

Who will be the Radiologists of Tomorrow? A survey of radiology during the “Practical Year” in Germany

Wer sind die Radiologen von Morgen? Deutschlandweite Evaluation der Radiologie im Praktischen Jahr

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ABSTRACT

Purpose Aim of our study was to evaluate the motivation of medical students in their final year of medical school to choose radiology for further specialization by means of a Germany-wide survey.

Materials and Methods The survey was performed during the 2015/16 semester among German medical students in their four months radiology elective during the final year. Invitations for the study were distributed by the Student Secretariats of each university. The survey was web-based with EvaSys 7.0 software. Questions on radiology contents during medical studies and “practical year” were part of the survey. Plans for residency and possible advantages and disadvantages of radiology as medical specialty were inquired. Descriptive statistics and group comparisons were used as analysis methods.

Results 89 students participated in the survey at the beginning and 60 students at the end of the practical year. Of these 39 students could be identified who answered both questionnaires. Most students were satisfied with their final year radiology elective (mean 1.8 on a range from 1 to 5). Nevertheless, they criticized mentoring during routine work (mean 2.1) and a lack of educational courses (mean 2.1). Most students (83 %) were uncertain about their residency choice at the beginning of their “practical year” and about one fifth changed their plans. From the students' point of view main advantages of radiology included contact with many other clinical disciplines (87 %) and the working conditions (68 %). The reduced patient contact (42 %), the large amount of work at a computer (43 %), and the dependency on referring physicians (42 %) were regarded as the main disadvantages. The students regarded the way radiology is taught during the studies as not practical enough. With regard to radiology the majority of students (63 %) felt poorly prepared for their future work.

Conclusion The “practical year” is important regarding the choice of future specialization. There was a high degree of satisfaction with the “practical year” in radiology. The mentoring during routine work and a lack of educational courses was mildly criticized. These factors provide room for improvement to foster students' interest in radiology.

Key Points

- The “practical year” is important regarding the choice of further specialization.
- Criticisms of radiology in the “practical year” were mentoring and courses.
- Students feel poorly prepared for their future work regarding practical radiological skills.

Citation Format

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ZUSAMMENFASSUNG

Ziel Ziel unserer Studie war es, anhand einer Umfrage auszuwerten, was junge Studierende im Praktischen Jahr zu einer Facharztweiterbildung in der Radiologie motiviert.

Material und Methoden Im Studienjahr 2015/16 erfolgte eine deutschlandweite Umfrage unter PJ-Studierenden mit dem Wahlfach Radiologie zu zwei Zeitpunkten, vor und nach dem PJ. Die Einladung zur Umfrage erfolgte über die PJ-Beauftragten aller 37 medizinischen Universitäten in Deutschland. Die Umfrage erfolgte web-basiert mit EvaSys 7.0, es wurden Fragen zur Lehre der Radiologie im Studium und im PJ, zum gewünschten Weiterbildungsfach und zu den Vor- und Nachteilen der Radiologie aus Studierendensicht abgefragt. Die Auswertung erfolgte über deskriptive Statistik und Gruppenvergleiche.

Ergebnisse An der Umfrage hatten 89 Studierende vor und 60 Studierende nach ihrem PJ teilgenommen. Anhand des persönlichen Codes konnten 39 Studierende identifiziert werden, die an beiden Umfrageteilen teilgenommen hatten. Die meisten Studierenden waren mit ihrem PJ in der Radiologie zufrieden (Mittelwert 1,8; Skala 1–5). Kritisiert wurden die Betreuung am Arbeitsplatz (Mittelwert 2,1) und die Fortbildungen der Abteilung (Mittelwert 2,1). 83 % der Studierenden waren zu Beginn des PJ bezüglich ihres Weiter-

bildungsfaches noch unsicher, 1/5 änderte während des PJ ihre Meinung diesbezüglich. Als Vorteile der Radiologie wurden insbesondere der Kontakt zu vielen Fachrichtungen (87 %) und die Arbeitsbedingungen (68 %) genannt, als Nachteile vor allem der geringe Patientenkontakt (42 %), die überwiegende Arbeit am PC (43 %) und die Abhängigkeit vom Zuweiser (42 %). 63 % der Studierenden fühlten sich durch die radiologische Lehre im Medizinstudium unzureichend auf ihre ärztliche Tätigkeit vorbereitet. In der curricularen radiologischen Lehre wird aus Studierendensicht insbesondere die praktische Bildbetrachtung nicht ausreichend vermittelt.

Schlussfolgerung Das PJ ist ein für die Facharztwahl wichtiges Studienjahr, in dem sich Wünsche bezüglich des Weiterbildungsfaches und Ansichten zur Radiologie noch ändern. Bei insgesamt großer Zufriedenheit waren insbesondere die Betreuung an den Arbeitsplätzen und die Fortbildungen Kritikpunkte und gleichzeitig relevante Faktoren für das Interesse an dem Fachgebiet, so dass hier Potenzial für Verbesserung besteht.

Introduction

In hardly any other area is there a greater demand for personnel than in human medicine, while the number of available specialists is declining. It is becoming increasingly difficult to attract qualified new blood. Is this only a result of demographics, or does a change in the younger generation's outlook on life play a role [1]? Now it is finally time to think about how to get medical students to be enthusiastic about radiology. Osenberg and colleagues performed an extensive survey of 4398 medical students regarding their plans for the future. The interesting result was that the proportion of students with a desire to continue their education in radiology during their studies dropped from 5.8 % in the first semester to 4.4 % in the practical year, that is, a 24 % decrease [2]. Are medical students being scared away from radiology?

Numerous factors play a role in the selection of a specialty. In addition to the characteristics of the specialty field, the needs of the individual are also significant [3]. Several studies have identified factors supporting radiology. An evaluation of the curriculum demonstrated the positive effect of early implementation of radiology in the coursework [4, 5]. Likewise, practical training using case studies [6, 7] and integrative instruction involving other subjects [5, 8] particularly increase students' motivation, thus enhancing the image of radiology among students. Due to close personal contact and hands-on activity, a practicum in radiology such as a medical clerkship particularly offers an opportunity to encourage students in a subject area [9, 10].

Although classroom teaching and clerkship in radiology have already been studied and the results published, such a study of the radiological practical year has not been done to date. However, this stage of medical studies, especially after the elimination of the physician during internship in 2004, has taken on

particular significance. The aim of our study was therefore to carry out and evaluate a Germany-wide survey of practical year students with respect to the radiology elective course. The study should determine why students should undertake radiology during their practical year and decide on further education in that specialty, establish what influence the practical year has on specialty selection, and recognize where students see the strengths and weaknesses of radiology in their course of study and practical year in order to identify areas where improvement is needed.

Materials and Methods

The evaluation was reviewed and approved by the local ethics committee (No. 7263).

The survey was performed Germany-wide and anonymized. The subjects were students who had started their practical year in the fall of 2015 and who were taking the radiology elective. The survey consisted of one part issued prior to the start of the practical year and a second section at the end of the year, and was performed online using EvaSys 7.0 (Electric Paper Evaluationssysteme GmbH, Lüneburg, Germany). In order to be able to estimate the response rate of the survey, the German Institut für medizinische und pharmazeutische Prüfungsfragen (Institute for Medical and Pharmaceutical Examination, IMPP) was queried regarding the number of students taking the radiology elective in the practical year in the fall of 2016 who had registered for the third state examination.

Invitation to the Survey

The invitation to the first part of the survey was handled by the practical year supervisors of all 37 universities offering medical studies in Germany. It is not known which universities actually

distributed the questionnaire and to how many students. Upon completion of the first part of the survey, students could provide their e-mail address so that the invitation to the second part could be issued.

Questionnaire

The question types included single and multiple-choice responses, response scales and free text questions. At the end of the questionnaire students were asked to enter a personal code to allow concatenation of the first and second questionnaires [11]. The questions covered a wide range of issues, including the model under which the respondents most recently studied (model educational program; reformed or traditional curriculum as described by Putz [12]), previous clerkship in radiology and its duration; the targeted discipline; the reason radiology was selected as an elective (planned as part of specialty training; to help decide future specialization, or to learn radiological skills as an adjunct to another specialty). Likewise queried were the contributing factors to the decision to take a course in radiology (e. g. mandatory course, elective coursework, clerkship or doctoral dissertation in radiology) as well as possible advantages and disadvantages of radiology as a discipline for medical activities (see questionnaire in the online supplement). Questions concerning the teaching of radiology during the course of studies covered the satisfaction of the students (technical and methodological principles, radiation protection, choice of modality, pathologies, individual assessment of images and projection radiographs) as well as preparation for future activities as a physician. Regarding the practical year rotation in radiology, students were queried about how satisfied they were on the whole and with respect to various sub-issues (e. g. organization, workstation support, training classes). Both German questionnaires are available as an online supplement.

Statistical analysis

Statistical analysis was performed using IBM SPSS Statistics Version 24 (IBM Corporation, USA). Descriptive statistics were used to report the results (mean, median, percentage). To compare the groups, the chi-square test was used for independent samples and the McNemar test analyzed dependent samples. Ordinal data was evaluated using the Mann-Whitney U test for independent samples. The selected significance level for all tests was 0.05.

Results

Prior to the practical year, 89 students participated in the survey, and 60 afterward. Based on the personal codes, 39 participants were identified who had responded to both surveys.

The IMPP is notified of elective subjects completed during the practical year according to par. 3 of the Medical Licensure Act [13]. A query indicated that of the 5574 students registering for the third state examinations in the fall of 2016, 342 had taken an elective course in radiology [14]. The rate of return of our survey was estimated based on this figure, indicating at least 26% for our pre-practical year questionnaire, and 18% for the post-practical year response.

Survey prior to the Practical Year

Motivation to select radiology as an elective in the practical year

When explaining their selection of radiology as an elective subject, 27 students (30%) indicated that they wanted to gain experience in specialized radiological training. Forty-four (49%) wanted to find out whether specialization in radiology was right for them. Fourteen (16%) intended to study a different specialty, but wanted to learn radiological procedures during their practical year.

When asked why they had selected radiology as an elective during the practical year, 40 (45%) indicated a previous clerkship in radiology. Sixteen students (18%) named a mandatory course in radiology and 18 (20%) stated elective courses in radiology. Contributing factors for the selection of radiology included: a doctoral dissertation in radiology (13 students, 15%), recommendation by another student (16 students, 18%), personal contact with radiology employees (20 students, 22%). Classes in radiology increased the interest of 25 students (28%), although they diminished the interest of 4 students (4%). For the majority (60 students, 67%), classes in radiology had no significant influence on the selection of radiology during the practical year.

Fifty-six students (63%) reported a prior clerkship in radiology. With an average of 3.9 weeks (2–10 weeks), 42 students (47%) had held a clerkship in radiology, and 14 respondents (16%) had a clerkship with an average duration of 7.1 weeks (4–12 weeks).

Radiological coursework

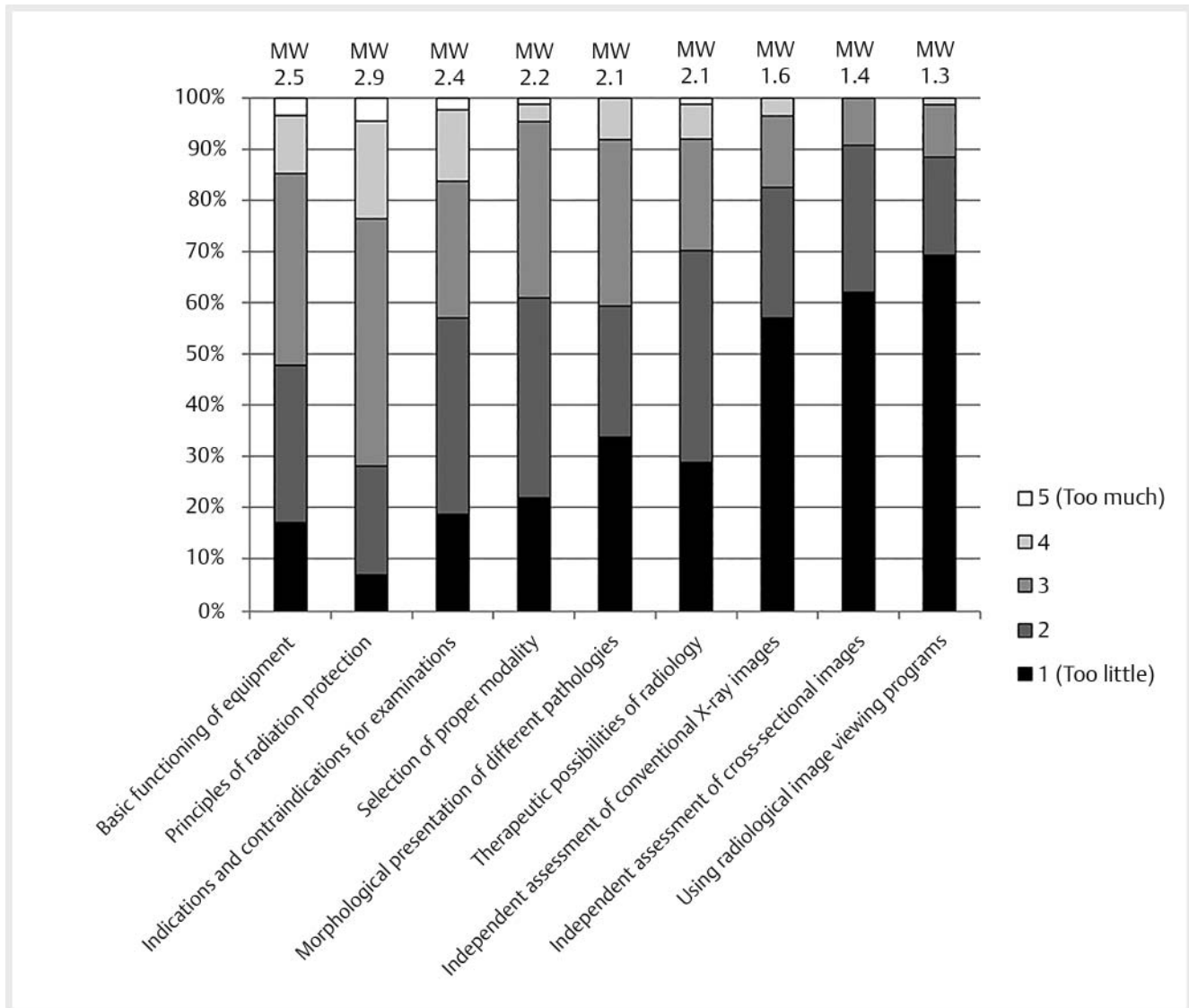
In response to the question regarding their satisfaction with coursework in radiology, a mean of 3.3 was reported on a scale of 1 (very satisfied) to 5 (very unsatisfied). Although 56 students (63%) felt they were not sufficiently prepared for future medical activities by the classes in radiology, 24 (43%) thought they were on the whole sufficiently prepared, and only 9 respondents (10%) thought they were well prepared.

On a scale of 1 (too little) to 5 (too much) regarding coursework in radiology, respondents indicated how adequately coursework covered the subject matter. Insufficiencies were particularly apparent with respect to using radiological image viewing programs (mean 1.3) as well as personal assessment of cross-sections (mean 1.4) and projection radiography (mean 1.6) (► Fig. 1, ► Table 1). The results were additionally analyzed separately according to the study course model (model curriculum, reformed curriculum or traditional curriculum) Similar results were shown for all curriculum models (► Table 1) without significant differences among the groups.

Intended specialty training and reasons for or against radiology

Of the respondents, 55 (62%) intended to specialize in radiology, 15 (17%) indicated internal medicine, 6 (7%) planned to study surgery and 10 (11%) indicated other areas. Only 15 students (17%) stated that their intention to specialize was certain.

The advantages of radiology named by the students included radiology as a varied field with interaction with other specialties (63 responses, 71%) as well as pleasant working conditions



► **Fig. 1** Survey at the beginning of the “practical year”. The diagram shows on a scale from 1 (too little, black) to 5 (too much, white) how reasonable the students considered different teaching content to be. N = 89. MW = mean.

(62 responses, 70%). Disadvantages identified by most students included low patient contact (36 responses, 40%) and extensive work on the PC (39 responses, 44%) (► **Fig. 2**).

Questionnaire after the Practical Year

Satisfaction with the radiology practical year term

Most students were very satisfied with their practical year term in radiology (23 responses, 38%) or mainly satisfied (29 responses, 48%). On a scale of 1 (very satisfied) to 5 (very unsatisfied), the mean was 1.8 (► **Fig. 3**). Particularly low ratings were given to support at the workstations (mean 2.1) and training classes in the department (mean 2.1) (► **Fig. 3**).

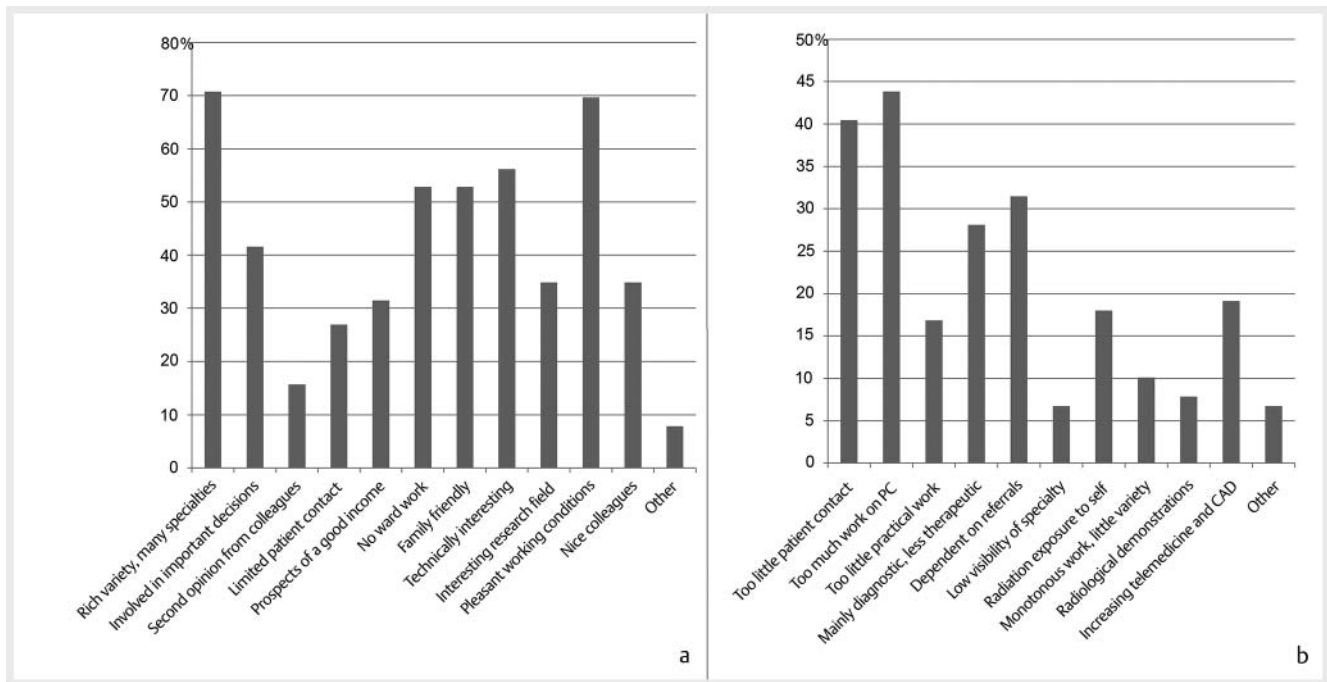
Intended specialty training and reasons for or against radiology

Of the respondents, 41 (68%) intended to specialize in radiology, 9 (15%) indicated internal medicine, 3 (5%) planned to study surgery and 2 (3%) indicated other areas. Three students (5%) had not yet made a firm decision.

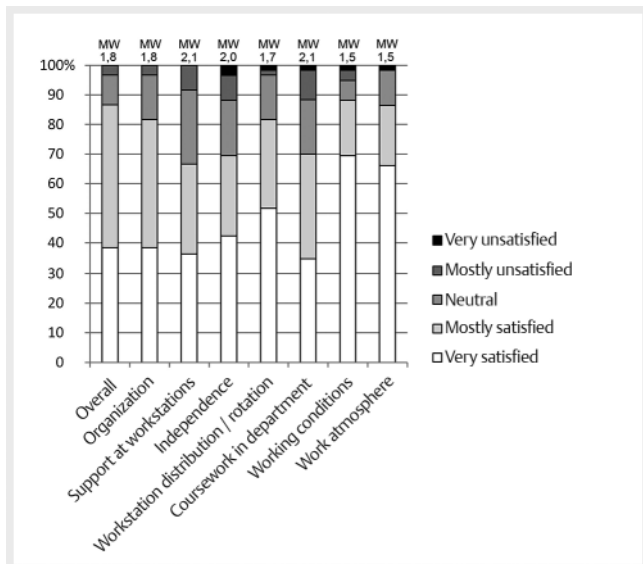
The advantage of radiology named by almost all the students was radiology as a varied field with contact with other specialties (52 responses, 87%). Many respondents also indicated that working conditions were pleasant (41 responses, 68%) and that working in wards was not required (37 responses, 62%). Disadvantages identified included extensive work on the PC (26 responses, 43%), low patient contact (25 responses, 42%) and dependence on referring physicians (25 responses, 42%) (► **Fig. 4**, ► **Table 2** in the online supplement). In the group comparison between students with radiology (N = 41) and those with another subject

► **Table 1** Survey at the beginning of the Practical Year. Results for the question regarding how reasonable on a scale from 1 (too little) to 5 (too much) students considered different teaching content to be. Mean and median are given for the whole cohort and separately for the different courses of study. Group comparisons were performed using the Mann-Whitney-U test.

	total mean/median (N = 89)	model curriculum mean/median (N = 12)	reformed standard curriculum mean/median (N = 14)	classic standard curriculum mean/median (N = 57)	integrative (N = 26) vs. non-integrative (n = 57) Mann-Whitney U test p-value	model (n = 12) vs. standard curriculum (n = 71) Mann-Whitney U test p-value
principles of radiation protection	2.93 (3.00)	2.67 (3.00)	2.57 (3.00)	3.05 (3.00)	0.063	0.328
equipment functions	2.51 (3.00)	2.25 (3.00)	2.43 2.50	2.58 (3.00)	0.471	0.594
indications/contraindications for examination	2.38 (2.00)	2.58 (3.00)	2.08 2.00	2.44 2.00	0.729	0.433
selection of proper modality	2.20 (2.00)	2.25 2.00	2.15 2.00	2.23 2.00	0.932	0.830
morphological presentation of different pathologies	2.13 (2.00)	2.00 (2.00)	2.14 (2.00)	2.14 (2.00)	0.795	0.642
therapeutic possibilities in radiology	2.08 (2.00)	1.92 (2.00)	2.23 (2.00)	2.07 (2.00)	0.920	0.648
using radiological image viewing programs	1.29 (1.00)	1.75 (1.00)	1.14 (1.00)	1.20 (1.00)	0.331	0.053
independent image assessment	1.44 (1.00)	1.42 (1.00)	1.36 (1.00)	1.42 (1.00)	0.968	0.994
independent assessment of conventional images	1.64 (1.00)	1.33 (1.00)	1.54 (1.00)	1.69 (1.00)	0.213	0.189
overall satisfaction with radiological coursework	3.27 (3.00)	3.08 (3.00)	3.36 3.50	3.28 (3.00)	0.902	0.463



► Fig. 2 Survey at the beginning of the “practical year”. The diagram shows the advantages a and disadvantages b of radiology from the students’ point of view. Question with multiple selections, results are given as a percentage of the whole cohort. N = 89.



► Fig. 3 Survey at the end of the “practical year”. The diagram shows the students’ satisfaction on a scale from 1 (very satisfied, white) to 5 (very unsatisfied, black) with their practical year in radiology in general and regarding several issues. N = 60. MW = mean.

(N = 16) as a desired subject for further education (3 students without responses were not included), there were significant differences regarding advantages and disadvantages in several points. Advantages such as varied work with contact with other specialties were identified more frequently by students desiring to study radiology, and the prospect of a good income as an established physician was identified less frequently compared to

students who intended to specialize in a different discipline. The dependence on referrals was more frequently mentioned by future radiologists, but the monotony of the work was mentioned significantly less (► Fig. 4, ► Table 2 in the online supplement).

Comparison before and after the Practical Year

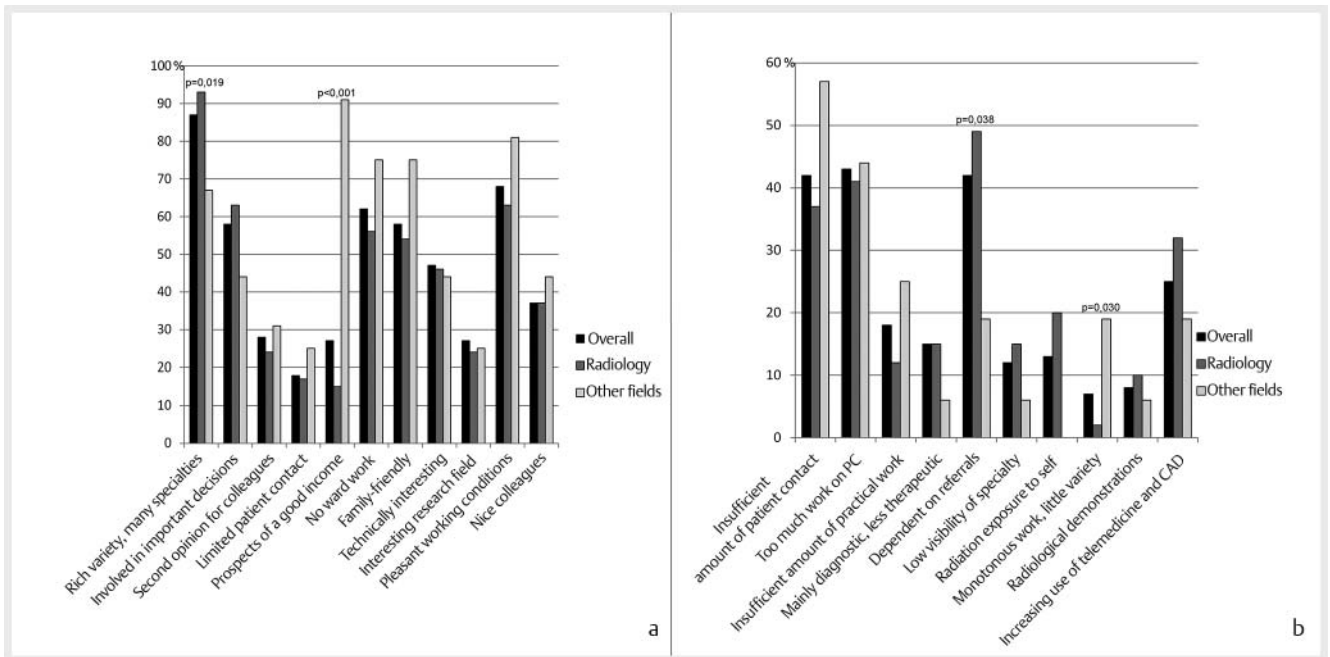
Based on the personal codes, 39 participants were identified who had responded to both surveys.

Reasons for or against radiology in intended specialty training

Regarding the advantages and disadvantages of radiology as a desired discipline for further education, the group comparison showed that the opinion of the students did not change significantly between the junctures before and after the practical year. Only the advantage of the involvement of radiology in important decision-making processes was identified by more students after the practical year compared to before the year (► Fig. 5, ► Table 3 in the online supplement).

Desired specialist training

Thirty-four students indicated an intended specialty before and after their practical year. Of these, 7 (21%) changed their intended discipline during the practical year. Both before and after the practical year 23 students indicated radiology as their desired discipline, although two students changed their mind in the course of the term. Of 4 students indicating surgery as their intended specialty at the start of their practical year, only 2 stayed with this intention. Of 5 respondents stating internal medicine as a specialty, likewise only 2 reaffirmed their intention.



► **Fig. 4** Survey at the end of the “practical year”. The diagram shows the advantages and disadvantages of radiology from the students’ point of view. Question with multiple selections, results are given as percentages of the whole cohort and separately for students with and without radiology as their intended area of specialization. P-values are given for significant differences. Additional values are given in ► **Table 2** in the online supplement. N = 60.

Discussion

The aim of our study was to carry out and evaluate a Germany-wide survey of practical year students with respect to the radiology elective course. We were able to demonstrate that

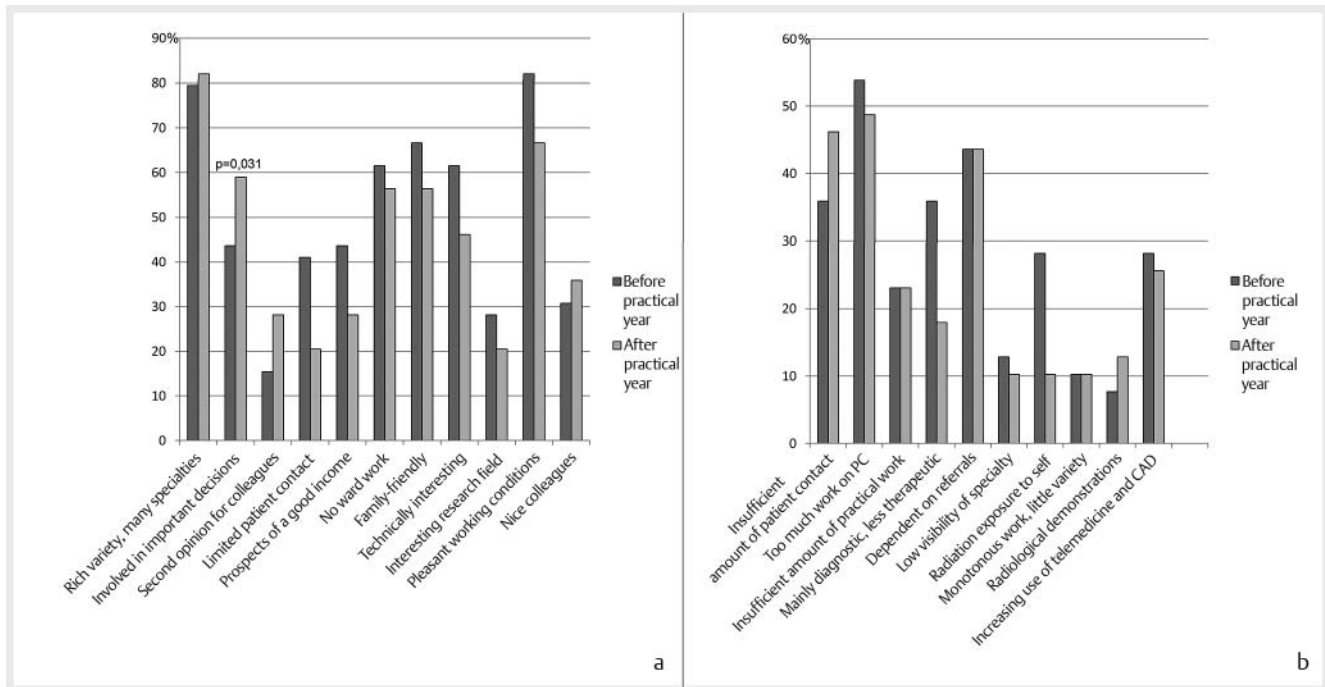
1. In the view of the students, the radiological curriculum offered few practical opportunities and the students felt they were insufficiently prepared for future medical activities.
2. The majority of students selecting radiology during their practical year were highly satisfied. Criticism mainly focused on support at the workstations and training classes in the department.
3. Students were still uncertain regarding their specialty during the practical year and some changed their minds. Likewise, the subjective advantages and disadvantages of radiology changed during the course of the practical year.

Although there was substantial satisfaction with the practical year rotation in radiology, there was minor criticism, especially regarding support at the workstations and training classes. Criticism of support at the workstations was especially surprising, since previous studies have shown that practical engagement during the course of study [15] and clerkships [1, 9] as well as the practical year [3], integration into the medical team and structured support had a positive influence on interest in the specialty. Exactly those aspects identified as decisive for the success of practical training and which encouraged students’ interest in the discipline were most commonly criticized by the students in the radiology rotation.

At the start of the practical year, many students were unsure of which specialty to pursue. Of the students taking radiology as an elective subject, 79% were seriously considering radiology as a specialty, since 30% wanted to gain experience in advance of selecting radiology as a specialty, and 49% wanted to find out whether radiology would be a viable specialty for them. During the practical year 21% of the students changed their mind about a specialty discipline, although this included fewer choosing radiology compared to other fields. This is largely comparable to the figures in a study by Abendroth et al. which showed that in the field of general medicine, one-third of students in the practical year decided upon a different specialty [16].

In a recent study, Kasch and colleagues demonstrated that a clerkship is an important practicum for developing interest in a discipline and plays an important role in selecting a specialty [9]. Likewise, in our survey a large proportion of students said they had already clerked in radiology and almost half of the students named the clerkship as the main reason for deciding upon radiology as an elective subject in the practical year. Nevertheless, 1/3 of the practical year students in radiology had not previously participated in a clerkship, and half the students did not indicate a clerkship as a significant factor in their selection. Although a clerkship contributed to decision-making, the final determination for or against radiology as a specialty in most cases is made at a later juncture.

The responses regarding the advantages and disadvantages of radiology are not surprising given the work of the radiologist, and are similar to comparable studies of other disciplines [3, 16]. On the other hand, it is surprising how the responses regarding radiology sometimes differ significantly depending upon the



► **Fig. 5** The diagram shows the advantages and disadvantages of radiology from the students' point of view at the beginning (dark grey) and at the end (light grey) of the practical year. P-values are given for significant differences. Additional values are given in ► **Table 3** in the online supplement. N = 34.

intended specialty. Our survey could not clarify the reasons for these differences, and it remains to be seen whether prejudices were involved or whether the differences are due to differing needs of the various groups of students.

Satisfaction with radiological coursework was neutral on the whole. It was notable that students in all three curricular forms were similarly satisfied. There were also no significant differences with regard to course content and criticism of the lack of practical relevance. This gives rise to the question of whether a major change has resulted with the introduction of the model curriculum in radiology. One reason for this difference could be that there are model curricula featuring both organ-based and subject-based modules and that standard curricula with traditional disciplinary focus have reformed their course content. A survey of professors of radiology showed that although model curricula implemented greater integration in teaching compared to standard curricula, this generally involved nuclear medicine and radiotherapy rather than unrelated disciplines such as internal medicine and surgery [17]. Strictly speaking, however, this is not an integrative approach, since the German Medical Licensure Act specifically associates these three fields in an interdisciplinary area [13]. In the view of the students in our cohort, the introduction of model curricula has not made the radiological curriculum more practice-oriented, since too little practical content and skills are presented in all curricular forms. Consequently only 10% of the students felt they were well prepared for their future medical activities. The National Competence-based Catalog of Learning Objectives (German NKLM) defined competencies and skills of professional medical action as learning objectives [18], and the German X-Ray Society (DRG) shortly thereafter

developed a model radiological curriculum in which basic radiological competencies and skills [18] were defined as objectives [19] in addition to scientific content. These curricular changes and their implementation are expected to lead to a more extensive change in course content for radiology than was previously achieved through changes in the model study curriculum.

Our study has limitations. Due to the heterogeneity of the available coursework and types of curricula in German medical faculties, the results do not allow conclusions to be drawn regarding individual universities. This limitation applies despite a good rate of response of 26% of all students taking radiology as an elective course. In particular, it may be that some universities have not been taken into account, since the response rate could not be controlled due to data protection regulations. Nonetheless, we believe that the results are sufficiently representative and usable.

Conclusions

The practical year is a practicum that is significant for the future choice of a specialty; medical students can change their opinions regarding both the advantages and disadvantages of radiology. Even a clerkship can be significant, whereas coursework can play a subordinate role in this respect. Despite the overall satisfaction of the students during the practical year, insufficient workstation support and training classes received mild criticism during the year; other relevant factors which influence interest in the discipline likewise indicate potentials for improvement.

RELEVANCE OF THE STUDY

- The practical year is an important academic year for the selection of a future specialty in which many students reconsider their desired discipline while at the same time they are encouraged to pursue radiology.
- Despite the overall satisfaction with the radiological practical year, students offer mild criticism of workstation support and internal coursework. These identifiable factors offer potentials for improvement.
- Students consider mandatory radiological coursework to be insufficient in preparing them for medical activities, no matter the curriculum model.

Conflict of Interest

The authors declare that they have no conflict of interest.

Acknowledgments

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