Mentoring perception, scientific collaboration, and research performance: Is there a 'gender gap' in academic medicine? An Academic Health Science Centre perspective

Short title: The "gender gap" in academic medicine

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Abstract

Objectives: The "gender gap" in academic medicine remains significant and predominantly favours males. This study investigates gender disparities in research performance in an Academic Health Science Centre, whilst considering factors such as mentoring and scientific collaboration.

Materials and methods: Professorial registry-based electronic survey (n=215) using bibliometric data, a mentoring perception survey, and social network analysis. Survey outcomes were aggregated with measures of research performance (publications, citations, and h-index) and measures of scientific collaboration (authorship position, centrality, and social capital). Univariate and multivariate regression models were constructed to evaluate inter-relationships and identify gender differences.

Results: One hundred and four professors responded (48% response rate). Males had a significantly higher number of previous publications than females (mean 131.07 (111.13) vs. 79.60 (66.52), p=0.049). The distribution of mentoring survey scores between males and females was similar for the quality and frequency of shared core, mentor-specific, and mentee-specific skills. In multivariate analysis including gender as a variable, the quality of managing the relationship, frequency of providing corrective feedback and frequency of building trust had a statistically significant positive influence on number of publications (all $p<0.05$).

Conclusion: This is the first study in healthcare research to investigate the relationship between mentoring perception, scientific collaboration and research performance in the context of gender. It presents a series of initiatives that proved effective in marginalising the 'gender gap'. These include the Athena SWAN charter, new recruitment and advertisement strategies, setting up a 'Research

and Family Life' forum, establishing mentoring circles for women and projecting female role models.

Keywords: gender; mentoring; scientific collaboration; research performance; social networks; social capital; survey

Introduction

The traditional discrepancies between women and men in clinical medicine have dropped dramatically over recent years. The data speak for themselves. In the US, the percentage of female medical students has seen an unparalleled increase from 5% to 50% between 1960 and 2006.[1] A similar - though less pronounced - pattern has been observed in the UK where the number of female medical students rose from 25% in the 1960s to 61% in the mid-2000s.[2] Also, looking at this trend after graduation from medical school, there is no difference between men and women in terms of career progression in the National Health Service (NHS). However, a particular caveat applies to this last statement, as this is only valid when men and women work full-time - and this is rarely the case for women.[3]

Despite those impressive improvements, this does not reflect the situation in academic medicine. As evident from an editorial in *The New England Journal of Medicine*, in 2005 only 11% of full professors were women and only 15% of departmental chairs in the US were women.[1] This represents a massive disparity in women's representation in academic medicine as compared to men in the US.[4] From a UK perspective, the situation appears no better. The more senior the academic position, the smaller the percentage of female representation (42.3% of Lecturers, 30.1% of Senior Lecturers/Readers and 15.1% of Professors).[5] The proportion of women classified as 'grade A' researchers (highest calibre researchers based on an international classification system) is merely

23%.[6] Men often have superior research performance than women, when using measures such as number of publications, number of citations, research funding (grants) received and remuneration.[2,7-10] This may not only be due to systematic discrimination that makes it challenging for women to access resources, but may somewhat be a consequence that women may collaborate less than men and have less established collaboration networks.[11] Similarly, gender differences exist in mentoring relationships within academic medicine.[12] Men are more likely than women to have positive mentoring experiences that impact their careers.[12,13] Women are more likely than men to identify lack of mentoring as an obstacle to their promotion, and to consider that same-sex mentors would be more supportive.[12,14,15]

Despite these negative findings, there is some encouraging evidence for women in academic medicine. Overall, there has been an increase in the number of female first and last authors from 11% in the 1970s to 37% in 2004 and from 12% to 17% respectively.[16] Also, in specialties where women are more represented, female authorship has shown a greater rise. Such specialties include paediatrics and obstetrics and gynaecology where the trend has been observed both in the US[17] and the UK.[16]

This profound disparity of women's representation in academic medicine does matter for three interconnected reasons. Firstly, lack of women in academic medicine results in wasted talent because many women would be keen to add value in this sector.[3] Secondly, female under-representation in academic medicine will inherently bias today's research outline and as a result future clinical practice.[3] Finally, the disparate representation of women in academic vs. clinical medicine and other fields, may reveal a hidden agenda potentially representing a recruitment bias in influential research positions and esteemed specialties.[3]

In this study, we aimed to evaluate gender disparities in research performance, whilst considering factors such as mentoring and scientific collaboration, in one of Europe's largest Academic Health Science Centres (AHSCs). Our study used a mentoring perception survey, as well as bibliometric and social network analysis (SNA) to answer gender-related research questions raised by another recently published study.[18] We also discuss various policies and implementations that have been used at the AHSC to tackle the "gender gap" in academic medicine.

Methods

Organisational context and sample population

Imperial College London is a public university based in the United Kingdom. The university specialises in science, engineering, medicine and business, and has been consistently ranked among the top 10 in the world.[19] The Faculty of Medicine (FoM) is one of Europe's largest medical institutions in terms of size of the workforce, number of students, and generation of research income. The publicly available university database was used to generate a list of all the professors in the FoM. Their demographic information were extracted including first name, surname, gender, and the affiliated division or department for each of the participants included in the study.

Generation of the publication and citation database

SciVerse Scopus® (Elsevier Inc., Amsterdam, Netherlands) Author Identifier was used as a tool to generate, for each professor, the publication list and corresponding citations.[20] For each professor the following research performance measures were identified: total number of publications, total number of citations, and the h-index. The study time period was from 1st January 2006 until 31st December 2012. The citations used were collected in March 2016 in order to allow sufficient time

for the most recent publications to be cited. To adjust for individual productivity, for each participant the total lifetime publication record preceding the study time period was identified.

Mentoring Survey Instrument

The mentoring survey instrument administered in this study was used with permission given by CCC/The Mentoring Group (TMG), one of four divisions of a not-for-profit corporation: the Coalition of Counselling Centres, Inc. (Grass Valley, CA). The source document for this survey was: *Skills for Successful Mentoring: Competencies of Outstanding Mentors and Mentees*.[21] The survey instrument was based on the conceptual model shown in **Figure S1**, which illustrates the shared core skills used by both mentors and mentees, and the unique skills needed by each group. The survey's research documentation offers evidence for construct validity and is presented in detail in the Appendix.

Generating the network for analysis (measures of scientific collaboration)

The individual publication files for each professor were inserted into a unified list, which was saved as a comma-separated value (.csv) file. Each of these files was loaded into a network analysis software named NetworkBench® (Network Science Center, Indiana University, Bloomington, IN).[22] The co-authorship network was then created. The nodes of the network were the authors, and links were assumed to exist between two nodes when the corresponding authors had co-authored one or more scientific publications. Degree, betweenness and Eigenvector were used as measures of network centrality. Local clustering coefficient and constraint were used to quantify network social capital.[23]

Authorship positions

The position of an author in the co-authorship list is an indicator of each individual's contribution to the publication task (citation).[24,25] These were categorized in 6 position-related variables (**Appendix**).[18,23]

Statistical Analysis

Descriptive statistics were used to present demographic, research performance, network and authorship characteristics as well as mentoring variables from the survey. Each variable was assessed for normality assumptions using Kolmogorov-Smirnov test. Bivariate correlation (Spearman's Rank for non-normal distributed data) was subsequently used to determine the relationship between independent variables (demographic, networking, authorship and mentoring), and dependent variables (research performance) and these were presented graphically in a Correlation Matrix. Data that followed a non-normal distribution underwent logarithmic ($\log_{10}$) transformation before using models of univariate and multivariate regression analyses to assess associations between independent and dependent variables. Finally, Wilcoxon Mann-Whitney test was used to establish if there were any gender differences between dependent variables such as research performance and independent variables such as mentoring survey scores. Statistical analysis was performed using IBM SPSS Statistics software version 18.0 and Microsoft Excel 2010. Statistical significance was considered where $p<0.05$.

Results

A total number of 104 responses were received out of 215 professors that were surveyed, which equated to a 48% response rate. Out of the 104 respondents, 70 were male (67%). **Table S3** summarises the descriptive statistics for the demographic, research performance, network and authorship variables, and **Table S4** the same data when the cohort was divided into male and female

groups. The same applies to **Figures S2 and S3** respectively where pie charts show the distribution of individual and institutional variables expressed as percentages (%, n = 104).

Male respondents had a significantly higher number of previous publications than females (mean 131.07 (111.13) vs. 79.60 (66.52), p = 0.049). There were no other statistically significant differences with regards to demographic, research performance, network and authorship variables.

The distribution of survey scores for males and females was similar for the quality and frequency of shared core, mentor-specific, and mentee-specific skills. **Figure 1** illustrates a box plot showing distribution of total survey scores for quality and frequency of mentoring skills and gender (male = blue, female = pink). **Figure 2** shows radial charts highlighting "subtle" differences between survey scores and gender, although none of these differences were statistically significant.

Univariate analysis

Table S5 shows the results of the univariate regression analyses between measures of research performance and individual, scientific field, social capital and authorship position variables.[18]

Multivariate analysis

The statistically significant results from the univariate regression analyses were encompassed to build multivariate models (36 in total) taking into account multi- co-linearity issues (VIF > 10).

Initially, multivariate models were constructed to determine any relationships between the 3 measures of research performance and the quality and frequency of mentoring skills. Based on these, further multivariate models were generated by including gender as an independent variable.

In all multivariate models there were no statistically significant relationships between quality or frequency of mentoring and research performance.

Moreover, multivariate models were created for each mentoring skill that had a statistically significant association with research performance in the univariate analysis including gender as an independent variable. Again, there were no statistically significant relationships between total survey scores for quality or frequency and research performance. However, model 13 (**Table S6**) demonstrated that the quality of managing the relationship had a statistically significant positive influence on number of publications (B = 1.100, SE = 0.382, p = 0.007) even when gender was included in model 23 (**Table S7**) (B = 1.203, SE = 0.386, p = 0.004). Model 18 (**Table S8**) demonstrated that frequency of providing corrective feedback had a statistically significant positive influence on number of publications (B = 0.700, SE = 0.277, p = 0.016) even when gender was included in model 28 (**Table S9**) (B = 0.701, SE = 0.288, p = 0.020). Model 34 (**Table S10**) demonstrated that frequency of building trust had a statistically significant positive influence on number of publications (B = 0.761, SE = 0.340, p = 0.032) even when gender was included in model 37 (**Table S11**) (B = 0.705, SE = 0.343, p = 0.048).

Network diagrams

Network diagrams were created using specialized software for picturing large-scale networks (http://visone.info). The size, shape and colour of the nodes representing authors was changed in the graphic so several attributes such as gender, research performance and quality of mentoring could be visualised. The biggest connected section of the co-authorship network of healthcare researchers in the FoM, Imperial College London is illustrated in **Figure 3**.

Discussion

This is the first study in healthcare research to investigate the relationship between mentoring perception, scientific collaboration and research performance in the context of gender. This research area is crucial for personal and organisational development and relies on the social and managerial skills of the academic healthcare professionals rather than just their scientific skills.

The most important finding from this study relates to the gender gap at Imperial College London, which was found to be 'subtle'. No significant qualitative or quantitative differences were found between males and females in terms of mentoring skills and mentoring perception (quality and frequency). The same applies to research performance and social capital.

It is important to understand how this may be achieved. The mainstay of this success is thought to relate to a fundamental change in the workplace ethos through promotion of 'a culture conductive to women's academic success'. The literature has clearly shown that when support in the workplace is low, women will underperform irrespective of the work demands imposed on them.[26]

It becomes apparent that in this type of situations the first thing to concentrate in changing is not the working hours but the workplace culture to ensure this is as supportive as possible to female academics. Identifying those cultural barriers and systematically addressing them can only achieve this.[27] In Imperial College London, a number of measures have been introduced over the recent years to promote this culture change. These led to the prestigious Athena SWAN Silver award showing organisation-wide commitment to gender equality across Science, Technology, Engineering, Medicine and Mathematics (STEMM).

Various policies and implementations were introduced. Data from central College records was retrieved and analysed. Following this, the Academic Opportunities Committee (AOC) organised workshops across College campuses to hear the views of FoM staff and PhD students on culture and organisation, career progression, development opportunities, mentoring, working environment, communication, and recruitment-retention-progression of research/academic women. The findings were discussed, consulted on best practice, specific actions that could be taken identified, and implementation began. The AOC Chair presented the findings and recommendations to the Management Board, who agreed with all recommendations. FoM members were then consulted on the recommendations through an online survey and campus visits by the Head of Department.[28]

As an example, a negative finding related to the falling percentage of female academics with progressively increasing seniority. Numerous actions were implemented to address this. A register was established for routinely recording numbers of clinical and non-clinical Career Development Fellows. Following this, an anonymous survey was launched to identify the reasons for this with questions such as “What do you think are the reasons for the steady decline of female academics with progression?” and “What can the department do to help?” Subsequently, changes were implemented to improve recruitment of females. Changes included having a good female-to-male balance amongst those featured in a video clip on the website telling what it is like to work in the FoM, switching to an open style of advertisement, and putting applicants in touch with female members of staff. Events were also organised by the Postdoc Development Center (PDC) such as ‘Aiming for a Lecturership’ or “Planning for an Academic Career and Interview” which were well attended by the departmental postdocs, 68% of them female. Refreshments followed each of these events to provide opportunities for networking.[28]

A mentoring scheme for researchers and academic staff was also established, ensuring that the mentoring team included a good number of females. Moreover, an annual 'Research and Family Life' panel discussion was introduced. For every new female academic staff starting in the department, an informal meeting was arranged soon after their arrival to give them the opportunity to discuss about life and progression and put them into contact with other female academics.[28]

As a testament for the success of the above interventions in addition to the Athena SWAN Silver Award, in the 2011 Imperial Staff survey, 93% of female and 92% of male academic staff reported they felt they had been offered fair and equal access to training and development.[28]

A meta-analysis assessing the effect of gender in the mentoring literature showed that gender effects may occur more often among mentors than among mentees.[29] The findings of this study contradict this meta-analysis because there was no difference in mentoring perception (frequency and quality) between males and females, which is also in accordance with the Ragins and Cotton study that assessed the "willingness to mentor" amongst genders.[30] That same study showed that rank is a predictor of "willingness to mentor" and that high-ranking individuals have stronger motivation to participate in mentoring activities.[30] In the current study, female professors showed similar perception which can be a mentoring resource for organisational success because women are exposed to less opportunities compared to men in terms of: (1) receiving mentoring, (2) providing mentoring, (3) high ranking positions, and (4) experiencing time constraints.[30]

Strengths of the study

The main strength of this study is firstly the extensive variety of confounders of research performance included. Secondly, the fact that quantitative measures of social capital were calculated which allowed relevant adjustments in multivariate analysis. Thirdly, the sample size

was considerable (i.e. more than 100 professors from one of the top 10 universities in the world), which emphasizes the importance of this study for academic healthcare sectors in developed countries. Finally, it is important to note that the study took place in the healthcare sector and in particular within an AHSC where, to our knowledge, no similar analysis has ever been conducted. It involved a true multidisciplinary project involving a team consisting of clinicians, statisticians, and academics.

Limitations of the study

The most important limitations of this study are that it is based on self-perceptions of mentoring and there is a potential for selection bias. A more robust study would include a 360-degree mentor evaluation. In addition, the survey instrument has not been extensively validated in the academic and healthcare sector. Finally, the outcome measures for research performance, such as number of publications, citations and h-index, are not the only metrics that can be used to characterise performance. Alternative performance measures for use in future studies include: financial parameters (not just the nominated salary, but also bonuses and royalties), grant income, nominations for senior Medical Research Council (MRC) and Wellcome Trust fellowships, patents and innovation metrics, which are all representative of global performance for knowledge management organisations and have implications for business and wider societal impact and organisational resilience.

Conclusion

This is the first study in healthcare research to investigate the relationship between mentoring perception, scientific collaboration and research performance in the context of gender. It illustrates that though there still is a ‘gender gap’ in academic medicine, a series of initiatives can prove

effective in marginalising it. These include the Athena SWAN charter, new recruitment and advertisement strategies, examining women's experiences of academic appointments and promotions processes, exploring clinical and non-clinical academic trajectories, setting up a 'Research and Family Life' forum, establishing mentoring circles for women and projecting female role models. These findings may offer guidance on patterns of scientific collaboration to improve research performance and show other AHSCs where the 'gender gap' remains wider how to address those differences in their respective institutions.

Main messages

- Despite improvements, the "gender gap" in academic medicine remains.
- This 'gender gap' consistently favours male over female academics.
- Changing the workplace ethos towards 'a culture conductive to women's academic success' is fundamental and should be the first step in addressing the 'gender gap'.
- Successful strategies include new recruitment and advertisement strategies, setting up a 'Research and Family Life' forum, establishing mentoring circles for women, and projecting female role models.

Current research questions

- Are there any gender differences in patterns of collaboration such as inter-disciplinary co-authorship?
- How can the strategies described to marginalise the 'gender gap' in academic medicine be implemented on a larger (nationwide) scale?
- Is there variation in the 'gender gap' in academic medicine between developed and developing countries?

- Is there any evidence of a 'racial gap' in academic medicine?

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Figures

Figure 1. Box Plot showing distribution of total survey scores for quality and frequency of mentoring skills and gender (male = blue, female =pink).

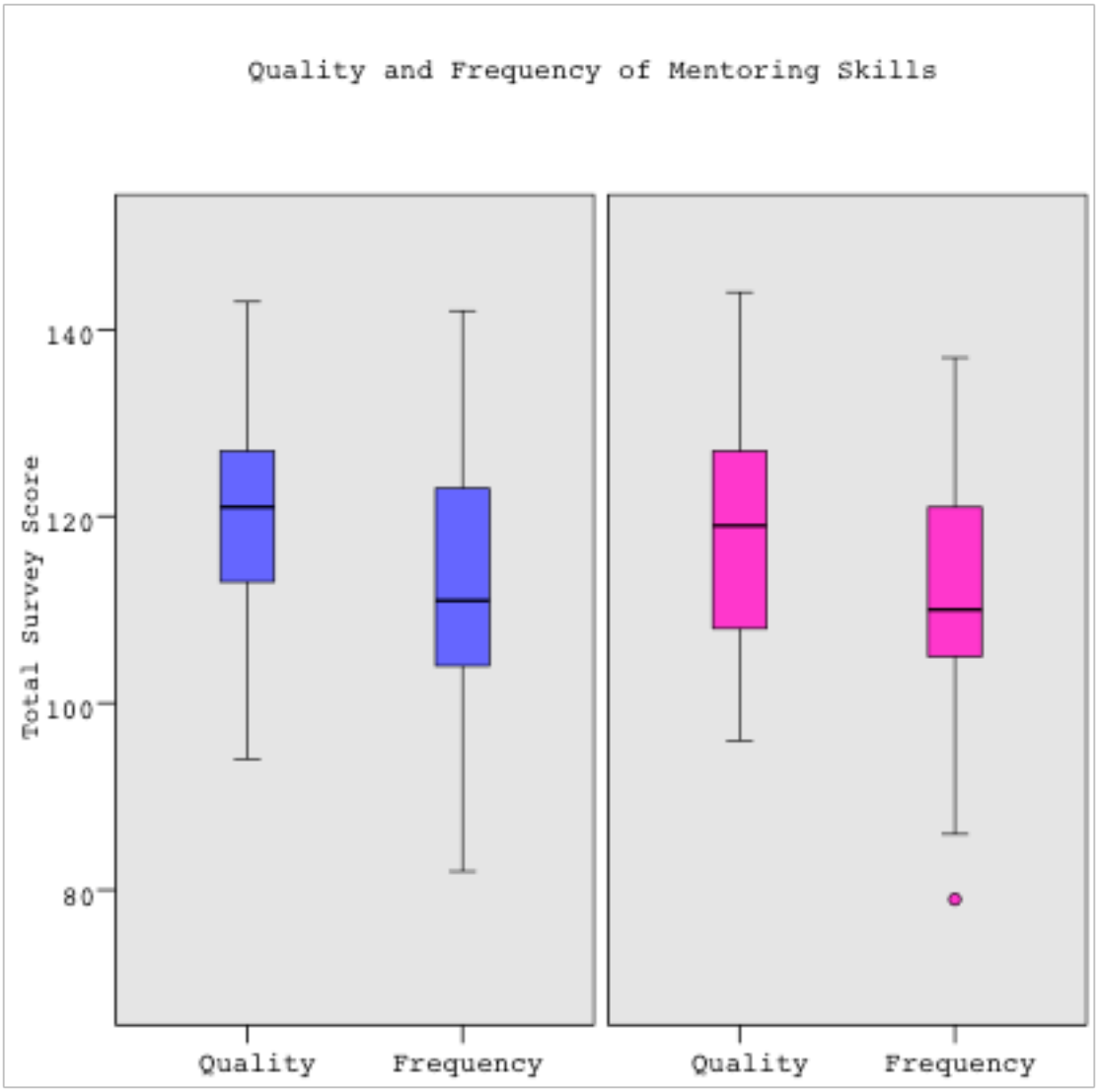


Figure 2. Radial plots showing male (blue) and female (pink) differences in (a) research performance metrics, (b) institutional affiliation, (c) network measures, (d) co-authorship position, (e) quality of shared core mentoring skills, (f) quality of mentor-specific skills, (g) quality of mentee-specific skills, (h) frequency of shared core mentoring skills, (i) frequency of mentor-specific skills, (j) frequency of mentee-specific skills, (k) overall quality of mentoring (l) overall frequency of mentoring. Male data is normalised to 1 in all plots except figure 1b, which is expressed as percentage.

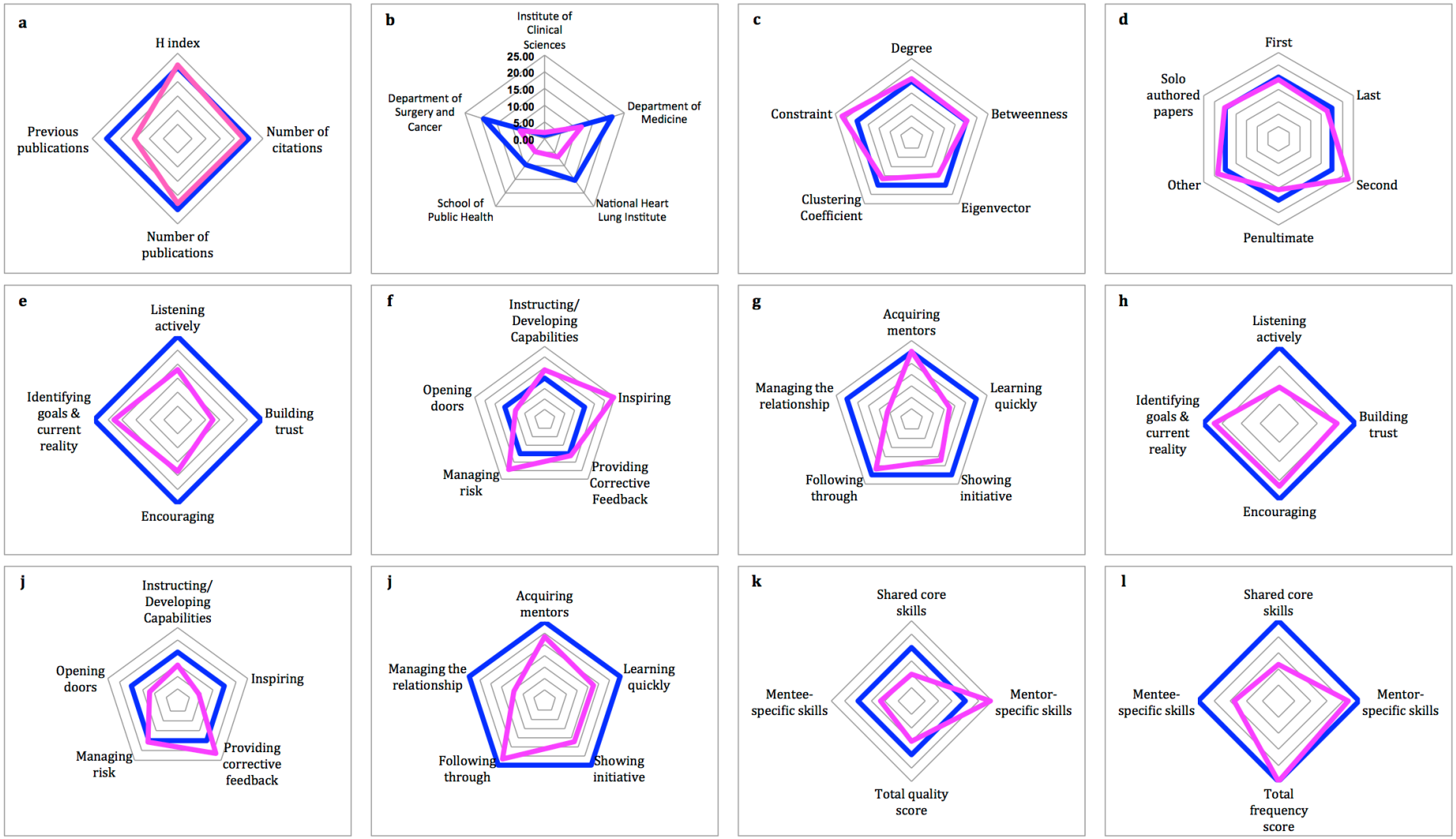
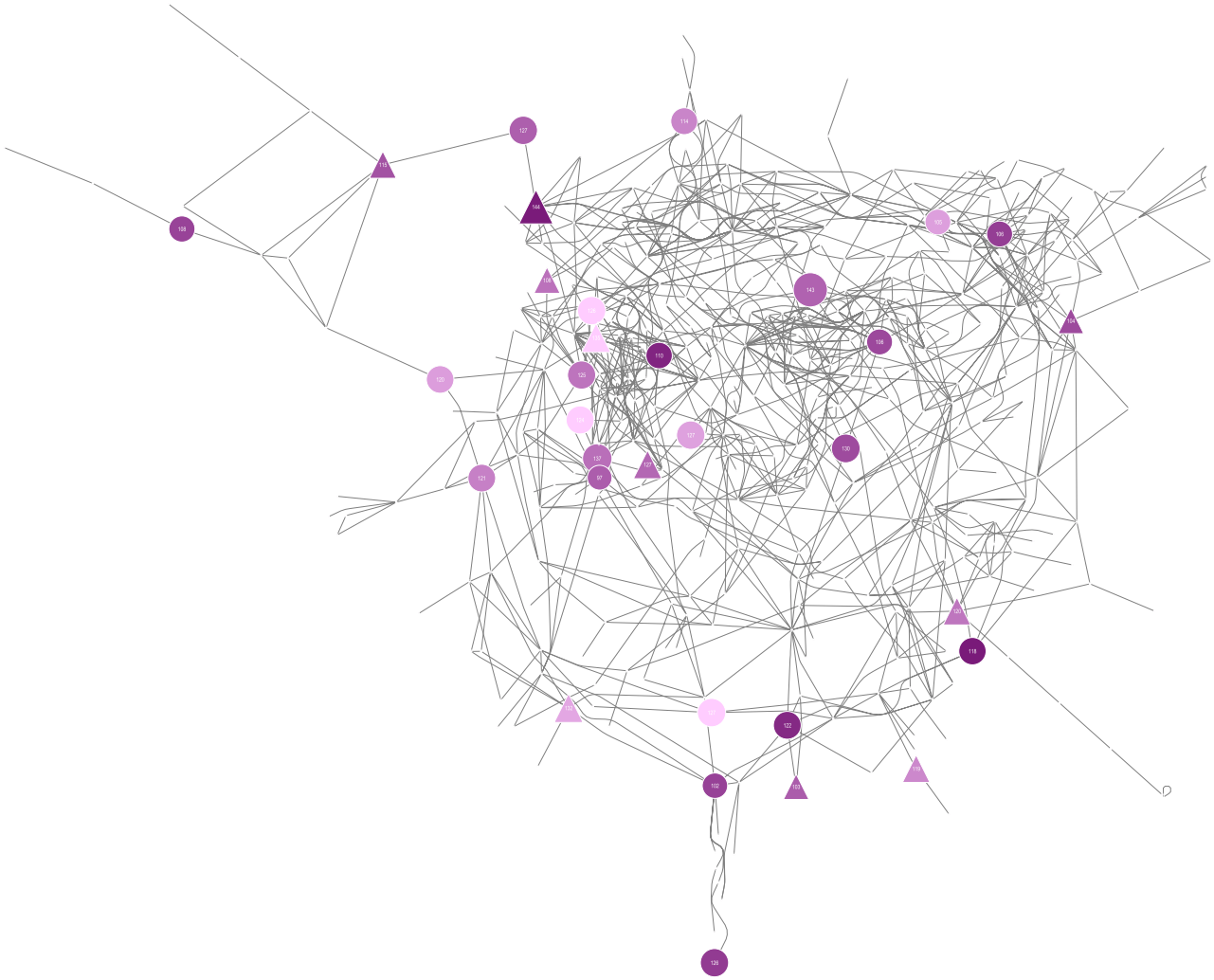
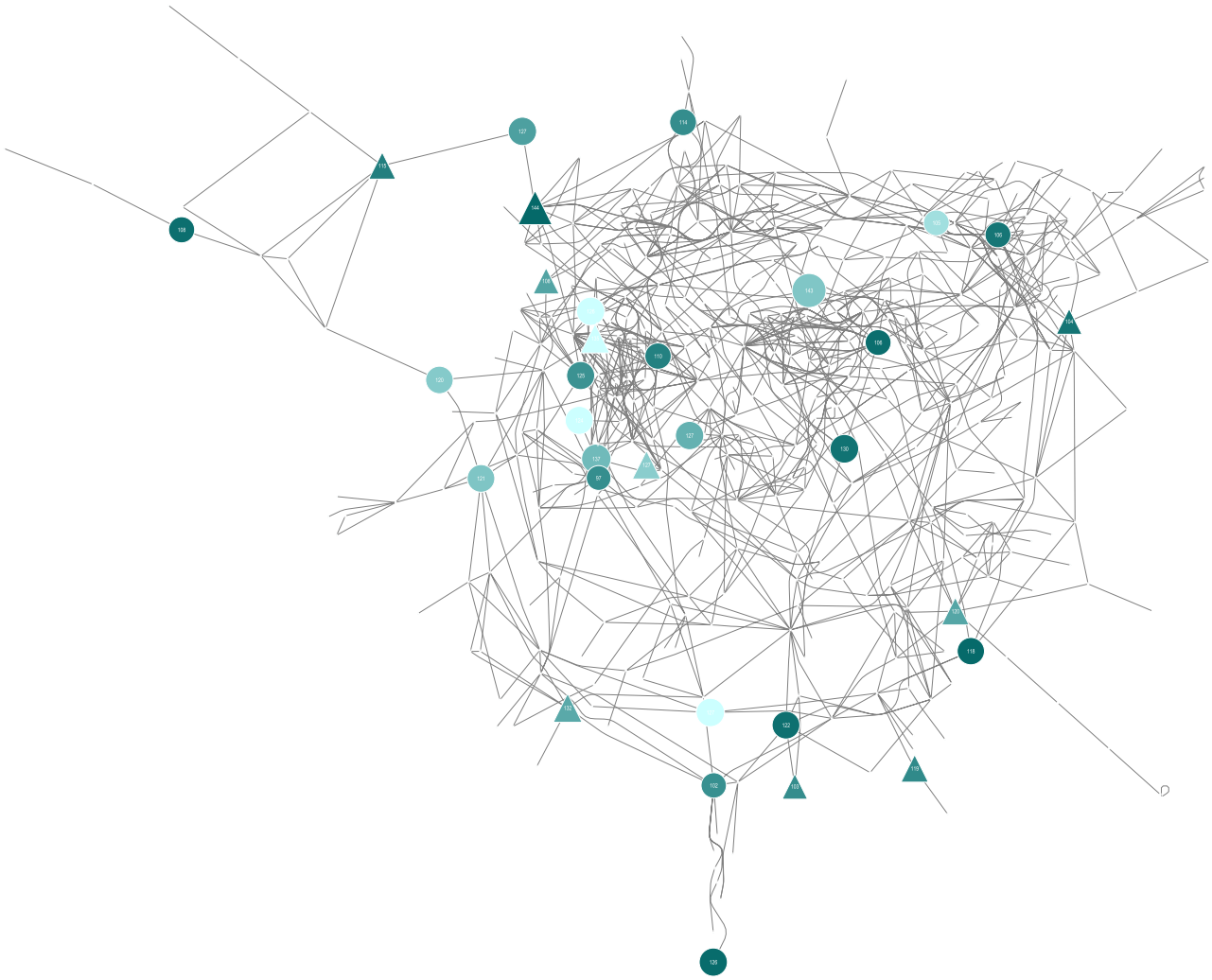

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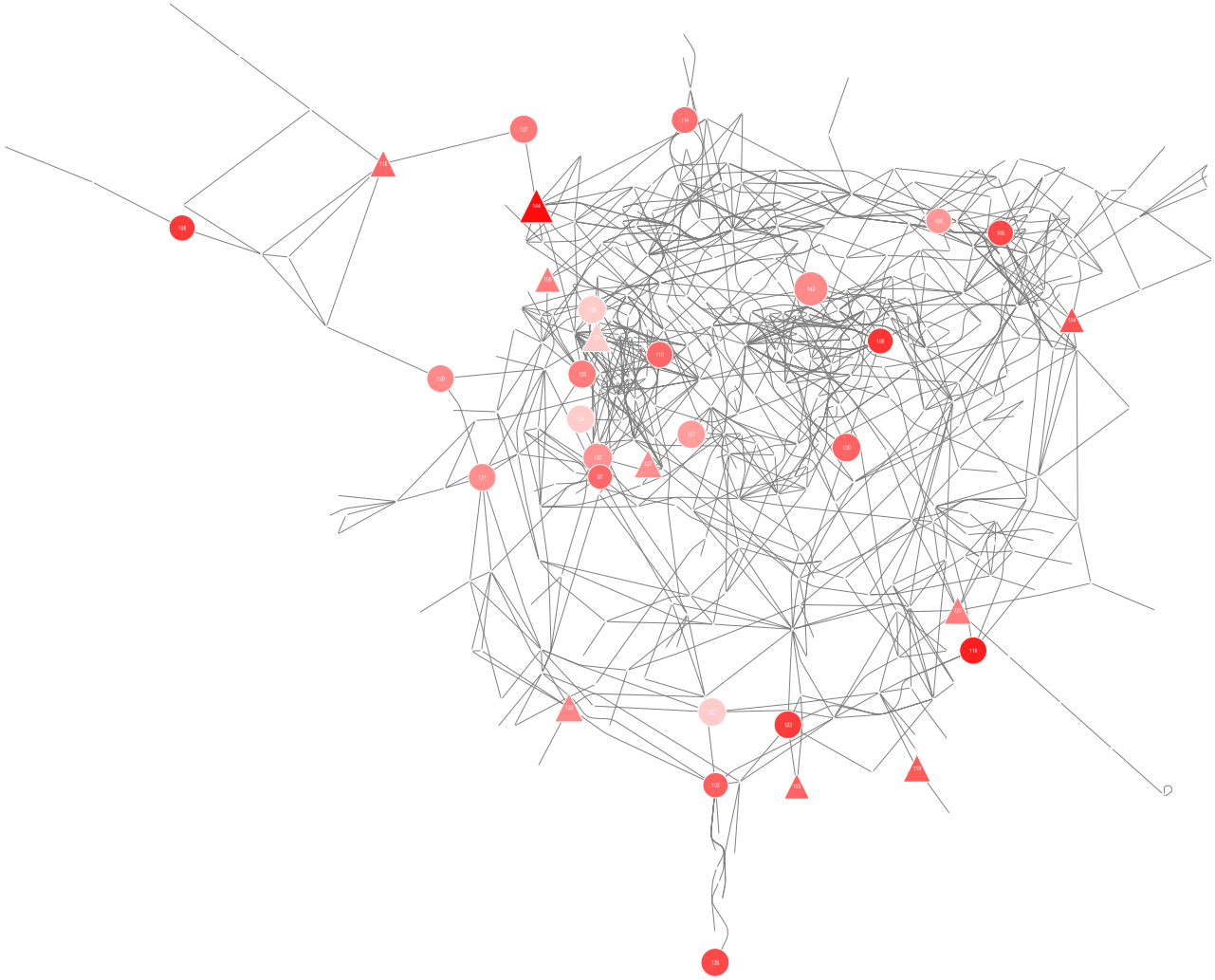
Figure 3. Individuals who did not reply to the survey have no colour. The node size illustrates mentoring quality (the larger the node, the higher the total score for quality of mentoring); the node shape illustrates gender, which was either a circle for male or a triangle for female professors. Research performance is illustrated by different node colors (color intensity increases with higher performance: (**a**) number of publications,



(**b**) number of citations,



(**c**) h index).



Author contributions:

TA, VP, GG, and HA contributed to the conception and design of the study, the analysis and interpretation of data, and the drafting of the paper. SP contributed to the conception and design of the study, and the interpretation of data. LH and NS contributed to the conception and design of the study, and to the acquisition of data. SH and AD contributed to the conception and design of the study, and to data analysis and interpretation. All authors contributed to the critical revision of the paper, interpretation of the data and approved the final manuscript for submission.

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Ethical approval:

Formal ethics approval was not necessary as the study team were not required to access any confidential data, and completion of the electronic survey was taken to indicate consent to participate in the study.

Appendix

*Mentoring Skills Self-Assessment (*http://mentoringgroup.com*).*

Thirty-six statements from the survey instrument were used to self-assess mentoring skills in the study population (**Table S1**). For each statement the participant was asked to indicate the quality (how well – in their personal opinion – they actually performed this skill when it was appropriate) and frequency of application (how often – in their personal opinion – they used the skill, given the opportunity) of their mentoring skills using a Likert scale (**Table S1**).

The total score for both quality and frequency of mentoring skills was calculated. Subsequently, the statement scores were aggregated to correspond with each shared core, mentor-specific, and mentee-specific skills (**Table S2**).

The model illustrated in **Figure S1** postulates that if the shared core, mentor-specific, and mentee-specific skills are possessed to a satisfactory quality level, and are used as frequently as necessary, then the chances of having a successful mentoring relationship is enhanced.

Authorship positions

For each publication the following authorship positions were extracted:

- The first-listed author (FLA)
- The last-listed author (LLA) (when the publication had more than two co-authors)
- The second-listed author (SLA) (when the publication had at least three co-authors)
- The penultimate author (PA) (when there were at least four co-authors on the publication)
- Any remaining position was recorded as “other”(O)

- The solo author (SA)

Table S1: Mentoring skills self-assessment survey statements.

	I believe I:
1	ask questions to be sure I understand what others are saying.
2	know what is important to me.
3	maintain confidentiality when other share sensitive information.
4	praise and compliment others.
5	demonstrate inspiring actions which challenge others to improve.
6	give others specific (as opposed to vague) feedback on their behaviours.
7	help others learn the risks involved in their actions or projects.
8	suggest people for others to contact or observe to help them develop.
9	assist others in setting achievable goals and identifying ways to react to them.
10	use appropriate nonverbal language when listening to others.
11	set appropriate goals to reach in my personal life and career.
12	admit my errors and take responsibility for correcting them.
13	point out others' positive traits in addition to their performance and accomplishments.
14	help others notice or observe people who are inspiring.
15	use positive non-derogatory words to tell others when their behaviours or products are not satisfactory.
16	make suggestions to help others avoid major mistakes.
17	personally introduce others to appropriate contacts who could help them.
18	directly teach others new knowledge or skills by explaining, giving examples, or asking questions.
19	summarise key elements of what I discuss with others, as appropriate.
20	recognize areas in which I am able to perform well.
21	help others feel valued and included.
22	express thanks and appreciation to others.
23	challenge others to rise above the mundane and do significant things in their lives.
24	give corrective feedback in private, not in front of others.
25	help others monitor their progress toward goals and refocus as needed.
26	make certain people's abilities and accomplishments are noticed by others.
27	act as a learning broker - assist others in finding resources such as people or books to help them learn.
28	avoid interrupting others when they are speaking.
29	recognize my specific weaknesses or growth areas.
30	respect others' limits and boundaries.
31	write encouraging notes, text messages , or e-mails or leave complimentary voice mail messages.
32	make optimistic predictions to others about their future successes.
33	offer useful suggestions to try next time when giving others corrective feedback.
34	intervene as an advocate for others in difficult situations, if requested.
35	give others opportunities or assignments that enable them to demonstrate their abilities to others.
36	demonstrate or model effective actions that help others learn new skills.

Quality
4 = very high quality (as well as very effective mentors I have observed)
3 = acceptable quality (I need some improvements)
2 = poor quality (I need many improvements)
1 = unacceptable quality (I am not competent in performing this skill)

Frequency
4 = use the skill very often (at least 75% of the opportunities available)
3 = use the skill often (50-74% of these opportunities)
2 = use the skill infrequently (25-49% of these opportunities)
1 = use the skill seldom, if at all (less than 25% of these opportunities)

Table S2: Survey statements transformed to mentoring skills.

Mentoring Skill	Item Number
<u>Shared Core Skills</u>	
Listening Actively	1 + 10 + 28
Building Trust	3 + 12 + 30
Encouraging	4 + 13 + 22 + 31
Identifying Goals and Current Reality	2 + 9 + 11 +20 + 29
<u>Mentor-Specific Skills</u>	
Instructing/Developing Capabilities	8 + 18 + 19
Inspiring	5 + 14
Providing Corrective Feedback	6 + 15
Managing Risks	7 + 16
Opening Doors	17 + 21
<u>Mentee-Specific Skills</u>	
Acquiring Mentors	23 + 32
Learning Quickly	24 + 33
Showing Initiative	25 + 34
Following Through	26 + 35
Managing The Relationship	27 + 36

Table S3: Means, standard deviations, and minimum and maximum values for performance, network and authorship variables.

Variable	Mean	Standard	Minimum	Maximum
Performance variables				
Previous publications	114.47	101.33	0.00	499.00
Number of publications	65.11	45.57	2.00	178.00
Number of citations	1791.57	1703.44	13.00	7462.00
H index	19.10	9.07	2.00	50.00
Network variables				
Degree	0.01	0.01	0.00	0.03
Betweenness	0.09	0.09	0.00	0.34
Eigenvector	0.00	0.00	0.00	0.00
Clustering Coefficient	0.23	0.19	0.06	1.00
Constraint	0.13	0.15	0.01	0.92
Authorship variables				
% of solo authored papers	0.05	0.09	0.00	0.53
First author$^{\Psi}$	0.05	0.07	0.00	0.33
Last author$^{\Psi}$	0.31	0.21	0.00	1.00
Second author$^{\Psi}$	0.10	0.09	0.00	0.44
Penultimate author$^{\Psi}$	0.17	0.11	0.00	0.60
Other author$^{\Psi}$	0.28	0.18	0.00	0.80

Ψ. % Non-alphabetical author sequence publications.

Table S4: Means, standard deviations, and minimum and maximum values for performance, network and authorship variables.

Variable	Male				Female			
	Mean	Standard	Minimum	Maximum	Mean	Standard	Minimum	Maximum
Performance variables								
Previous publications	131.07	111.13	0.00	499.00	79.60	66.52	0.00	238.00
Number of publications	67.05	42.70	2.00	178.00	61.15	51.92	3.00	175.00
Number of citations	1835.37	1606.81	13.00	6253.00	1701.80	1927.49	207.00	7462.00
H index	18.85	8.30	2.00	43.00	19.57	10.62	7.00	50.00
Network variables								
Degree	0.01	0.01	0.00	0.03	0.01	0.01	0.00	0.03
Betweenness	0.09	0.09	0.00	0.34	0.10	0.09	0.00	0.29
Eigenvector	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Clustering Coefficient	0.24	0.21	0.06	1.00	0.21	0.13	0.07	0.51
Constraint	0.12	0.12	0.01	0.55	0.15	0.20	0.03	0.92
Authorship variables								
% of solo authored papers	0.05	0.10	0.00	0.53	0.05	0.07	0.00	0.20
First author$^{\Psi}$	0.05	0.08	0.00	0.33	0.05	0.05	0.00	0.18
Last author$^{\Psi}$	0.32	0.23	0.00	1.00	0.29	0.17	0.00	0.57
Second author$^{\Psi}$	0.09	0.10	0.00	0.44	0.12	0.07	0.00	0.29
Penultimate author$^{\Psi}$	0.18	0.11	0.00	0.60	0.15	0.11	0.00	0.33
Other author$^{\Psi}$	0.27	0.19	0.00	0.80	0.30	0.16	0.00	0.56

Ψ. % Non-alphabetical author sequence publications.

Table S5: Univariate regression analyses between measures of research performance and individual, scientific field, network and authorship position variables. Boldface denotes significance

	Number of publications					Number of citations					h index				
	B	SE	CI - L	CI - U	p	B	SE	CI - L	CI - U	p	B	SE	CI - L	CI - U	p
Individual															
Previous publications	.651	.105	.442	.861	**.000**	.687	.158	.369	1.004	**.000**	.286	.068	.149	.423	**.000**
Male	.125	.103	-.080	.331	.228	.042	.127	-.213	.297	.742	-.012	.053	-.118	.095	.829
Physician	.177	.097	-.018	.372	.074	.132	.121	-.111	.375	.281	.077	.051	-.025	.179	.135
Surgeon	-.132	.177	-.487	.222	.458	-.296	.215	-.726	.133	.173	-.080	.092	-.264	.104	.390
Scientific Field															
Rheumatology	-.064	.385	-.833	.706	.869	.253	.470	-.688	1.194	.593	-.087	.200	-.487	.313	.665
Medicine	-.102	.099	-.300	.097	.310	-.158	.121	-.400	.084	.196	-.062	.051	-.164	.041	.233
Cardio Respiratory	.025	.119	-.214	.263	.837	.209	.144	-.078	.496	.151	.116	.060	-.004	.236	.059
Public Health	.086	.131	-.177	.349	.514	.087	.161	-.236	.410	.592	.002	.069	-.135	.139	.980
Surgery and Cancer	.055	.119	-.183	.294	.643	-.080	.146	-.371	.212	.587	-.020	.060	-.140	.101	.745
Network centrality															
Degree	.462	.090	.281	.642	**.000**	.670	.087	.496	.843	**.000**	.276	.038	.200	.353	**.000**
Betweenness	.376	.081	.212	.539	**.000**	.471	.088	.295	.646	**.000**	.199	.037	.125	.274	**.000**
Eigenvector	.116	.024	.068	.163	**.000**	.139	.026	.086	.191	**.000**	.056	.011	.033	.079	**.000**
Network social capital															
Clustering Coefficient	-.851	.128	-1.107	-.595	**.000**	-.786	.164	-1.114	-.458	**.000**	-.352	.069	-.490	-.214	**.000**
Constraint	-.527	.102	-.732	-.322	**.000**	-.565	.120	-.805	-.326	**.000**	-.265	.050	-.366	-.165	**.000**
Authorship position															
% of solo authored papers															
First author$^{\Psi}$	-1.847	1.681	-5.214	1.519	.276	-2.954	1.924	-6.809	.900	.130	-1.149	.839	-2.829	.531	.176
Last author$^{\Psi}$	-.984	.662	-2.311	.343	.143	-1.213	.764	-2.743	.317	.118	-.699	.326	-1.352	-.047	**.036**
Second author$^{\Psi}$	.943	1.279	-1.620	3.506	.464	.280	1.486	-2.697	3.256	.851	.420	.643	-.867	1.708	.516
Penultimate author$^{\Psi}$	2.145	1.113	-.084	4.374	.059	2.402	1.289	-.181	4.985	.068	1.066	.559	-.053	2.185	.062
Other author$^{\Psi}$	.560	.740	-.922	2.041	.452	1.855	.823	.207	3.504	**.028**	.874	.354	.164	1.583	**.017**

Ψ. % Non-alphabetical author sequence publications.

Table S6. Multivariate regression analysis (dependent variable number of publications). Boldface denotes significance.

	Model 13					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.384	.086	.209	.559	**.000**	1.258
Network centrality						
Eigenvector	.040	.017	.005	.074	**.025**	1.355
Network social capital						
Clustering Coefficient	-.432	.117	-.669	-.195	**.001**	1.272
Mentoring skills quality						
Managing the Relationship	1.100	.382	.326	1.874	**.007**	1.095
Mentoring skills frequency						
Listening Actively						
Building Trust						

Table S7. Multivariate regression analysis - including gender as an independent variable (dependent variable number of publications). Boldface denotes significance.

	Model 23					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.404	.087	.228	.580	**.000**	1.297
Male	-.073	.055	-.184	.038	.189	1.166
Network centrality						
Eigenvector	.044	.017	.009	.078	**.014**	1.401
Network social capital						
Clustering Coefficient	-.397	.119	-.638	-.156	**.002**	1.337
Mentoring skills quality						
Managing the Relationship	1.203	.386	.421	1.985	**.004**	1.141
Mentoring skills frequency						
Listening Actively						
Building Trust						

Table S8. Multivariate regression analysis (dependent variable number of publications). Boldface denotes significance.

	Model 18					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.430	.087	.253	.606	**.000**	1.200
Network centrality						
Eigenvector	.045	.018	.009	.081	**.015**	1.385
Network social capital						
Clustering Coefficient	-.469	.120	-.713	-.226	**.000**	1.253
Mentoring skills frequency						
Providing Corrective Feedback	.700	.277	.138	1.261	**.016**	1.023
Managing Risks						
Acquiring Mentors						

Table S9. Multivariate regression analysis including gender as an independent variable (dependent variable number of publications). Boldface denotes significance.

	Model 28					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.429	.092	.242	.616	**.000**	1.303
Male	.001	.060	-.120	.123	.983	1.200
Network centrality						
Eigenvector	.045	.018	.009	.082	**.017**	1.400
Network social capital						
Clustering Coefficient	-.470	.125	-.723	-.217	**.001**	1.319
Mentoring skills frequency						
Providing Corrective Feedback	.701	.288	.116	1.286	**.020**	1.078
Managing Risks						
Acquiring Mentors						

Table S10. Multivariate regression analysis (dependent variable number of publications). Boldface denotes significance.

	Model 34 (h index)					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.105	.073	-.043	.254	.159	1.447
Network centrality						
Degree	.323	.098	.123	.523	**.002**	3.677
Network social capital						
Clustering Coefficient	.056	.090	-.127	.240	.536	2.549
Authorship position						
Last author[Ψ]	.143	.477	-.827	1.114	.766	2.542
Other author[Ψ]	.027	.493	-.976	1.030	.957	2.604
Mentoring skills frequency						
Building Trust	.761	.340	.069	1.453	**.032**	1.157
Managing Risks						
Acquiring Mentors						

Table S11. Multivariate regression analysis (dependent variable number of publications) including gender as an independent variable. Boldface denotes significance.

	Model 37 (h index)					
	B	SE	CI - L	CI - U	p	VIF
Individual						
Previous publications	.127	.075	-.026	.281	.101	1.554
Male	-.048	.043	-.137	.040	.275	1.111
Network centrality						
Degree	.321	.098	.121	.521	**.003**	3.679
Network social capital						
Clustering Coefficient	.054	.090	-.129	.237	.553	2.551
Authorship position						
Last author$^{\Psi}$	.151	.475	-.817	1.120	.752	2.542
Other author$^{\Psi}$	.052	.492	-.950	1.054	.916	2.609
Mentoring skills frequency						
Building Trust	.705	.343	.007	1.403	**.048**	1.182
Managing Risks						
Acquiring Mentors						

Ψ. % Non-alphabetical author sequence publications.

Figure S1: Venn diagram of the mentorship skills model.

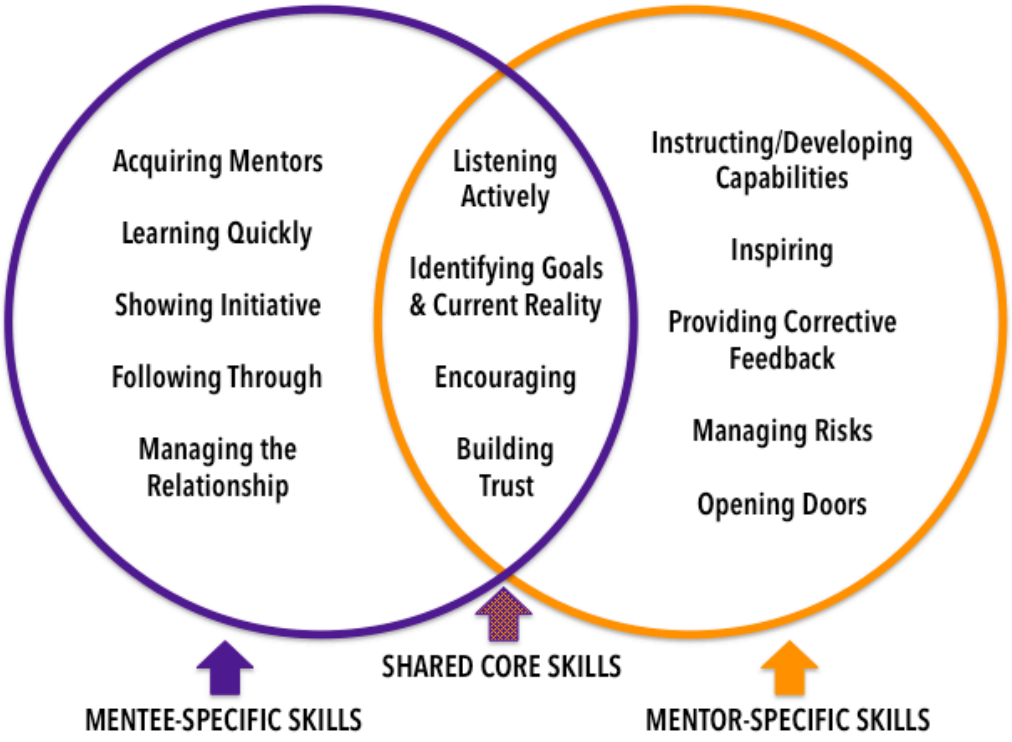


Figure S2. Pie charts showing distribution of individual and institutional variables (%, n = 104).

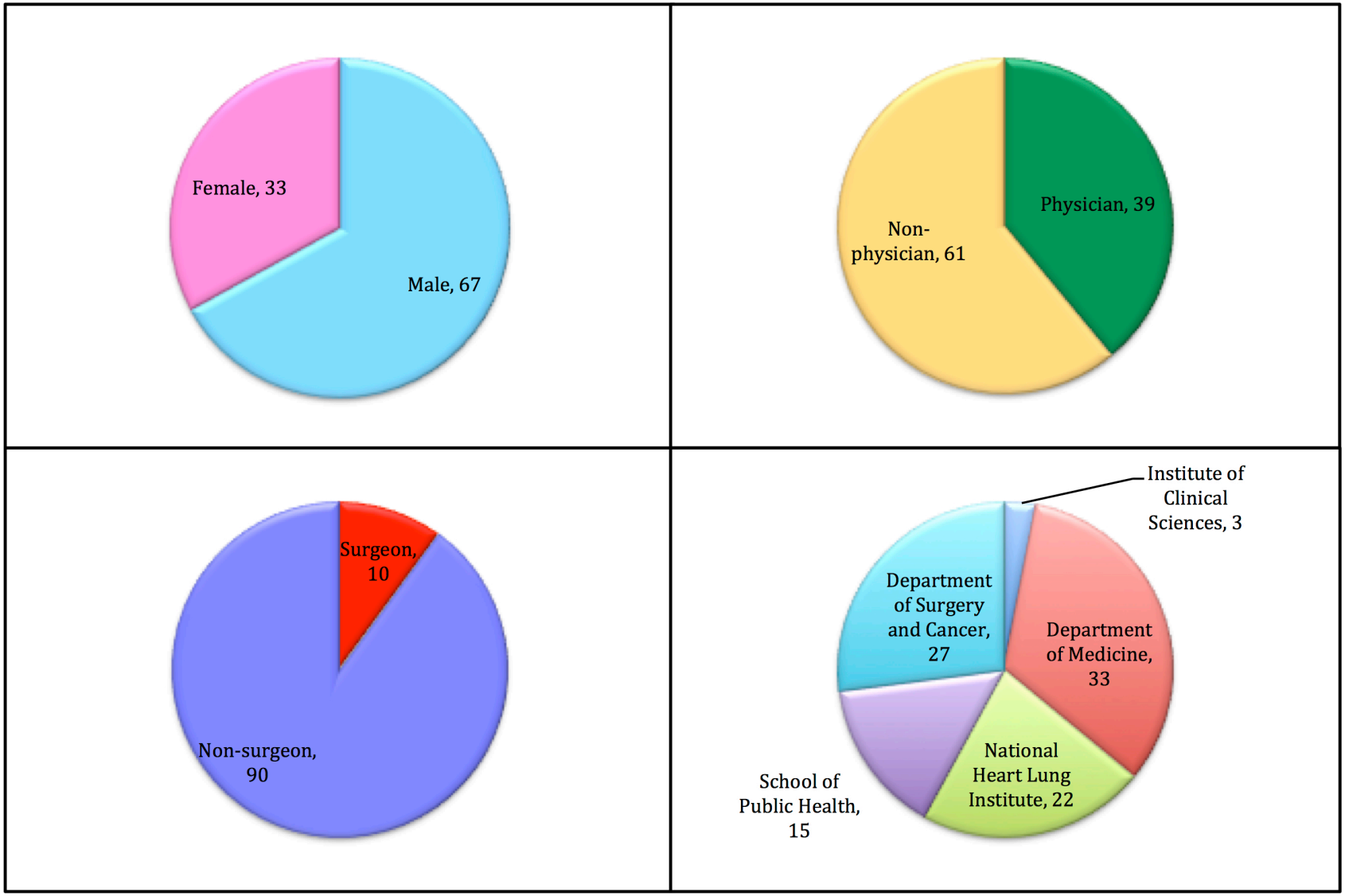


Figure S3. Pie charts showing distribution of individual and institutional variables (%, male n = 70, female n = 34).

