,

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Social Sciences, and Public Health, yet face challenges in career development and salary disparities. According to UNESCO, women dominate early research stages but decrease in prevalence at higher, better-paid positions (5). Additionally, it appears that female researchers have lower chances of securing research project grants and being appointed in prominent roles in high-profile journals in their research career (6,7).

Women produce less research than men, impacting their retention and advancement in science (8). This gap may arise from productivity differences or a lack of acknowledgment of women's contributions (9). The reasons behind these disparities are not thoroughly comprehended. Women's access, participation, and advancement in science are influenced by individual, family, social, educational, and economic factors (10). Numerous studies support the notion that our culture harbors unconscious biases, positioning women as more aligned with theoretical thinking and family-care responsibilities (11). There is a perception that women are unsuitable for high-level scientific positions, while men are seen as more suited for advanced managerial roles due to their perceived greater aptitude for rational and scientific thinking (12).

Despite the existing literature highlighting gender disparities in science, specific evidence regarding the Physiotherapy research community remains limited. Thus, we conducted a cross-sectional survey to investigate the characteristics, knowledge, and attitudes of Physiotherapy researchers and examine how gender influences performance and career advancement. Specifically, we aimed to explore: i) gender characteristics of respondents; ii) gender perceptions and attitudes in Physiotherapy research; and iii) the role of gender in research performance and career progression.

Methods

Design, study protocol, and ethics approval

We undertook a cross-sectional study via a structured online closed survey, which was disseminated to all PhD students or Physiotherapists who completed a PhD, listed in the Società Italiana di Fisioterapia (SIF) database (13). The SIF database was established through a systematic process. The eligibility criteria included Physiotherapists with completed or ongoing PhDs, working in Italy, regardless of their nationality. These Physiotherapists were identified through systematic screening of PhD calls and enrollment lists across Italian universities. After the identification of the eligible candidates, a verification of the professional profile required was conducted by two independent researchers. Once verified, identified individuals were contacted via email to confirm and give consent to their inclusion in the database. The database is periodically updated through reviews of new admissions and completions and through newsletters that allow self-reporting of missing or newly eligible professionals. No incentives were provided to participants. Guidelines for Reporting Survey-Based Research (14,15) and Observational Studies were followed (16,17) as reported in Supplement 1. We followed the reporting guidelines for Sex and Gender Equity in Research (18). The study complies with the Declaration of Helsinki. The study protocol was approved in June 2023 by the National Ethics Committee of the University of Genoa. Documentation and protocol details are stored in the Open

Science Framework, at the following link [Online](#). No significant amendments were made.

Survey invitation and management

We created a web-based questionnaire using the SurveyMonkey platform (19) for collecting response data. The survey was launched on September 14, 2023, with two reminders on September 20 and 27, 2023. Data collection concluded two weeks later. Before completing and submitting the survey, respondents provided explicit informed consent and data protection. Questionnaires were completed anonymously, with responses automatically recorded and not attributable to individuals. The SurveyMonkey platform restricted multiple submissions by IP address to minimize duplicates. Entries with the same IP address were deduplicated, keeping the last complete submission. Completeness was ensured using server-side techniques that flagged missing or inconsistent responses. Questionnaires with atypical characteristics (e.g., implausible age) were reviewed. Data collection and analysis were managed independently, ensuring subjects could not be re-identified.

Content and face validity of the Questionnaire

Drawing on similar questionnaires published in the literature (20-22), we built our theoretical framework and piloted the survey with all members of the Scientific Committee of AIFI (Associazione Italiana di Fisioterapia) to assess content validity of survey development and refine the face validity of the final questionnaire version. The invitation outlined the study's purpose, estimated completion time, and question content. The Scientific Committee approved the final 62-item questionnaire: "consent to participate and privacy", (I) "demographic characteristics" (items 1-7), (II) "Education" (items 8-13), (III) "Research experiences" (items 14-19), (IV) "Postdoctoral experience" (items 20-28), (V) "PhD experience" (items 29-38), (VI) "Work-life balance" (items 39-50), (VII) "Attitudes and social norms" (items 51-55), (VIII) "Awards and fundings" (items 56-58), and (IV) "Bibliometrics" (items 59-62). The questionnaire was formulated in Italian to ensure suitability for the target demographic. The original questionnaire and the translated version in English are available in Supplement 2.

Sample size calculation for survey response

We used SurveyMonkey (23) to calculate the expected number of complete responses as the sample size. Based on a population size of 169 subjects, which is the total number of PhD students or Physiotherapists who completed a PhD listed in the SIF database (13), with a margin of error of 5% and a sampling confidence level of 85%, we obtained a sample size of 93.

Outcomes

We defined some proxy outcomes for *performance and advancing a career in Physiotherapy research*, such as i) the H-index, ii) the number of publications obtained in the whole career, iii) the number of publications during the PhD period, iv) the presence of any awards (e.g., best oral presentation or best abstract). We collected data on the four outcomes from



our sample of invited participants, who are listed in the SIF database (13) and responded to the survey.

Exploration of public reports from Scopus

Additionally, we documented the number of publications obtained in the whole career and the H-index of all participants by using publicly accessible data from Scopus as the whole population of interest (24). In Supplement 3, we reported national and database data.

Statistical analyses

All analyses reported here were planned and conducted post hoc. Therefore, analyses should be interpreted as hypothesis-generating rather than confirmatory, and we report all analytic choices transparently.

Metrics are summarized using the median with interquartile range (IQR), or the count with percentage (%). Characteristics of the respondents stratified by gender are compared using the Chi-square/Fisher's exact test, the independent t-test or the Mann-Whitney *U* test. To examine if the association between social and work conditions varies with gender, logistic regression models were fitted to ascertain the statistical significance of the interaction, and gender differences are presented as probabilities with 95% Confidence Interval (CI). Due to the minimal occurrence of missing responses, no specific handling procedures were implemented, as their impact on the overall analysis was deemed negligible.

Multivariable modeling using negative binomial (NB), or logistic regression, was fitted to identify factors associated with the H-index, number of publications during career, number of publications during PhD, and achievement of awards. Given the modest sample size, we intentionally adopted a parsimonious modelling strategy to mitigate overfitting and estimate instability. Covariates were included based on the author's knowledge rather than data-driven screening or automated selection procedures. Models were developed using age as a covariate (years), being married/living together (whether the interviewee lives with a partner) and time invested in research activities (%) as adjusting factors (the latter was not considered as an adjustment factor in the model for the number of publications during PhD). Particularly, in the model with H-index as dependent variable, we used subset of Physiotherapists aged <52 years, excluding 10 individuals who enrolled in, or completed their PhD program at later age; also, in the model with number of publications during PhD as dependent variable, we used age at the beginning of the PhD program and tutor gender (males, females or both) as further adjusting factors. Using Akaike Information Criteria to assess model fit, age was modelled using a restricted cubic spline with 3 knots at 10th, 50th and 90th percentiles of the distribution of age. An omnibus Wald test was used to assess the overall association between age and the outcome. The likelihood ratio test was used to test the model with and without interactions between gender and selected covariates. NB models used the logarithm of time since obtaining a bachelor's degree as exposure; results are presented as predicted marginal means or probabilities provided with 95%CI. All models were checked for specification and goodness-of-fit (Supplement 8). The significance level was

set as $p < 0.05$. All analyses were carried out using STATA-MP 18.0 (25).

Role of the Funding Source

AIFI exclusively sponsored the SurveyMonkey license. The AIFI Scientific Committee received no remuneration for their role in the study. MP received the "Women in Physiotherapy Science" grant from AIFI to carry on the study.

Results

Response rate

Overall, 102/167 Physiotherapists responded to the survey, yielding a participation rate of 61%. The sample for each section is presented in Figure 1. Ten out of 102 respondents (10%) dropped out before completing the whole questionnaire. Coverage rate for PhD students and Physiotherapists who completed the PhD was 74% (45/61) and 53% (56/106), respectively.

Respondent characteristics, education, PhD and postdoctoral experience.

Table 1 presents the general characteristics of the respondents. One participant stopped the questionnaire before declaring whether the PhD was completed or ongoing. All respondents, except one, reported having Italian nationality. Over two-thirds of participants are married or live with a partner and have a higher education degree (e.g., University). Three participants were referred to as having disabilities/handicaps. The 50% of the respondents obtained a BSc in Physiotherapy before 2011 (IQR 2005-2015), whereas the 44% were enrolled in a PhD program before 2018 (IQR 2015-2021). Particularly, 27 participants (12 females) earned their BSc degree before 2006, when PhD programs in Italy became available to physical therapists.

Males and females do not show evidence of difference in terms of age ($p = 0.16$) or year of PhD access ($p = 0.89$); nor are they married/living together ($p = 0.21$), nor tutor gender ($p = 0.37$). In Supplement 4, we reported characteristics of the respondents stratified by PhD students/Physiotherapists who completed a PhD and gender. In Supplement 5, we reported the satisfaction of the respondents about work (sections 4 and 5 of the questionnaire) in the whole population, stratified by gender, whereas in Supplement 6, satisfaction of the respondents was stratified by PhD students/Physiotherapists who completed a PhD and gender.

Gender modifies the association between having a PhD and being satisfied with intellectual challenges ($p = 0.04$): females with a PhD (14/26) have 36% (95%CI: 14-58%) lower probabilities than males (26/29) to be satisfied. Having a PhD and being satisfied with job contents varies according to gender ($p = 0.03$), with males (24/29, 83%) having 25% (95%CI: 16-49%) higher probabilities of being satisfied compared to females (15/26, 58%). The association between having a PhD and being satisfied with job services varies as well with gender ($p = 0.03$), with males (19/29, 66%) having 46% (95%CI: 23-69%) higher probabilities of being satisfied compared to females (5/26, 19%). Also, gender modifies the association between having a

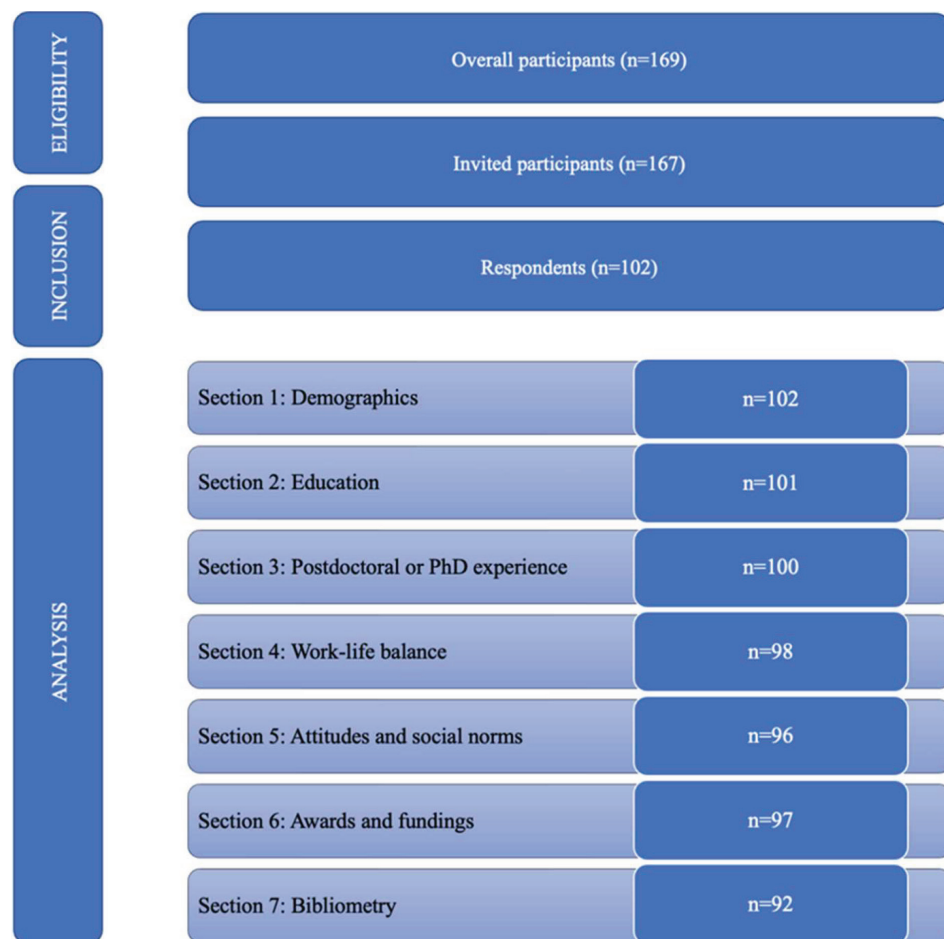


FIGURE 1 - Flow diagram of respondents. The number of participants is reported for each section of the questionnaire.

TABLE 1 - Characteristics and education of the respondents by gender

	All respondents N = 102	Females (n = 50)	Males (n = 52)
Age (y)	38 (33-43)	36.5 (31-44)	38.5 (34-41)
Married/living together (n[%])	75 (74%)	34 (68%)	41 (79%)
PT degree (y)	2011 (2005-2015)	2012 (2006-2016)	2008 (2005-2012)
PhD ongoing or completed**			
<i>PhD ongoing</i>	45 (44%)	23 (46%)	22 (42%)
<i>PhD completed</i>	56 (55%)	27 (54%)	29 (56%)
PhD access (y)**	2018 (2015-2021)	2018 (2015-2021)	2018 (2014-2021)
PhD abroad**	30 (29%)	10 (20%)	20 (38%)
Funded PhD**	38 (37%)	22 (44%)	17 (34%)
Latency PT and PhD access (y)*	7 (4-12)	5 (3-12)	7 (5-11)
Tutor gender**			
<i>Male</i>	54 (53%)	26 (52%)	28 (54%)
<i>Female</i>	33 (32%)	19 (38%)	14 (27%)
<i>Both male and female</i>	14 (14%)	5 (10%)	9 (17%)

Legend. Values are presented as median and interquartile range or as count and percentages. y = years, n = number of participants, PT = Physiotherapy
*Two participants obtained their PhD before obtaining a PT degree and were thus excluded from the analysis. **one missing answer

PhD and satisfaction with career advancement opportunities ($p = 0.04$), with males (16/29, 55%) having 36% (95%CI: 12-60%) higher probabilities of being satisfied compared to females (5/26, 19%). The association between international mobility opportunities and having a PhD is affected by gender ($p = 0.002$), with males (16/29, 55%) having 32% (95%CI: 8-56%) higher probabilities of satisfaction compared to females (6/26, 23%). Further, gender affects the association between having a PhD and overall satisfaction ($p = 0.02$): males (26/29, 90%) have 32% (95%CI: 10-54%) higher probabilities of overall satisfaction compared to females (15/26, 58%).

On the contrary, gender does not show any effect modification on the association between PhD status and salary satisfaction ($p = 0.10$); however, males with a PhD have 42% (95%CI: 18-66%) higher probability of salary satisfaction compared to females with the same academic title.

Work-life balance

Regarding work-life balance, to the question "Have you ever needed to take breaks from your work (including parental leave)?", 21 (of which 14 females) participants responded "yes". In total, females had to leave work for a median of 6 (95%CI: 2-11) months more than males. Some participants declared more than one reason that led to temporary work leave. The main reason for these interruptions was parental leave in both males (5/7, 71%) and females (10/14, 71%), followed by unpaid leave for relatives' care (i.e., children, elderly and/or persons with disabilities) in females (5/14, 36%) and males (2/14, 29%).

The association between being married/living together and taking care of their relatives ($p = 0.55$) or taking work leaves ($p = 0.28$) does not change with gender. Among Physiotherapists who are married/living together, the 62% of females (21/34) and 71% of males (29/41) take care of their relatives, and the 41% of females (14/34) and 17% of males (7/41) who are married/living together take work leave.

Comparing responsibility in daily-life activities (i.e., shopping/errands, meal preparation, laundry, house cleaning, gardening, extraordinary house maintenance, and management of children or persons with disabilities within your family), 43% of females were in charge of these activities compared to 10% of males ($p = 0.01$).

Attitudes and social norms perception of the respondents

A total of 96 respondents answered the item investigating attitudes and social norms perception (six interviewees skipped this section). In general, males and females feel equally adequate in their roles as researchers; however, women report different economic treatment, less success, and a different attitude (Table 2). In Supplement 7, we reported positive responses about attitudes and social norms perception of the respondents stratified by PhD students/physiotherapists who completed a PhD and gender.

Performance and advancing a career in Physiotherapy research.

The H-index ($p = 0.27$), number of publications during the whole career ($p = 0.11$) and receipt of any awards ($p = 0.15$)

were comparable between males and females. Looking at the PhD period, males published a significantly higher number of papers (median = 5, range 0-46) than females (median = 3, range 0-21) ($p = 0.02$). Table 3 presents the outcomes of performance and advancing career in Physiotherapy research by gender, investigated through the survey.

The NB model for H-index ($\chi^2 = 9.94$, $p = 0.077$, Table 4) found a statistically significant association with age ($p = 0.02$). The predicted mean H-index for a female aged 40 is 11 (95%CI: 7-15), whereas for a male is 8 (95%CI: 6-11), without evidence of difference between genders ($p = 0.15$, Supplement 8, Fig. 8.1). Number of publications ($\chi^2 = 21.56$, $p = 0.001$) is statistically associated with the percentage of time dedicated to research ($p = 0.09$) and with age ($p < 0.001$), but not with gender ($p = 0.92$, Supplement 8, Fig. 8.2). At 40 years old, Physiotherapists are expected to have published 36 (95%CI: 24-49) papers. As the time allocated to research increases (e.g., 25%, 50%, and 70%), the expected numbers of papers increase at 22 (95%CI: 17-28), 29 (95%CI: 22-35) and 37 (95%CI: 24-49), respectively.

TABLE 2 - Positive responses about attitudes and social norms perception of the respondents by gender

	No of participants (n = 96)		
	Females (n = 46)	Males (n = 50)	Difference (95% CI)
Equal treatment F/M	31 (67%)	45 (90%)	23% (7% to 38%)
Equal Salary F/M	37 (80%)	47 (94%)	14% (0.3% to 27%)
Equal Success in research F/M	24 (52%)	46 (92%)	40% (24% to 56%)
Equal "being adapted" in research F/M	45 (98%)	49 (98%)	0.2% (-6% to 6%)

Values are presented with the count and percentage of participants answering "yes" to the reported parameters. N = number of participants, F = female, M = male. 95%CI denotes lower-upper 95%CI limits of the difference.

TABLE 3 - Performance and advancing career in Physiotherapy research by gender (survey source)

	All respondents N = 92	Females (N = 43)	Males (N = 49)
H-index*	5 (2-12) 0-31	3.5 (1-12) 0-31	6 (2-12) 0-28
No of publications during the career	12 (5-40.5) 0-177	10 (5-30) 0-104	18 (8-47) 0-177
No of publication during PhD	4.5 (2-8) 0-46	3 (1-6) 0-21	5 (3-11) 0-46
Participants with awards	47/96 (49%)	19/46 (41%)	28/50 (56%)

Values are presented as median (IQR) with range (min to max) or as count with percentages. N = number of participants. *one missing participant, in total: 42 females and 49 males.



With regards to the number of publications during the PhD, the fitted model ($\chi^2 = 14.8$, $p = 0.02$) shows an association with age ($p < 0.001$). As the age at PhD enrolment increases, the number of publications done during the PhD decreases. At 30 years old, 9 (95%CI: 7-11) publications are expected compared to 2 (95%CI: 0-3) at 50 years old. Males are expected to have 8 (95%CI: 6-10) publications compared to 6 (95%CI: 4-7) for females, without evidence of difference ($p = 0.16$, Supplement 8, Fig. 8.3). The logistic model ($\chi^2 = 18.2$, $p = 0.006$) shows evidence of an association between time dedicated to research and the probability of getting an award ($p = 0.005$), which is 52% (95%CI: 42-62%) when one dedicates 50% of his/her time to research. As age increases, the probability of winning an award decreases (Supplement 8, Fig. 8.4), with no statistically significant difference ($p = 0.13$): 58% (95%CI: 37-80) at 30 years to 24% (95%CI: 1-47) at 50 years. Males have 11% higher chance of winning an award than females ($p = 0.28$). Model coefficients with 95%CI are provided in Table 4, together with the likelihood ratio test for the model with and without gender interactions (Supplement 8). Model diagnostics indicated good specification and adequate goodness-of-fit.

Results on the public report from Scopus

Exploring the published list ($n = 169$) of Physiotherapists with a PhD and publicly available data in the Scopus database (24), 63% are male, and 37% are female. The median H-index for males is 6 (range 0-30), compared to 4 (range 0-32) for females ($p = 0.07$). Males have a median of 15.5 publications (range 0-233), whereas females have a median of 9 publications (range 0-110) ($p = 0.04$), slightly higher than the numbers reported in the survey questionnaire.

Discussion

In this cross-sectional study, we explored gender characteristics and perception among all Italian Physiotherapists who have completed or are currently enrolled in a doctoral program; further, we investigated the association of gender with performance and advancement in physiotherapy research. We found consistently higher probabilities of satisfaction regarding job content, work services, career advancement opportunities, international mobility opportunities, intellectual challenges and overall work satisfaction, potentially determined by gender, favoring males. These differences were observed between female and male PhD

TABLE 4 - Models estimates

	H-Index ^a	Career ^a	Career during PhD ^a	Awards ^b
Gender				
male	-0.28	0.02	0.29	0.51
	[-0.65, 0.10]	[-0.37, 0.41]	[-0.11, 0.69]	[-0.42, 1.44]
Age spline1	0.12	0.15	0.03 [§]	0.02
	[0.02, 0.21]	[0.08, 0.22]	[-0.06, 0.12]	[-0.16, 0.19]
Age spline2	-0.09	-0.21	-0.14 [§]	-0.19
	[-0.45, -0.17]	[-0.30, -0.11]	[-0.28, -0.00]	[-0.39, 0.06]
Research Time	0.01	0.01		0.03
	[-0.00, 0.01]	[0.00, 0.02]		[0.01, 0.04]
Married/living together				
Living alone	0.30	0.30	0.06	-0.03
	[-0.11, 0.72]	[-0.14, 0.75]	[-0.40, 0.52]	[-1.05, 0.99]
Tutor Gender				
Female			-0.06	
			[-0.48, 0.37]	
Male and Female			-0.21	
			[-0.82, 0.40]	
Years from BSc PT				0.12
				[-0.01, 0.25]
Number of observations	84	92	92	96

Estimated coefficients with 95% Confidence Intervals [lower-upper] from Negative binomial models expressed as log counts (^a) and from logistic model expressed as log odds (^b). § denote age at PhD enrollment.

Physiotherapists students, but not among those who had already completed their PhD. These results are consistent with the study by Corvino and collaborators (21) in which female PhD students reported worse perceptions during their doctoral studies compared with their male counterparts.

Despite the Italian stereotype of female roles within families (20), we did not find evidence that taking care of relatives or work leave depends exclusively on females. However, combining this information with reported daily-life responsibilities, a higher percentage of females compared to males have domestic, social, and family burdens. These gender disparities in work-life balance have already been reported elsewhere (22,26,27) and were also studied compared with other countries. For example, in Norway, family responsibilities are assumed to be less extensive: over 90% of the children go to kindergarten compared to 24% in Italy (28,29).

Moreover, the female gender seems to explain some different attitudes and behaviors towards social life, specifically in terms of equal treatment and equal success in research. Specifically, females are less convinced about equal salary and equal success in research. This particular finding aligns with the research of Corvino et al., (21) which found that female PhD students exhibit lower scores than their male counterparts in perceptions of health and safety at work, probably due to gender bias influenced by cultural norms and gender-based stereotypes (30-33).

Regarding academic achievements, we did not find evidence of a difference in H-index, number of publications during the entire career, and awards between males and females, nor an effect modification of gender. Regarding awards, our results agree with a previous systematic review with meta-analysis of 55 studies that found no significant difference in award acceptance rates between men and women, with a slight, non-significant 1% higher acceptance rate for men (34). As far as publications are concerned, only during the PhD period, males published more, but the difference was not statistically significant once adjusting for the considered factors. Generally, the only factors that matter for academic performance are age and the time dedicated to research. In particular, the modelling of H-index reinforces the time-dependent nature of this metric, indicating that older individuals are expected to have a higher H-index, peaking around 40 years. Our results differ from a large previous systematic review in academic medicine that reported lower H-indexes for female faculty compared to male faculty, even after adjusting for academic rank (35). This difference may reflect the unique dynamics of our field, where many researchers are at the beginning of their careers, with very few participants covering academic roles within university faculties. A potential interpretation of such original result is that potential gender biases are not due to individual scientific productivity (which is genderless), but to other social dynamics more related to representativeness, which affect the capability of women to improve their productivity indexes belonging to networking at the top of the academic pyramid. In this regard, the cohort of Italian Physiotherapists approaching the academic career deserves to be monitored to observe whether this gap might emerge as long as academic positions continue to be covered.

Age plays a different role in explaining the number of publications during the PhD period. Indeed, as the age at PhD enrolment increases, the number of publications completed during PhD decreases, maybe due to already established personal and professional duties.

Our performance outcomes confirm previous findings in the biological and biomedical sciences (37) as well as in the academic organizational well-being of Italian PhDs (21).

Looking at the national data on the Scopus database, it seems that males have a higher number of publications than females. Similarly, regarding H-index, men tended to have higher metrics than women, as in other medical fields (37-40). Among 1922 academic urologists (38), men had higher median H-indices than women. In a study of 10118 internal medicine authors, men had higher H-indexes and more citations (39). For 1031 radiation oncologists (39), men had a higher median m-index than women, and among 134 pharmacists, men had more publications, citations, and higher H-indices than women (40). In these fields, males are predominantly represented, suggesting that the situation may be even more challenging in our sample of Physiotherapists, where nearly 60% are women. Recent research shows women held 29.8% of authorships, with significant underrepresentation in prestigious roles, as evidenced by lower odds ratios for first and last authorships compared to men (41).

Despite some differences that could be attributed to gender, our young population of Physiotherapist researchers began with the same opportunities and achievements. There is no overt evidence of a gender bias in the metrics of academic performance. Future research in this field should consider other factors that could influence research productivity, such as cultural influence, available resources, institutional support, and funding opportunities (10, 11). These elements are crucial for a more comprehensive understanding of research dynamics within the Physiotherapy community.

Addressing gender disparities in research requires a multifaceted approach involving individual, institutional, and systemic changes. Our study found that differences in performance and career advancement in Physiotherapy research between genders begin to emerge during the PhD program. Females are aware of these differences, as they have exhibited different attitudes and social perceptions compared to their male colleagues.

Young researchers should acknowledge gender disparities in academia and advocate for equality. Mentorship programs (42), gender equality plans, and professional development opportunities like "Women in Science" (43) can help women overcome challenges and advance their careers. Future research should continue to examine these disparities to inform strategies for fostering an inclusive and diverse research landscape (44).

Limitations

Although the participation rate was moderate (61%), the study has some limitations. The small sample size prevents us from statistically handling any further adjustments with sufficient power. Our sample had a balanced gender distribution, with both genders starting their PhDs around the same

time. However, it was not fully representative of the invited population, which had a higher male representation, even though the Physiotherapy profession has historically been predominantly female (13,45). According to the national data from *Federazione nazionale degli Ordini della professione sanitaria di Fisioterapista* on 69,848 Physiotherapists, 58.9% are female. Additionally, 29,362 Physiotherapists (42%) are under 40 years old (13,45).

Furthermore, we did not explore whether these differences exist between those who graduated (BSc) before or after 2005, particularly since admission of Physiotherapists to PhD programmes started only in 2006. This timing may influence career opportunities, although we did not specifically examine differences in PhD admission time across genders. However, it is important to note that Physiotherapists older than 52 years (90th percentile of age) were excluded from the NB models. These individuals began their PhD only recently, and their research productivity may therefore appear delayed compared with younger cohorts. This delay likely reflects the fact that Physiotherapy research opportunities in Italy only became available after 2006, when PhD programs for physical therapists were first introduced following the establishment of the Bachelor's degree regulation (47, 48). Nevertheless, a cohort effect is evident in our models, suggesting that older researchers in the sample may have experienced fewer cumulative research opportunities or different career trajectories.

The survey was extensive, but shorter e-questionnaires and a statement about other responses could have improved the response rate, as indicated by a Cochrane review (49). Moreover, subjective data in some sections might be affected by recall bias. When testing behaviours and perceptions, the accuracy of data is uncertain as it was collected via a self-reported survey (49).

Finally, because our sample comprises participants still enrolled in PhD programs, the performance metrics should be interpreted as provisional. Importantly, the analyses were specified and undertaken post hoc and were not guided by a prespecified, published statistical analysis plan. The modest sample size constrained model complexity; therefore, models were deliberately kept parsimonious to limit overfitting and estimate instability. These methodological limitations should be considered when interpreting the findings, particularly for smaller effects and interaction terms. Future studies should be supported by a published protocol with an a priori statistical analysis plan and sample size calculations to enable more robust, confirmatory inference as additional data become available.

Conclusions

Potential gender-based disparities in research attitude and productivity within the field of Physiotherapy exist, particularly during the PhD period, favoring males. However, disparities in academic performance are not associated with gender when corrected for age, living with a partner, and time invested in research activities.

Further research and interventions are warranted to fully understand and address potential discrepancies and promote gender equity in academic and research settings. Addressing

these disparities early in young researchers' careers is crucial to mitigating potential gender gaps as they establish credentials and advance in Physiotherapy.

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Authors Contributions: MP, S Gianola, and GC conceived the idea of this study. MP and S Gianola contributed to the study design and data collection. S Gambazza was responsible for data analysis and interpretation. GC and AT provided critical revisions to the manuscript. S Gianola and MP supervised the study and drafted the manuscript. All authors read and approved the final version of the manuscript.

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