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Gender Bias in Peer Review and Research Funding: An Empirical Analysis of Grant Applications in Pakistan

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ABSTRACT

The current study examined research project submissions by discipline. It also reviewed the peer evaluation reports of these projects. All projects were submitted to a funding agency for grant consideration. There was no gender bias in the selection of the Scrutiny Committee. This committee shortlisted 622 projects out of 1,787 submissions. Female representation in both submitted and shortlisted projects was below 20%. Each shortlisted project was evaluated by two subject experts. They provided detailed comments and a final score. Grade A indicated the highest funding priority, B was medium, and C was the lowest. Each project received two grades, resulting in six possible combinations: AA, BB, CC, AB, BC, and AC. Tests such as Cronbach's alpha and Fleiss' Kappa showed low internal consistency between peer reviewers' grades. This suggests that the scores were based on scientific criteria and not awarded randomly. However, further analysis showed a trend. Male applicants received more favorable scores than females. Female applicants were at a relative disadvantage. The study recommends that peer review alone should not determine funding decisions. A follow-up bulk review, like the one done by the Scrutiny Committee, is necessary. This can help minimize gender bias. Detailed comments and grades from peer reviews can guide the bulk review. They help assess the strengths and weaknesses of each project. This ensures that decisions focus on scientific merit and the project's potential for socio-economic impact through local research. While bulk review may not fully remove gender bias, it reduces the chances of gender-based discrimination. Funding decisions would then be based on well-argued scientific evaluations.

Key Words: Gender Bias, Research Grants, Funding, Peer Review, Bulk Review

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1. Introduction

Peer review is a critical component in the decision-making process of funding agencies and is prone to biases and inefficiencies (Recio-Saucedo et al., 2022). Experts from relevant fields assess research proposals for quality, alignment with national priorities, and relevance to the agency's objectives (Higgins et al., 1990). Research is evaluated with higher emphasis on scientific parameters than on societal relevance (Abma-Schouten et al., 2023) and gender balance is a big phenomenon when it comes to research funding existing in scientific community with varying degrees (Ranga et al., 2012). This paper analyzes a set of research projects submitted to a Pakistani funding agency between 2019 and 2021. The women participation in these projects is less than 20% and exactly similar ration is reported in European study of 11 countries (Hermansson et al., 2021). The evaluation process includes (1) A Scrutiny Committee that shortlists proposals based on scientific merit, commercial viability, researcher credentials, and national priorities and (2) the Peer review of shortlisted projects by subject experts in a single-blind format. Reviewers remain anonymous to both the applicants and each other.

This study explores several key aspects:

- Gender bias in Scrutiny Committee decisions.
- Gender patterns in peer review scoring.
- The influence of research field on gender-based review outcomes.
- Consistency in grading between peer reviewers.
- Appropriate methods for awarding research grants.

Peer review is expected to be objective, free from gender or disciplinary bias. However, it significantly influences how researchers are perceived and their ability to secure grants. This paper specifically investigates the presence of gender and field-based biases in peer review.

Funding of research grants is scarce (Wessely, 1998). Pakistan presents unique challenges due to limited research funding. For example, in 2020–21, the Ministry of Science & Technology had only Rs. 37.91 (approx. $0.10) per capita for scientific initiatives (Finance, 2021). making fair and effective use of funds even more critical.

While journals use peer review to select papers for publication, funding agencies use it to allocate financial resources—making the stakes higher. Gender balance in grant funding is therefore more consequential than in academic publishing (Squazzoni et al., 2025).

Although scientific merit must remain the priority, gender balance ensures equitable inclusion of nearly half the population in national development. Identifying and addressing gender bias in grant review processes is essential (Cruz Castro & Sanz Menéndez, 2020). A standardized, bias-free approach could help female scientists compete on equal footing and contribute more effectively to national progress.

2. Literature Review

There are evidences that gender bias is reflecting in decision making through peer review and the work of women are more likely to be lower graded than those of men, despite high quality of design, quality, and relevance (Budden et al., 2008; Helmer et al., 2017). The gender bias may be implicit due to the general perception of women being less competent and thus less favorable for innovative work through indigenous Research & Development. The Research studies have

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moved a step ahead that the gender bias is not only reflected in rejection rates, instead it is less likely that women are invited as peer reviewers (Lerback & Hanson, 2017; Lerchenmueller & Sorenson, 2018). Such facts lead women towards under representation and lead towards gender bias creating disadvantage for women in scientific endeavors (Squazzoni et al., 2025).
Women are at disadvantage from another point of view citing domestic challenges and childcare which makes it cumbersome for them to serve as active peer reviewer (Nielsen et al., 2017) which perpetuates a stereotype perception that women are less likely to effectively contribute in scientific fields.

Women are considered less likely in collaborative research projects. Male researchers are more likely to be nominated as lead author despite that the woman has significant contribution in the study (Larivière et al., 2013). This scenario limits chances for women to be professionally known.

Single blinded review is more inclined towards high reputation institutions and famous authors than double blinded review (Tomkins et al., 2017) similarly women are less likely to be biased in double blinded peer review than single blinded peer review (Kern-Goldberger et al., 2022). On the contrary, studies also determined the fact that women authors are altogether less in number than men and that double blinded peer review also had no favor increasing probability of women authors' share (Cox & Montgomerie, 2019). Furthermore, the acceptance rate also reduced almost 18%, going from single blinded to double blinded peer review (Ucci et al., 2022).Thus few perceive double blinded as a solution (Rodgers, 2017), few regard it as generating no favor to reduce this bias and designate that a general bias already exist. Another perspective comes across suggesting a triple blind review if that could minimize.

Authors believe triple blinded review can remove biases (Conklin & Singh, 2022; Brodie et al., 2021). The triple blinded peer review is just proposed as it ensures anonymity which in itself is difficult to manage to find peer reviewers being so much anonymous and the solutions proposes are conflict of interest classification and machine learning processes (Jung Jisooand Kim, 2017).

There are available studies that show overall bias towards females (Moss-Racusin et al., 2012) and there are also studies that double blinded peer review shows improvement towards increased representations of females (Budden et al., 2008). There is a section of research that advocates triple blinded review (Brodie et al., 2021; Conklin & Singh, 2022; Jung Jisoo and Kim, 2017). The triple blind study is effective in the context of medical research where anonymity resolves that only result of certain disease or some medicine is important than anybody else and that is prevalent without any critics (Henker et al., 1979; Mills et al., 2006; Nikpour et al., 2014)

The gender bias can even lead towards lack of diversity. The concerns are further being endorsed that the lack of diversity in science can even lead towards biases which will ultimately undermine equity in science (Haffar et al., 2019; Liévano-Latorre et al., 2020). Despite awareness to ensure gender equality in academia the imbalance remains for underrepresented groups (Llorens et al., 2021). Due to many ifs and buts, few even go to extreme and designate the overall peer review system as a flawed system (Smith, 2006). However, its efficacy is determined in multiple studies (Budden et al., 2008; Conklin & Singh, 2022b; Kern-Goldberger et al., 2022; Rodgers, 2017; Snodgrass, 2006) and the argument of a particular study cannot be borrowed.

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There is very thin margin to detect an overall standardized approach towards balanced decisions. Scientific funding may have multiple other merits other than gender and geography which can cause gender bias. At-least we must know that to what extend gender bias is existing so that the best possible measures could be taken to minimize this factor without compromising scientific merits of research studies. Most of these research studies are carried out for Journals, their review process, and ultimate publications (Squazzoni et al., 2025). The context of Peer review and the ultimate decision making for funding agencies is least studied sector where overall research projects could be segregated gender wise and then the peer review reports would be analyzed to determine the overall gender balance. This niché is being addressed in this study.

3. Data Collection

The data were collected in 2019 and in 2021. Two different calls for proposals were announced in national dailies. 1787 research proposals received under the two different calls for proposals. A total of 1030 projects received in 2019-20 and 757 under the second call for proposals in 2020-21. The maximum funding limit for one project was Rs. 20.0 Million ($71,500 US).

The research projects were categorized into 13 major fields of Research & Development, important in the context of Pakistan, like "Agriculture & Food Security", "Information Communication Technology", "Earth, Environment & Climate Change", "Biotechnology, Biochemistry & Molecular Biology", "Water & Soil", "Energy", "Engineering & Manufacturing", "Health Sciences", "Livestock", "Chemistry & Physics", "Other Emerging Areas", "Science Technology Education Mathematics (STEM)" and "Space Sciences".

3. Review Process

A total of 1787 research projects were received. All these projects were screened by a Scrutiny Committee whose role was to investigate the Project Title, its objectives, plan of work, expected outcomes and commercial prospects of the project. Keeping in view above facts, series of fields of study wise scrutiny committee meetings were held which shortlisted 622 research projects out of 1787. These shortlisted projects were sent to subject experts for peer reviewers for full length review. Each project was Peer Reviewed by two subject experts. Each subject expert was paid an amount of Rs. 10,000 for peer review and was given the time for two weeks for peer review. The experts who could not review under the given timeline were changed after the time expiry. All subject experts selected for Peer Review were selected from the relevant fields.

4. Statistical Model:

The total of 622 research projects were peer reviewed, each project by two subject experts. The raters had to give A: Highest Priority for Funding, B: Medium Priority for Funding and C: Lowest Priority for Funding. Each project was reviewed single blinded. The peer reviewer had complete information of the Principal Investigator (P.I.) of the project and the reviewer was anonymous for Principal Investigator (P.I.)

Each project got two grades (A, B or C) from two peer reviewers. Six combinations emerged as AA, BB, CC, AC, BC, and AC. First alphabet from one peer reviewer and the second one is from other. Thus, information emerged under different fields of studies. Each category has gender wise segregation vis-à-vis information of received rating by each peer reviewer.

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So, Crobach's Alpha determined to gauge internal consistency of peer reviewer in awarding grades to the project. Cross tabs analysis of the ratings with Expert-I and Expert-II determines the six combinations of scoring. Fleiss' Kappa was also tested as the peer reviewers were not unique. Further, the percentage of combinations was used to interpret results as the number of female participants were less and male were more in number and thus magnitude could not result in optimum projection to let us have a clear comparison of males versus females scores.

5. Research Findings

The scrutiny committee reviewed 1787 project proposals and sorted out 622 best projects for full length peer review by the relevant subject experts. This study mainly aims to predict the extent of variability in scoring in terms of gender. Following is the total gender balance in the project proposals submitted:

Table 1

Gender Balance in total Projects

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	338	18.9	18.9	18.9
	Male	1449	81.1	81.1	100.0
	Total	1787	100.0	100.0	

Table 2

Gender Balance after Shortlisting by Scrutiny Committee

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	115	18.48	18.48	18.48
	Male	507	81.51	81.51	100.0
	Total	1787	100.0	100.0	

Table Out of 1787 research projects received, female to male ration was 18.9 % and 81.1 % respectively, (**Error! Reference source not found.**) However, after review by scrutiny committee where 622 projects were shortlisted out of 1787, female to male ratio was 18.48% and 81.51% respectively. So, the negligible gender difference indicates that there is no gender bias in the committee's decisions as the overall female representation remained constant.

5.1.Cronbach's Alpha

Scale: ALL VARIABLES

Table 1

Cronbach's Alpha Results

		N	%
Cases	Valid	622	34.8
	Excluded[a]	1165	65.2
	Total	1787	100.0

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a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.157	2

Intraclass Correlation Coefficient

	Intraclass Correlation[b]	95% Confidence Interval		F Test with True Value 0			
		Lower Bound	Upper Bound	Value	df1	df2	Sig
Single Measures	.085[a]	.007	.163	1.187	621	621	.016
Average Measures	.157[c]	.014	.280	1.187	621	621	.016

Two-way mixed effects model where people effects are random and measures effects are fixed.

a. The estimator is the same, whether the interaction effect is present or not.

b. Type C intraclass correlation coefficients using a consistency definition. The between-measure variance is excluded from the denominator variance.

c. This estimate is computed assuming the interaction effect is absent, because it is not estimable otherwise.

Table 1 The Cronbach's Alpha coefficient value for two items is .157 for two items which suggests low internal consistency. As two subject experts have to evaluate same research project being anonymous to each other. There is very less homogeneity (15.7%) in the grades awarded by the peer reviewers after thorough evaluation of the research proposals. This test reflects very low chance that the projects will be evaluated with random similar grading by the both experts.

The crosstabs analysis also showed little internal consistency, be it overall, female or male. The cross tabs were obtained with Grades A, B & C awarded by both subject experts I & II.

Table 4

Expert_I * Expert_II * Gender Crosstabulation

Genders			**Expert_II**			**Total**
			A, Highest Priority for Funding	**B, Medium Priority for Funding**	**C, Least Priority for Funding**	
Female	Expert-I	A, Highest Priority for Funding	9	10	9	28
		B, Medium Priority for Funding	9	12	10	31
		C, Least Priority for Funding	15	13	28	56
	Total		**33**	**35**	**47**	**115**

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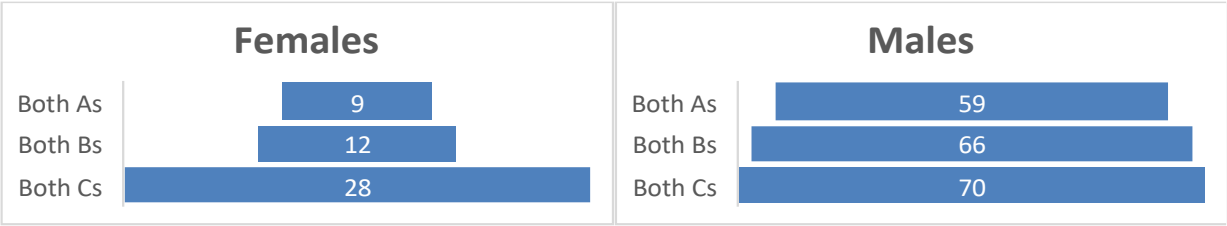
Male	Expert-I	A, Highest Priority for Funding	59	47	40	146
		B, Medium Priority for Funding	35	66	62	163
		C, Least Priority for Funding	63	65	70	198
	Total		**157**	**178**	**172**	**507**
Total	Expert-I	A, Highest Priority for Funding	68	57	49	174
		B, Medium Priority for Funding	44	78	72	194
		C, Least Priority for Funding	78	78	98	254
	Total		**190**	**213**	**219**	**622**

Error! Reference source not found. Only 68, 78 and 98 projects are those who obtained A, B and C grades respectively by both subject experts I & II out of sample of 622 projects. This reflects interesting picture that trend is increasing in terms of percentage moving from A to C grades i.e., 10.93% (Both As), 12.54% (Both Bs) & 15.76% (Both Cs). Total 244 out of 622 (39.23%) projects have same evaluation by both experts. The similar pattern is also reflected in Cronbach's Alpha coefficient having low internal consistency of 0.157.

Table 5

Tendency of Moving from Both As to Both Cs



Error! Reference source not found. Both A grades reflect high tendency of funding and Cs means lowest. The trend of evaluation of the projects submitted by females has sharp increase moving from Both As to Both Cs i.e., 9 (Both As), 12 (Both Bs) and 28 (Both Cs). However, the situation is different in males where only marginal increase is observed moving from both As to Cs. For males the scores are 59 (Both As), 66 (Both Bs) and 70 (Both Cs). So, the difference is high in females going from both As to both Cs (9 to 28) and it is marginally increasing in males going from both As to both Cs (59 to 70) reflects females at disadvantage in the peer review gradings.

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6. Fleiss' Kappa

The Kohen Kappa being not the relevant test citing that each project was evaluated by two subject experts but the subject experts keep changing for every project. The subject experts were chosen from the relevant field of study of the research project. So, the Fleiss' Kappa was relevant where the raters are not-unique and are randomly selected keeping in view relevance of subject field. The A, B and C grades were given numeric numbers 1, 2 & 3 respectively.

Table 6

Fleiss Kappa Overall Agreement

	Kappa	**Asymptotic**			**Asymptotic 95% Confidence Interval**	
		Standard Error	**z**	**Sig.**	**Lower Bound**	**Upper Bound**
Overall Agreement	.083	.028	2.922	.003	.081	.085

a. Sample data contains 622 effective subjects and 2 raters.

Table 7

Agreement on Individual Categories

Rating Category	Conditional Probability	Kappa	Asymptotic			Asymptotic 95% Confidence Interval	
			Standard Error	z	Sig.	Lower Bound	Upper Bound
1	.293	.115	.040	2.857	.004	.112	.117
2	.327	.083	.040	2.080	.037	.081	.086
3	.380	.055	.040	1.374	.169	.053	.058

a. Sample data contains 622 effective subjects and 2 raters.

Error! Reference source not found. & **Error! Reference source not found.** For three individual categories, there is stark difference and the agreement for highest rating A=1, the value of kappa is just 0.115, for medium rating B=2, the value of kappa is 0.83 and for least rating C=3, the value of kappa is 0.055. As kappa is the degree of agreement, there is very less agreement in higher priority for funding (A=1, kappa=0.115), highest in medium priority for funding (B=2, kappa=0.83) and lowest agreement in least priority for funding (C=1, kappa=0.055). Overall Fleiss' kappa is 0.83 with P value of 0.003 being statistically significant. Citing a thin range of A, B and C grades, the peer reviewer had to choose any one score vis-à-vis kappa value lying in the middle reflects that projects are not least prioritized by the peer reviewers nor the highest prioritized as both A and C have very little agreement of reviewers. However, the agreement seems trending towards B.

With low internal consistency and major agreement trending towards the middle, reflects the projects submitted for funding are not of very high-end quality as rated by peer reviewers. Secondly, the kappa agreement also reflects that no gender bias can be planned as one expert has to rate only one project and that overall agreement is also not lying in A and C categories.

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7. Gender-Wise Grading of Peer Reviewers

The sample contained total 115 projects from female scientists and 507 from male scientists, each got reviewed by two subject experts. Therefore, gender wise percentages were calculated to have a clear picture of the tendency of subject experts to award different grades to the research projects during peer review. The peer review was single blinded where the subject expert had complete detail of the Principal Investigator (P.I.) submitting project for review but the subject expert was not known by the P.I.

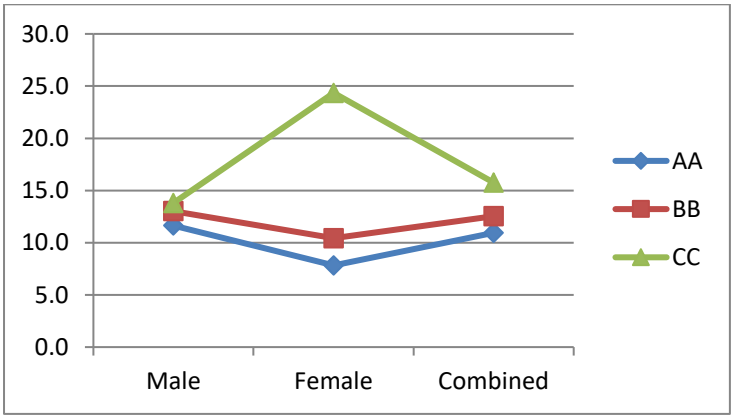

Figure 1 Percentage of projects received A, B & C grades by both Experts

Figure 1 Percentage of projects received A, B & C grades by both Experts, The percentage of projects of females getting CC grades by the subject experts is all the way higher than the average of Male scientists and the combined.

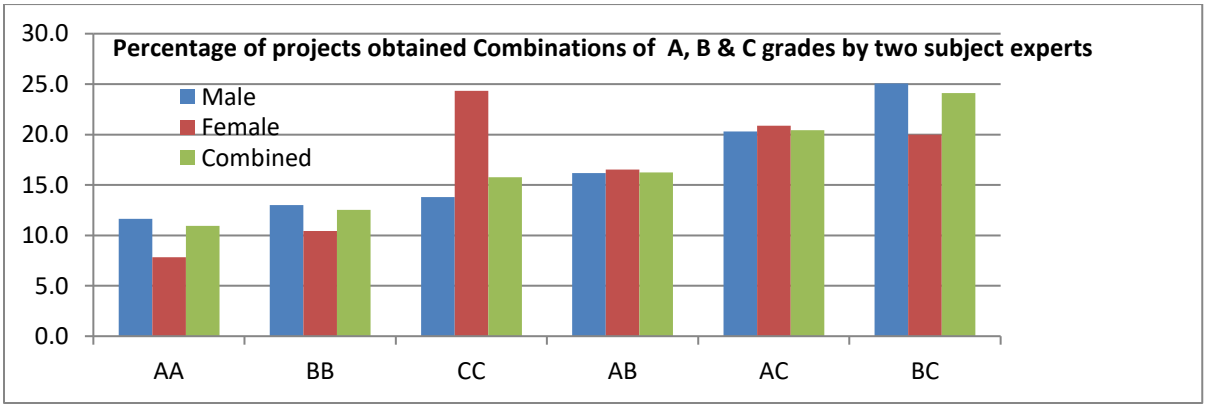

Figure 52 Percentage of projects scored AA reflects both experts awarding A grades…BC means one expert awarding B and the other expert awarding C grade to same project. (A is Higher Priority for Funding, B is Medium Priority for Funding and C is Least Priority for Funding.)

It is once again giving clear reflection that the tendency of giving both CC grades to female scientists is higher as compared to male scientists and even combined average.

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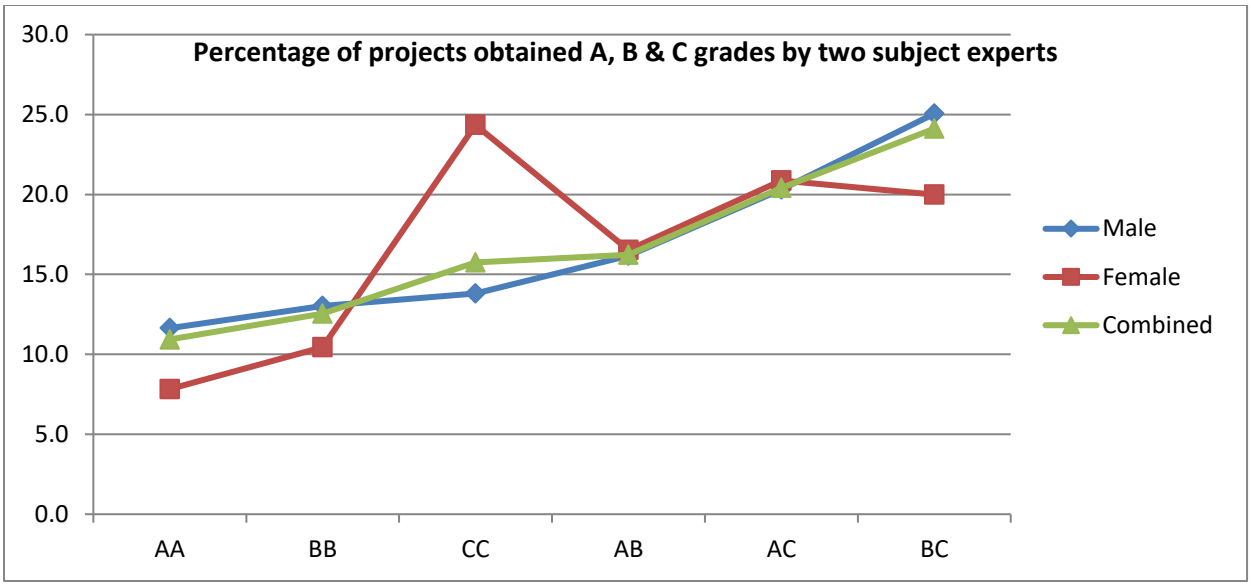
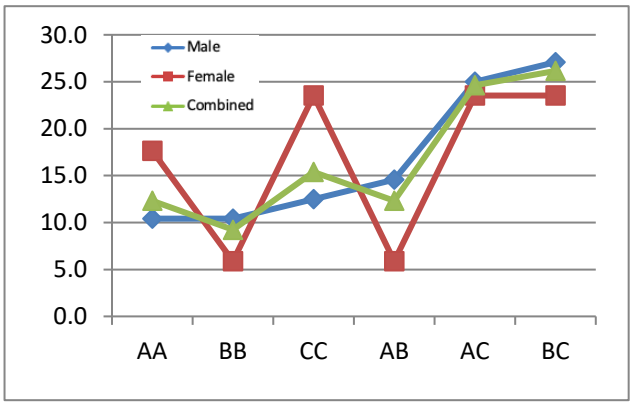


Figure 53 Scores Awarded by Both Experts in all 622 Projects Peer Reviewed by Subject Experts

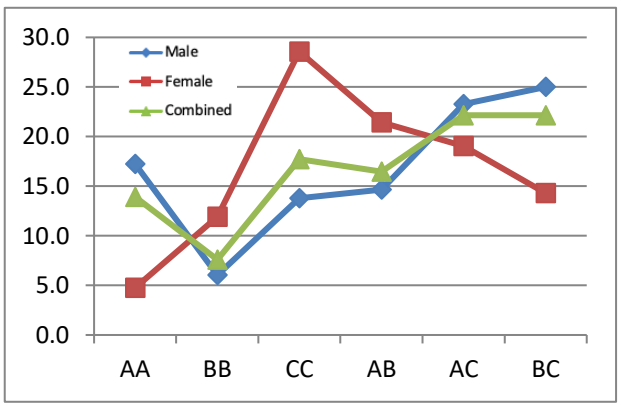
Figure 53 At points of better performance like AA or BB, where the tendency of project to be funded is high, the grades of female scientists are less than males and even less than the combined average. Where the grades reflect least performance, the female value crosses the average and higher in percentage i.e. CC where both experts designate a project as least considerable for funding. So, female gender is least favored.

8. Subject Wise and Gender Wise Grading by Peer Reviewers

The research projects were submitted in different disciplines. The projects were reviewed by two subject experts. Following is the discipline wise grading of peer reviewers reflected in terms of gender:



A. Agr. & Food Sci.



B. Biotech., Biochem. & Mol. Bio.

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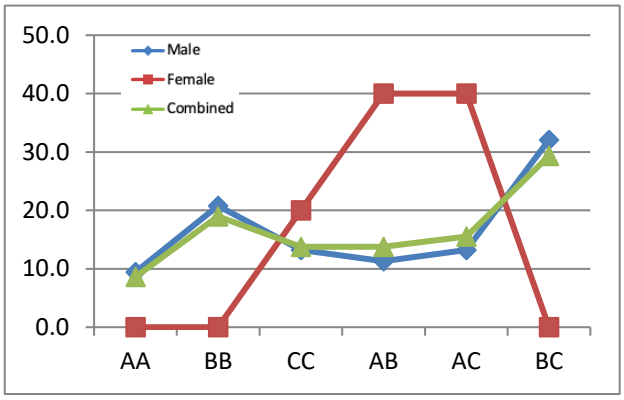
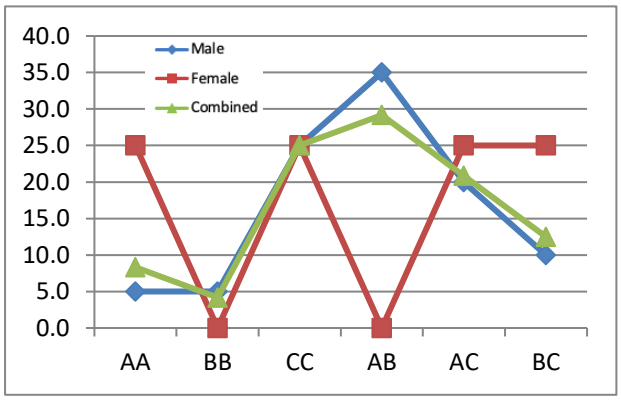
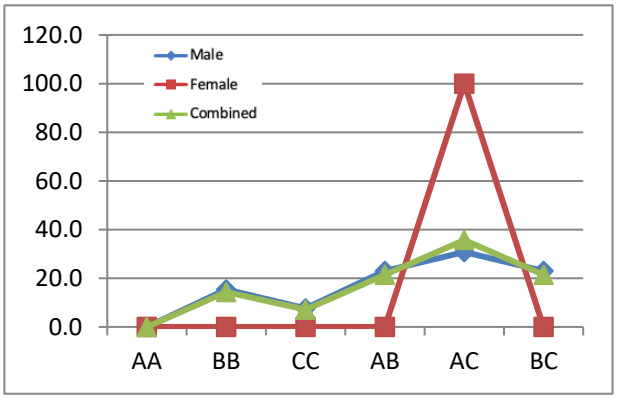


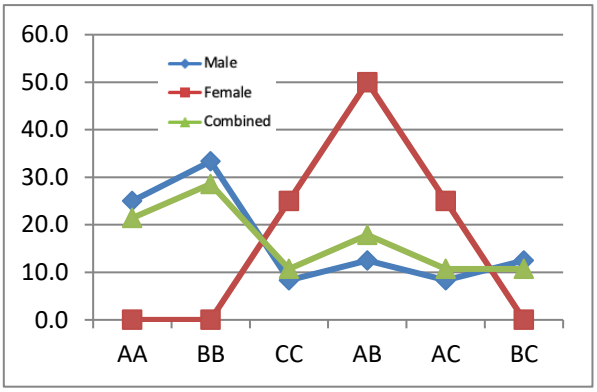
C. ICT



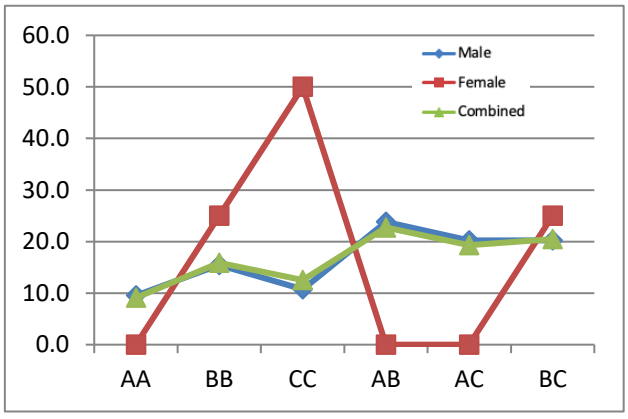
D. Earth. Env. & Climate Ch.



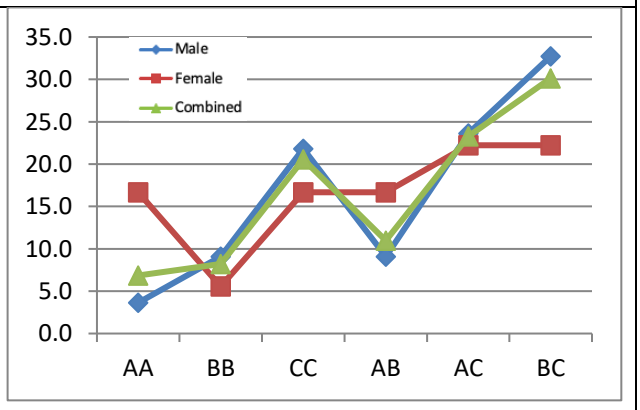
E. Water & Soil



F. Energy



G. Engg. & Manuf.



H. Health Sci.

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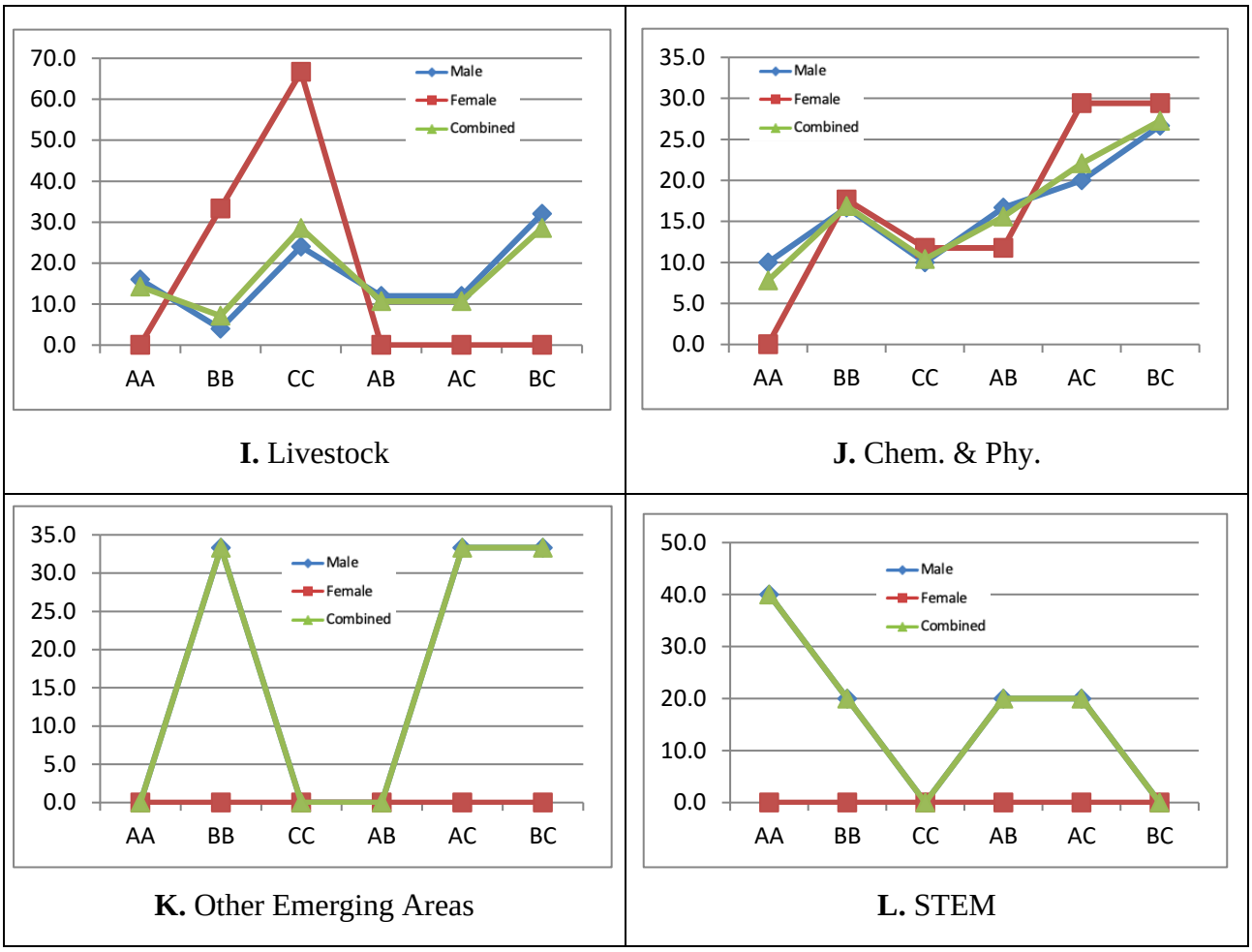

Figure 4 (A-L) Discipline-wise percentage of Peer Review Scoring of Males, Females and Combined

Figure 1(A-L): The pattern reflects scores awarded by peer reviewers in six probable combinations versus the percentage of the number of projects getting those scores' combinations for males, females and combined categories. The impression of female discrimination gets more evident as reflected in Fig. 3 which is combine form of all 12 disciplines from A-L, except Space Science where only one project was submitted from only male member. Grades awarded by all the subjects' experts reflect same pattern that women ratings are at disadvantage than male scientists except in few cases like "Health Sciences" and "Earth, Envr., Climate Change" where females scores are marginally better than males especially at CC levels. In rest of the fields, the female scoring at the levels of CC, is more than males and combined which reflects females at disadvantage.

9. Conclusion

The Cronbach's alpha indicated very low internal consistency, and Fleiss' Kappa revealed weak inter-rater agreement, suggesting a low likelihood of both experts assigning the same grades. Grading was limited to three levels—A (highest), B (moderate), and C (lowest)—offering little room for nuanced interpretation. Graphical analysis of scores by gender (male, female, and

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combined) further highlighted that female scientists consistently received lower peer review grades than their male counterparts.

This finding reinforces the need for double-blinded peer review, where reviewers are unaware of the principal investigator's identity or affiliation. Previous studies have shown reduced bias under this model (Budden et al., 2008; Mulligan et al., 2013; Rodgers, 2017; Snodgrass, 2006; Tomkins et al., 2017), though results have been mixed. Some studies report increased female authorship under double-blind review (Budden et al., 2008), while others found no significant reduction in gender bias (Cox & Montgomerie, 2019; Tomkins et al., 2017). Thus, single-, double-, and triple-blinded reviews each have strengths and limitations.

Controlled studies have also shown that highly rated proposals were sometimes poorly graded, with low inter-rater reliability, challenging the reliability of peer review alone for grant decisions (Mayo et al., 2006). A proposed alternative is the hybrid peer review model, which enables anonymous reviewers to interact with known researchers through a mediated process (Bravo et al., 2019; Lee et al., 2013). This model, in place in Pakistan since the 1970s with support from the U.S. National Science Foundation, is still practiced at the Pakistan Science Foundation (PSF).

At PSF, a technical committee or "bulk review" approach allows multiple experts to collectively evaluate proposals, promoting balanced decisions. In contrast, other agencies like the Higher Education Commission (HEC) rely solely on single-blinded peer reviews. While Pakistan's hybrid system is functional, its true efficacy still needs formal evaluation.

10. Recommendation

Peer review alone—whether single-, double-, or triple-blinded—is insufficient to ensure unbiased funding decisions, as gender bias may still influence outcomes. This study found that while peer review results reflected gender disparity, the Scrutiny Committee's deliberative process-maintained gender balance in the final shortlisting (622 out of 1,787 projects).

Therefore, it is recommended that after peer review, all projects should undergo a consultative review by a panel of experts who examine the reports collectively and reach decisions through mutual discussion. This layered approach may not fully eliminate bias, but it significantly reduces the risk of gender-based discrimination and increases transparency, credibility, and confidence in the funding process within the scientific community.

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