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European Trainee Forum

Medical students' perspectives on IR: A European survey from CIRSE's European Trainee Forum



Cardiovascular and Interventional Radiological Society of Europe

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Executive Summary

The European Trainee Forum (ETF), a subcommittee of young CIRSE members, performed a large survey of medical students with more than 2,700 respondents to assess pan European attitudes to interventional radiology and help guide future training and recruitment of the best and most talented candidates to the specialty. The main findings were:

- There is persistently low understanding of IR among medical students.
- Two thirds of respondents had not received any formal exposure to interventional radiology.
- 95 % of students felt that there was a bright future for radiology and nearly 1 in 5 stated that they were likely or very likely to pursue a career in IR.
- There is a lower rate of interest from female medical students which can only exacerbate the underrepresentation of female physicians among the ranks of our specialty. More dedicated undergraduate IR mentoring is needed targeted to female medical students.
- Lack of patient contact and risk of radiation exposure and difficulty accessing the necessary training are some of the main perceived barriers deterring medical students from pursuing a career in IR.
- We have proposed several initiatives in response to these findings in our call to action which include more formal teaching in IR, the introduction of medical student webinars and steps to encourage gender equality in IR.

Introduction

Interventional radiology (IR) as a specialty has seen a rapid growth and evolution in recent years; and therefore, it has become one of the most modern medical specialities, having come into being little over half a century ago¹. Technological developments and the polyclinic nature of many IR-treatments suggest IR will continue to develop and require a greater number of certified practitioners.

IR training has evolved in tandem with this transformation as evidenced by the range and opportunities of training for would-be practitioners. Dedicated IR training schemes and residencies have been developed in the United States of America, where IR is now available as an integrated and independent residency that can be applied for directly from medical school².

The European Trainee Forum (ETF) was founded in 2015 under the auspices of CIRSE. The ETF is run by a group of young European interventional radiologists who are within the first 12-year after completing the medical studies and whose nomination in the ETF is proposed by each national European IR society. The ETF promotes the IR culture among medical students, junior doctors and young radiology trainees with the aim of attracting and recruiting the most talented and qualified young physicians to the specialty.

To achieve such a goal, the ETF organises different initiatives including dedicated sessions at the annual CIRSE meeting, as well as many different educational and networking events. Lastly, the ETF runs surveys with the intent of investigating specific aspects of IR dealing with medical students, junior doctors and young radiology trainees³. In this perspective, the ETF has recently promoted an online survey targeted for medical students with the intent of better understanding their degree of IR knowledge; their level of interest in pursuing an IR career, and their preferences regarding learning platforms and formats which would work best for acquiring IR knowledge. Hereby, we report all the major findings of this survey.

Methods

An online survey was created by members of the ETF using SurveyGizmo (today's Alchemer, alchemer.com) and was composed of a total of 14 multiple choice questions, with follow-up questions depending on responses. The survey was online from May to August 2020. A digital non-interactive copy of the survey can be accessed in **Appendix A**. Participants were recruited using all channels available to the ETF. In particular, the following actions were taken to distribute the survey:

- 1) All medical students being in the CIRSE database since having previously attended annual CIRSE meetings were emailed.
- 2) Social media channels, including the ETF Twitter-, LinkedIn- and Facebook-account, were used to disseminate the survey.
- 3) ETF Subcommittee members were asked to contact medical universities in their countries to facilitate the circulation of the survey.

Analysis

Data was imported and analysed using google sheets (google.inc) and SPSS (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp). Statistical differences between subgroups were tested using the chi-square test with 95% confidence limits and p-values of significance at $P < 0.05$.

Results

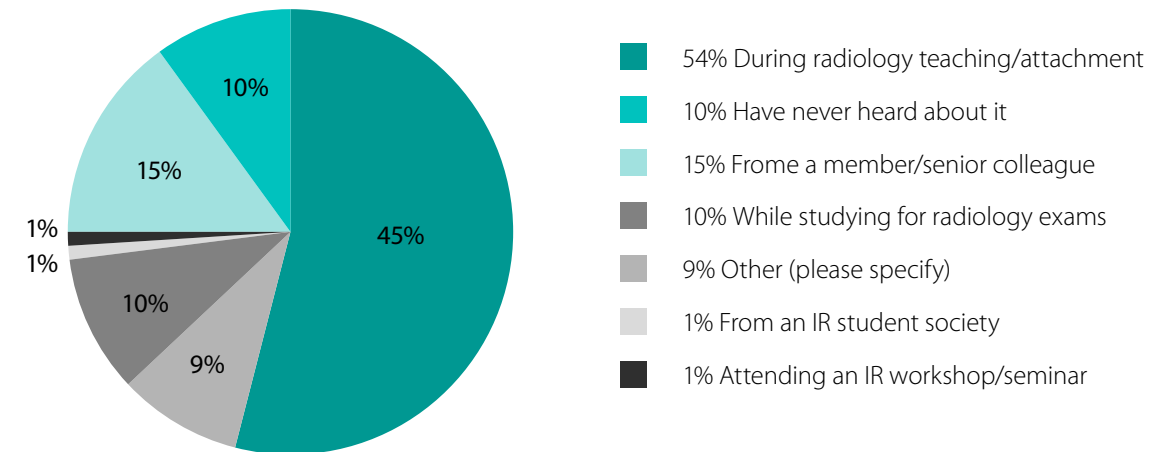
Demographic information

3,872 participants took part in the survey. 71% participants completed the entire survey. Most respondents (57%) were in the second half of their medical school training (years 4 to 6). Respondents studying in France and Italy represent 37% and 15% of all respondents, respectively. Participants studying in 30 European countries participated in the survey. Background information of participants, including listing of countries with 50 or more respondents are listed in Table 1. 60% of participants were female. 2.6% respondents were studying in a total of 15 non-European countries.

Table 1: Background information of participants

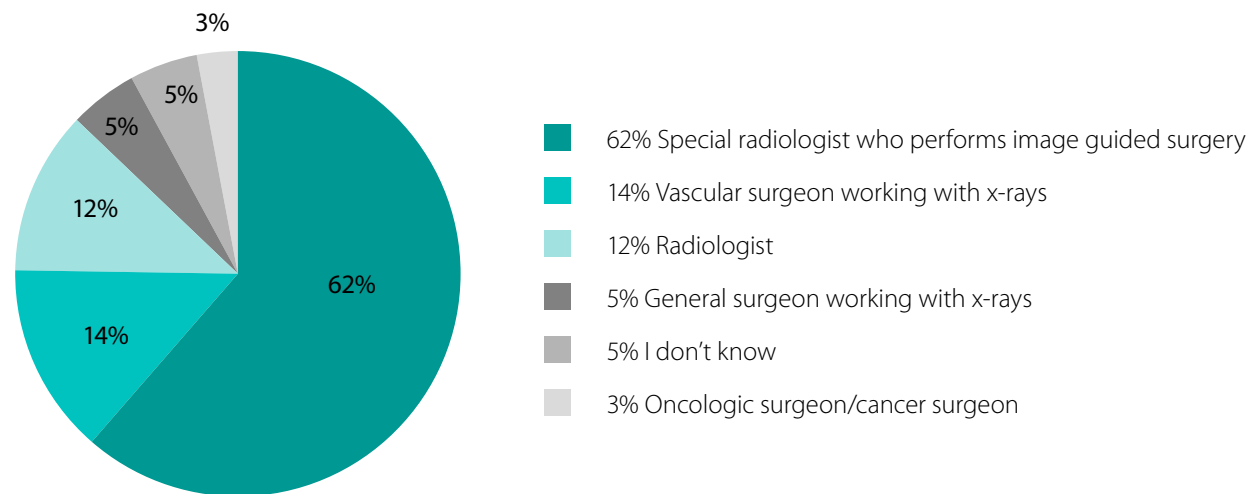
Year in medical school (n=3,483)			Country of study (n=3,481)		
1st	429	12%	France	1,330	38%
2nd	429	12%	Italy	547	16%
3rd	494	14%	Belgium	272	8%
4th	714	20%	Czech Republic	261	7%
5th	739	21%	Greece	171	5%
6th	459	13%	Germany	131	4%
Total	3,264	94%	Finland	109	3%
			UK	103	3%
			Ireland	96	3%
Sex (n=3,842)			Denmark	58	2%
Female	2,100	60%	Slovenia	50	1%
Male	1,365	39%	Total	3,128	90%

Figure 1: Pie chart shows the responses when asked how medical students had heard about IR for the first time.



Respondents were asked how they had heard about IR for the first time and given a selection of choices (see Figure 1). Most students (54%) first heard of IR during radiology teaching/attachment. Others reported senior colleagues (15%) or studying for exams (10%) as their first contact with IR. About 10% of participants reported never having heard about IR at all prior to completing this survey.

Figure 2: Pie chart demonstrating the responses when asked which description most closely fits an interventional radiologist.

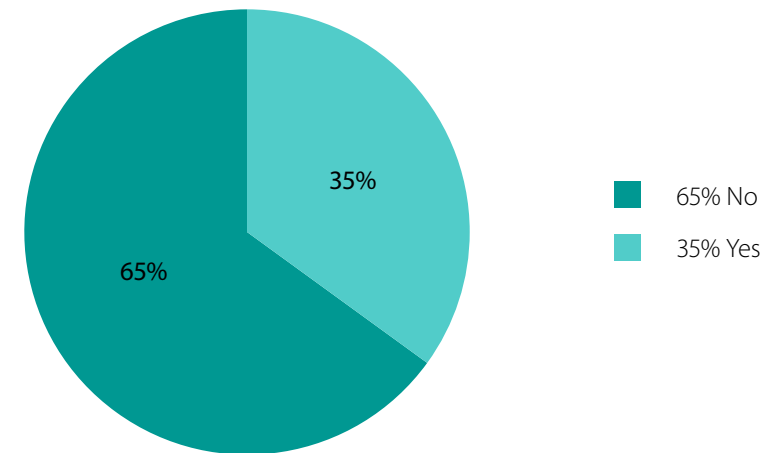


Respondents were asked to select which of the following description most closely fitted an interventional radiologist (see Figure 2): *radiologist; special radiologist who performs image-guided surgery; vascular surgeon working with x-rays; general surgeon working with x-rays; oncologic surgeon/cancer surgeon*. 74% of respondents chose the two options defining the interventional radiologist as “a specialised radiologist who performs image-guided surgery” or “radiologist” (62% and 12%, respectively). 5% and 14% of respondents, respectively, chose the options “general surgeon working with x-rays” and “vascular surgeon working with x-rays”. Only 3% of respondents choose “oncologic surgeon/cancer surgeon”. 5% answered that they did not know.

When asked if they understood what training was required to complete higher training as an interventional radiologist, the majority of respondents (51%) chose *diagnostic radiology training plus training in image guided surgery*. 32% of respondents chose the option *both surgical and diagnostic radiology training*. 5%, 4%, 4% and 1% choose *Diagnostic Radiology, Surgical training, Vascular surgical training and Cardiology training*, respectively. 4% participants responded *I don't know*.

Respondents were further given a list of clinical areas and activities and asked to select all those in which they understood the IR service to be involved. 55% selected *treats patients with major illnesses*, 41% selected *can be on call*, 39% selected *treats patient with minor illness*, 25% selected *treats patients in a palliative situation*, 23% selected *does ward rounds in the hospital*, and 22% selected *has outpatient clinics*. Over one quarter of respondents, 29%, chose *all of the above*.

Figure 3: Responses when asked “Have you ever attended any lectures/workshops on IR during your medical studies?”



Formal exposure to IR at an undergraduate level

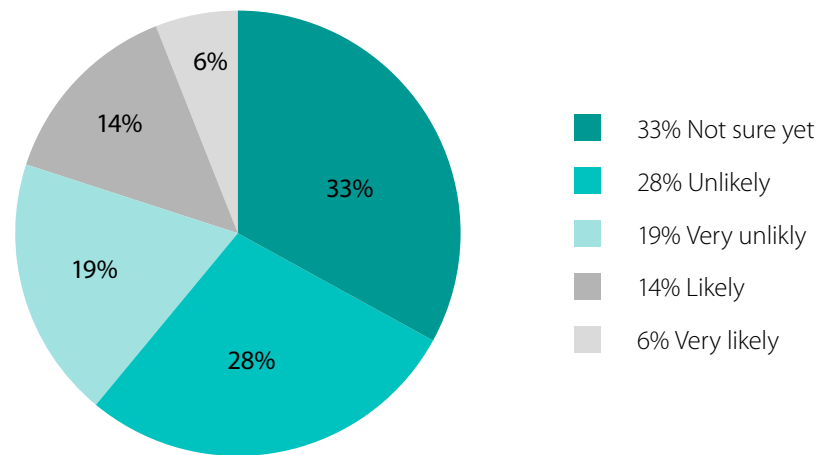
Almost two thirds (65%) of respondents (Figure 3) had received no formal exposure to IR. 35% of respondents had attended a lecture or workshop on IR during their medical studies. For students in their first, second or third years of studies, 20% reported attendance of lecture or workshop. This was significantly higher in the group of older students (years 4-6), which reported attendance of 43% (Chi-square, $P < 0.05$). Among 6th year medical students, over half (53%) responded that they had not been exposed to formal IR lectures or workshops. Of the dedicated IR teaching, 81% of respondents stated that it had been organized by a medical university, and 24% by a hospital. Less than 9% had attended an IR event organised by a medical student/trainee organisation. Only 20 participants reported having attended CIRSE, which represents less than 2% of respondents who had received IR education and less than 0.5% of all survey respondents. Only a very small proportion (6%) of respondents had heard about CIRSE’s “beinsplRed” Student Programme. Only 1.8% of respondents (51 participants from 16 European countries) had attended the programme. Out of these, 94% rated the programme as very good or good.

A large majority of respondents (82%) were motivated to learn more about IR. The subgroup of students in their first three years of their medical training (34.2% respondents) was more motivated than the subgroup in the fourth, fifth and sixth year (80%; $P < 0.05$). When asked to rate by which means they would prefer to learn about IR, respondents picked possible options in the following order: internships/traineeships (47% responses); case-based workshops (44.6%); university lectures (43% responses); YouTube videos (39% responses); online webinars (27% responses); attending national/international congresses on IR (22.6% responses); and other (<1% responses).

The future of IR

Participants were overall positive to the future of IR with 95% of respondents reporting that they think that IR has a bright future as a medical specialty. A majority (82%) selected minimal invasiveness as the primary reason; 65%, 27% and 26% of respondents selected the options possibility to combine with other treatments, possibility to repeat treatment, and cost effectiveness, respectively. A small number of respondents (< 5%) responded that IR does not have a bright future and chose other specialists performing IR on their own as the most commonly selected reason (58%) with Artificial Intelligence (39%), and other specialists reading images (26%) as the other most frequently selected responses, respectively.

Figure 4: Pie chart showing responses to the question “How likely is it that you will choose interventional radiology as a career after completing the first stages of your medical training?”.



IR as a career path

About 20% of respondents stated that they were likely (13.9%) or very likely (5.7%) to choose IR as a career after completing the first stages of their medical training (see Figure 4). There is little variation between students of different study years with regards to choosing IR as a career path with 23% of 1st years and 22% of 6th years stating that they are likely or very likely to choose IR as a career. A large group of participants (33%) were not sure of their career choice yet. In the subgroups of younger (year 1-3) and older (year 4-6) medicine students the corresponding numbers were 43 and 28%, respectively. The follow-up question asking what the reasons for not choosing IR as future career are showed that *lack of personal interest* (68%) was the main reason with lack of patient contact (35%) and risk of radiation exposure (15%) chosen as second and third most common responses. Other responses regarding reasons for not choosing IR as a future career included difficulty accessing the necessary training (13%).

When broken down between male and female respondents, 24% of male respondents (17.1% + 7.1%) and only 16% of female respondents (11.7% + 4.7%) stated that they were likely or very likely to choose IR (Table 2). In response to the question regarding the reasons for not choosing IR there was a higher proportion of responses in the female respondents concerned regarding the risk of radiation exposure (17% in female vs 14% in male), lack of patient contact (40% in female vs 30% in male) and lack of personal interest (76% vs 65%). Interestingly, female respondents were less concerned regarding the future of IR (only 2.8% of female respondents) or the difficulty involved in being accepted onto a training pathway (only 12.8%; Table 3).

Table 2: Summary of responses dealing with the question “How likely is it that you will choose interventional radiology as a career after completing the first stages of your medical training?”. Data are stratified according to gender and expressed in percentages.

	Overall (2,747)	Men (1,117)	Women (1,630)
Very Likely	5.7	7.1	4.7
Likely	13.9	17.1	11.7
Not Sure Yet	33.1	34.6	32.1
Unlikely	28.2	25.3	30.1
Very Unlikely	19.1	15.9	21.3

Table 3: Summary of responses dealing with the question “What would be the reason(s) for not choosing IR as your future career?”. Data are stratified according to gender and expressed in percentages.

	Overall (2,210)	Men (847)	Women (1,363)
Risk of radiation exposure	15.2	14.2	17.0
No personal interest	68.4	65.3	75.6
Not sure if IR is the future of medicine	3.4	4.7	2.8
Difficult to get necessary training	13.3	15.6	12.8
Lack of patient contact	34.9	30.3	40.6
Lack of recognition	9.1	9.2	9.7
Other	11.2	12.0	11.4

Discussion

There has been much written in the IR literature regarding the familiarity to, exposure to, and understanding of IR among undergraduate medical students⁴⁻⁷. Many of these surveys have been national or local, specific to a single country or institution. This report is, to our knowledge, the first such analysis of medical student awareness and attitudes over an entire continent.

The large number of participants shows that we were successful at distributing the survey among medical students outside the CIRSE community. France and Italy dominate, accounting for 37% and 15% of responses, respectively. Little can be said about large countries such as Germany and the UK where only 4% and 3% of responses originated, respectively. However, to put this into context there were 103 fully answered responses from the UK in our survey as compared to 312 in the largest UK based survey in the literature⁸. This was by far the largest medical student interventional radiology survey in the literature with 2,746 complete responses. The next largest student survey had only a fraction of this with 729 complete responses⁹. Most prior surveys from the North America^{10,11}, Europe^{5,11,12}, Australia⁶ and around the world^{13,14} had between 40 to 400 respondents. 103 of the respondents were studying in non-European countries. This is reflective of the often-international nature of medical training with many students moving between Europe, North America, Africa and Asia to undergo their medical school training. Female respondents were slightly overrepresented making up 60% of respondents.

Nearly 10% of respondents had never heard of IR when completing this survey. Most respondents who were familiar with IR had first come across it during radiology teaching/attachment (54%). The section in which respondents were invited to choose the best description of what an IR physician does was very revealing. Nearly ¾ of respondents correctly identified IR as a radiologist or “special” radiologist who performs image guided surgery. One of the most striking results was that just over half of respondents correctly identified the current training pathway for IR as *diagnostic radiology training plus training in image guided surgery*. This is an area of concern for IR as a specialty, as it may be difficult to attract the most enthusiastic and talented medical students to consider and pursue a dynamic specialty like IR when the training pathway is not clear to them. In addition, the medical students’ understanding of the day-to-day activities of the IR team also provide food for thought. In reality, IR has a role to play in all of the activities described in the survey; however, only 28% of respondents chose all of the above and only 41% stating that they *treat patients with major illnesses*. Over 20% of respondents selected has outpatient clinics and does ward rounds which may reflect student experience in the evolving patient-centred IR practice across Europe.

Despite the growing importance of IR our survey found that almost two thirds of medical students’ respondents had received no formal exposure to IR in the form of dedicated teaching or workshops. Even among 6th year medical students, over half responded that they had not been exposed to formal IR lectures or workshops. This may be the most surprising aspect of our results suggesting a significant proportion of European medical graduates may be leaving medical school and embarking on a career in medicine without adequate knowledge and understanding of what IR can offer them and their patients. Unsurprisingly, most previous work in this area found that IR is not well understood among medical students^{5,7,13,15}, and in keeping with our results, most students receive little if no formal training or exposure to IR during their training years. In our survey, of the minority who had received formal teaching, the majority of this training (81%) was organized by their medical university. Interestingly, less than 0.5% of respondents reported having attended CIRSE and less than 6% of respondents had heard of CIRSE’s “beinsplRed” Student Programme. Promisingly, 94% of the 51 participants who had attended the programme rated it as very good or good.

The 2010 European Society of Radiology survey found that on average medical students received less than 6 hours of formal education in IR¹⁶. A recent systematic review in the *Annals of Medicine and Surgery*¹⁷ found that the majority of published studies on undergraduate IR training and awareness showed very limited exposure to IR and limited formal teaching in the undergraduate curriculum. This limited exposure persists although two separate medical student’s curriculums have been published by CIRSE and the European Society of Radiology which both promote the increased IR presence in the undergraduate medical training. We suggest a coordinated approach of interested societies to integrate these curriculums in the undergraduate medical programs across Europe.

The lack of experience in understanding of IR and engagement directly in IR teaching described above clearly does not reflect the interests of the students. In fact, a large majority (82%) of respondents were positive to learning more about IR. The types of learning that were favoured by the students who responded were internships, university lecturers and case-based workshops. The scale of the unmet need for undergraduate IR teaching is surprising given the volume of material written in recent years on the optimal strategies to get more IR into the undergraduate curriculum^{15,18}, including types of curriculum design¹⁹, methods for increasing student awareness and engagement IR^{7,15,18}, and even a suggestion to include IR didactic teaching in the foundational gross anatomy teaching in medical school²⁰. It has also been shown that knowledge and exposure to radiology can increase student interest, awareness and openness to learning more about the specialty^{21,22}.

About 20% of respondents state that they are likely or very likely to choose IR as a career after completing the first stages of their medical training. This is reassuring and points towards a positive trend with previous studies finding 7% and 10% of students expressing an interest in IR^{6,12}. Two of the main reasons why students stated they would not pursue a career in IR were lack of patient contact (35%) and risk of radiation exposure (15%). In modern practice IRs have a large amount of patient contact comparable to other procedural based specialities and modern radiation shielding has meant radiation damage for radiologists are almost completely a thing of the past. The perception that radiation exposure remains a major issue for practitioners of IR still seems to persist in environments outside the IR and as evidenced by our results is a concern for medical students. This is likely to continue unless we can promote IR a clinical specialty and to reassure potential future trainees the danger from radiation exposure is now well monitored.

The user-specified free-text responses to questions regarding a career in IR provide some interesting insights. Many of these responses made references to the difficulty accessing the necessary training. Other insights from free-text responses referenced that they felt admission to IR training programmes would be too competitive or that the length of training would be too long. The length of training was an issue that came up time and time again as a hurdle in the free text responses: “the need of long non-IR training before doing it, and even then you can’t be sure the hospital will let you specialize in interventional...” (Czech, 5th year female student); “In my Residency, I will spend years on diagnostic radiology that I am really not interested at all” (Greek, 4th year female student). The reputation of IR regarding work-life balance seems to weigh heavily in many cases: “Mostly a Public hospital specialty and very long working days” (French, 4th year male student); “It might be not a female/family friendly job... a lot of on call, emergencies.” (German, 3rd year female student); “I want to have a family life... not on call all the time like the IR in my hospital” (French, 6th year male student).

There are great differences between European countries with regard the training pathway for interventional radiology specialisation as described in the recently published Status of Vascular and Interventional Radiology Training in Europe report from the ETF. There is significant heterogeneity in terms of duration of training from one to three years and only 11/24 countries mandate an official IR certification examination post completion of training. IR societies both nationally and internationally are in perfect position to offer the access to required training by promoting international mobility. The ETF has recently launched a student internship programme to provide students with the opportunity to complete an internship in a variety of countries across the continent.

Worryingly, in an already male dominated specialty there was a marked difference between male and female respondents with 24% of male respondents and only 16% of female respondents stated that they were likely or very likely to choose IR. Although not as dramatic as the difference in interest expressed by the student survey from Australia in 2018⁶, this still remains an area of concern. This is also reflected in several of the free text responses by female students: “The head of the radiological clinic in [...] hates me...”, (Czech, 5th year female student); “Preference of male candidates” (Czech, 6th year female student); and “Sexism” (Italian, 4th year female student). Two respondents list disabilities or handicaps as hindering them, although it is not clear from their responses exactly what these disabilities are.

The reasons given by the female respondents for not choosing interventional radiology (Table 3) such as increased risk of radiation exposure and lack of patient contact are stark reminders about the lack of understanding of modern IR practice. The modern IR practitioner deals with outpatients and inpatients and many now have admission rights and radiology day wards in which they can manage their own patients. In addition, with modern radiation shielding equipment the risk associated with radiation exposure is extremely low. Education, exposure and mentorship could help dispel these myths about IR and attract more talented female practitioners to the specialty^{23,24}.

Limitations

This survey has several limitations, most of them relating to various forms of sampling bias inherent in a study of this scale and design. A non-response bias is probable. With the survey being voluntary we can speculate that students with interest in the IR were more likely to respond to the survey on the familiar topic. In like manner the acquiescence bias (also known as agreement bias) is also possible given that most of the participants came from a group which is already interested in IR and are likely to give us a more positive view. Pre-screening bias is also imaginable, given that one of the ways in which the survey was distributed was through existing CIRSE networks in which the medical students would almost certainly have more familiarity with IR.

Considering these biases, one could think of the results as the best-case scenario for medical student engagement, enthusiasm and knowledge about our specialty. In reality the knowledge about the IR among medical students is likely to be even lower than the results of the survey.

ETF-PROMOTED INITIATIVES ACCORDING TO THE RESULTS OF THE PRESENT SURVEY

- 1) *Our survey has revealed a significant difference in attitudes to IR between men and women. This issue is not new and there is a substantial need to balance the demographic makeup of IR trainees. The ETF is active in promoting female involvement and gender equality in IR. From a practical point of view, the ETF seeks a nearly perfect gender equality within its members, and systematically invites experienced female IRs to share their experience with particular regards to concerns such as radiation exposure, sexism, and family/work-life balance.*
- 2) *Formal teaching of IR in medical faculties and university hospitals, if, implemented more broadly would greatly help in dispelling any myths surrounding the specialty and encouraging more engagement from potential trainees and future colleagues. Medical school curriculum development and implementation is, at present, outside the scope of the ETF actions. The results of the medical student survey did show, however, that a large proportion of respondents favoured YouTube, case-based workshops and online webinars as preferred educative methods to know more about IR. To improve the knowledge, interest and enthusiasm for IR among students the ETF has recently started a large social media and webinar series campaign with the intent of promoting education in IR.*
- 3) *A majority of respondents feel that IR has a bright future, and 20% of them are likely to start an IR career. Therefore, the ETF is working on initiatives aiming at:*
 - a. *promoting national IR trainee committees that may directly work “on the ground” to promote IR;*
 - b. *promoting IR as a clinically-based specialty among medical students, junior doctors and young radiology trainees;*
 - c. *stimulating young IRs to start research activities with the perspective of gathering large data supporting IR procedures;*
 - d. *and improving mentoring initiatives for young IRs.*

Conclusion

The survey results show how little is in fact known and understood about IR among our student colleagues. This is important for two reasons. Firstly, we want to attract the best, most creative and enthusiastic candidates into our field. Secondly, IR physicians operate predominantly in secondary, tertiary and quaternary referral centres. Engagement and understanding from our colleagues in other fields such as surgery, obstetrics, urology, etc. regarding what we do and how we can help manage their patients is vital if we are to continue moving forward as a specialty. The medical students of today are not only the IR trainees and IR colleagues of tomorrow; they are the doctors of tomorrow. These results help us understand how our field will be perceived by the doctors of tomorrow in all specialties and areas of expertise. If we are to continue to evolve and thrive as a specialty in the future, we will need our colleagues in other disciplines to fully understand what we have to offer and what role we can play in the care of patients. Despite recent trends with increasing IR outpatient services and direct referrals, we remain among proceduralists uniquely dependent on our fellow medical specialties for referrals and for patients. It would be wise therefore that we invest time and resources into the medical students of today not only for better and more competitive trainee selection but also to ensure that the doctors of tomorrow have an understanding of what role IR can play.

References

- Baum RA, Baum S. Interventional Radiology: A Half Century of Innovation. *Radiology*. 2014;273(2S):S75-S91. doi:10.1148/radiol.14140534
- ABR. Interventional Radiology Training Pathways. ABR. Published 2020. <https://www.theabr.org/interventional-radiology/initial-certification>
- Makris GC. Status of vascular and interventional radiology training in Europe A report by the CIRSE European Trainee Forum Subcommittee. *CIRSE*. 2020;1(1):1. https://www.cirse.org/wp-content/uploads/2020/05/ETF_survey_brochure_2020_web.pdf
- Alnajjar SF, Alshamrani HM, Banasser AM, Alshehri HZ, Wazzan MA, Abduljabbar AH. Awareness of Interventional Radiology Among Medical Students at a Saudi Medical School: Clerkship versus Pre-clerkship Years. *Oman Med J*. 2019;34(5):420-426. doi:10.5001/omj.2019.77
- de Gregorio MA, Guirola JA, Sierre S, Serrano-Casorran C, Gimeno MJ, Urbano J. Interventional Radiology and Spanish Medical Students: A Survey of Knowledge and Interests in Preclinical and Clinical Courses. *Cardiovasc Intervent Radiol*. 2018;41(10):1590-1598. doi:10.1007/s00270-018-1995-z
- Foo M, Maingard J, Phan K, et al. Australian students' perspective on interventional radiology education: A prospective cross-institutional study. *J Med Imaging Radiat Oncol*. 2018;62(6):758-763. doi:10.1111/1754-9485.12764
- Lee AM, Lee MJ. Teaching IR to Medical Students: A Call to Action. *Cardiovasc Intervent Radiol*. 2017;41(2):203-205. https://www.unboundmedicine.com/medline/citation/29086059/Teaching_IR_to_Medical_Students:_A_Call_to_Action
- Muzumdar S, Dayal S, Mohamed M, Sandhu S, Singh S, Walker P. Understanding the Awareness, Knowledge and Perceptions of Interventional Radiology Amongst Undergraduates in the UK. *Cardiovasc Intervent Radiol*. 2019;42(10):1459-1465. doi:10.1007/s00270-019-02234-5
- Nissim L, Krupinski E, Hunter T, Taljanovic M. Exposure to, understanding of, and interest in interventional radiology in American medical students. *Acad Radiol*. 2013;20(4):493-499. doi:10.1016/j.acra.2012.09.026
- Commander CW, Pabon-Ramos WM, Isaacson AJ, Yu H, Burke CT, Dixon RG. Assessing medical students' knowledge of IR at two American medical schools. *J Vasc Interv Radiol*. 2014;25(11):1801-1806. doi:10.1016/j.jvir.2014.06.008
- O'Malley L, Athreya S. Awareness and level of knowledge of interventional radiology among medical students at a Canadian institution. *Acad Radiol*. 2012;19(7):894-901. doi:10.1016/j.acra.2012.03.009
- Leong S, Keeling AN, Lee MJ. A survey of interventional radiology awareness among final-year medical students in a European country. *Cardiovasc Intervent Radiol*. 2009;32(4):623-629. doi:10.1007/s00270-009-9569-8
- Agrawal D, Renfrew MA, Singhal S, Bhansali Y. Awareness and knowledge of interventional radiology among medical students at an Indian institution. *CVIR Endovasc*. 2019;2(1):45. doi:10.1186/s42155-019-0093-x
- Alshumrani GA. Awareness of interventional radiology among final-year medical students and medical interns at a university in Southwestern Saudi Arabia. *Saudi Med J*. 2013;34(8):841-847.
- Alsafi Z, Bhrugubanda V, Ramachandran S, Alsafi A, Hamady M. Is it Time for a Specific Undergraduate Interventional Radiology Curriculum? *Cardiovasc Intervent Radiol*. 2017;40(7):1062-1069. doi:10.1007/s00270-017-1612-6
- (ESR) ES of R. Undergraduate education in radiology. A white paper by the European Society of Radiology. *Insights Imaging*. 2011;2(4):363-374. doi:10.1007/s13244-011-0104-5
- Emin EI, Ruhomaulu Z, Theodoulou I, et al. Are interventional radiology and allied specialities neglected in undergraduate medical education? A systematic review. *Ann Med Surg*. 2019;40:22-30. doi:10.1016/j.amsu.2019.03.004
- Ojha U, Mohammed R, Vivekanantham S. Should there be greater exposure to interventional radiology in the undergraduate curriculum? *Adv Med Educ Pract*. 2017;8:791-795. doi:10.2147/AMEP.S139298
- Theodoulou I, Louca C, Sideris M, et al. A prospective study integrating a curriculum of interventional radiology in undergraduate education: a tetra-core simulation model. *CVIR Endovasc*. 2020;3(1):12. doi:10.1186/s42155-020-0104-y
- DePietro DM, Kiefer RM, Redmond JW, et al. Increasing Medical Student Exposure to IR through Integration of IR into the Gross Anatomy Course. *J Vasc Interv Radiol*. 2017;28(10):1455-1460. doi:10.1016/j.jvir.2017.06.040
- Ghatan CE, Kuo WT, Hofmann L V, Kothary N. Making the case for early medical student education in interventional radiology: a survey of 2nd-year students in a single U.S. institution. *J Vasc Interv Radiol*. 2010;21(4):549-553. doi:10.1016/j.jvir.2009.12.397
- Shaikh M, Shaygi B, Asadi H, et al. The Introduction of an Undergraduate Interventional Radiology (IR) Curriculum: Impact on Medical Student Knowledge and Interest in IR. *Cardiovasc Intervent Radiol*. 2016;39(4):514-521. doi:10.1007/s00270-015-1215-z
- Wah TM, Belli AM. The Interventional Radiology (IR) Gender Gap: A Prospective Online Survey by the Cardiovascular and Interventional Radiological Society of Europe (CIRSE). *Cardiovasc Intervent Radiol*. 2018;41(8):1241-1253. doi:10.1007/s00270-018-1967-3
- Makris GC, Burrows V, Lyall F, Moore A, Hamady MS. Vascular and Interventional Radiology Training; International Perspectives and Challenges. *Cardiovasc Intervent Radiol*. 2021;44(3):462-472. doi:10.1007/s00270-020-02688-y

Appendix A – Survey questions

- 1) In which year of your medical studies are you?
 - a) 1st
 - b) 2nd
 - c) 3rd
 - d) 4th
 - e) 5th
 - f) 6th
 - g) Other: (please indicate your answer)

- 2) In which country do you study?

- 3) Please indicate your gender
 - a) Female
 - b) Male
 - c) Not specified

- 4) How did you hear about IR for the first time?
 - a) During radiology teaching/ attachment
 - b) While studying for radiology exams
 - c) From a mentor/senior colleague
 - d) Attended an IR workshop/seminar
 - e) Attended an international IR congress
 - f) Attended a national IR conference/congress
 - g) From an IR student society
 - h) Have never heard about it
 - i) Other (please specify)

- 5) Do you think that interventional radiology has a bright future as a medical specialty?
 - a) Yes, because
 - a) it is minimally invasive
 - b) it's ideal to combine with other treatments
 - c) it can be repeated
 - d) it is cost effective
 - b) No, because
 - a) artificial intelligence will take over
 - b) other specialties will read images on their own
 - c) other specialties will perform interventional procedures on their own
 - d) other: (please indicate your answer)

- 6) Which description most closely fits an interventional radiologist? (please select one answer)
 - a) Radiologist
 - b) Oncologic surgeon/cancer surgeon
 - c) Vascular surgeon working with x-rays
 - d) General surgeon working with x-rays
 - e) Special radiologist who performs image guided surgery
 - f) I don't know

- 7) To become an interventional radiologist, you have to complete higher training in (please select one answer)
 - a) Surgical training
 - b) Diagnostic radiology training
 - c) Diagnostic radiology training plus training in image guided surgery
 - d) Both surgical and diagnostic radiology training
 - e) Vascular surgery training
 - f) Cardiology training
 - g) General medical training
 - h) I don't know

- 8) An interventional radiologist
 - a) Has outpatient clinics
 - b) Does ward rounds in the hospital
 - c) Can be on call
 - d) Admits patients to the hospital
 - e) Treats patients with minor illnesses
 - f) Treats patients with major illnesses
 - g) treats patients in a palliative situation
 - h) All of the above
 - i) None of the above
 - j) I don't know

- 9) Have you ever attended any lectures/workshops on IR during your medical studies?
 - a) Yes
 - a. The lecture/workshop was organised by the medical university
 - b. The lecture/workshop was organised by a hospital
 - c. The lecture/workshop was organised by medical student organization/trainees
 - d. Other: (please indicate your answer)
 - b) No

- 10) Would you like to learn more about IR?
- a) Yes
 - Which means of learning would you prefer?
 - a. University lectures
 - b. Internships/traineeships
 - c. Attendance at national/international congresses on IR
 - d. Case-based workshops
 - e. YouTube videos
 - f. Online webinars
 - g. Other: (please indicate your answer)
 - b) No
- 11) Have you ever attended CIRSE's be inspIRed Student Programme?
- a) Yes
 - How would you rate the programme?
 - a. Very good
 - b. Good
 - c. Neutral
 - d. Poor
 - e. Very poor
 - b) No, but I have heard of the programme
 - c) No, I have never heard of the programme
- 12) How likely is it that you will choose interventional radiology as a career after completing the first stages of your medical training?
- a) Very likely
 - b) Likely
 - c) Not sure yet
 - d) Unlikely
 - e) Very unlikely
- *(If unlikely/very unlikely)* What would be the reason(s) for not choosing IR as your future career?
- a. Risk of radiation exposure
 - b. No personal interest
 - c. Not sure if IR is the future of medicine
 - d. Difficult to get the necessary training
 - e. Lack of patient contact
 - f. Lack of recognition from patients and other specialties
 - g. Other (please indicate your answer):