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Many studies have been undertaken to assess the attitudes of medical students to the clinical importance of gross anatomy. However, much less is known about their attitudes toward the clinical importance of histology. Using Thurstone and Chave methods to assess attitudes, over 2,000 early stage medical students across Europe provided responses to a survey that tested the hypothesis that the students have a high regard for histology’s clinical relevance. Regardless of the university and country surveyed, and of the teaching methods employed for histology, our findings were not consistent with our hypotheses, students providing a more moderate assessment of histology’s importance compared to gross anatomy but more positive than their attitudes toward embryology. Histology should play a significant role in medical education in terms of appreciating not just normal structure and function but also pathology. We conclude that teachers of histology should pay special attention to informing newly-recruited medical students of the significant role played by histology.
in attaining clinical competence and in underpinning their status as being learned members of a healthcare profession. This work was conducted under the auspices of the Trans-European Pedagogic Research Group (TEPARG). Clin. Anat. 00:000–000, 2017. © 2017 Wiley Periodicals, Inc.

Key words: anatomy; student attitudes; histology; medical students; microscopical anatomy

INTRODUCTION

The clinical importance of gross anatomy in the medical curriculum has been extensively reported (e.g., Monkhouse, 1992; Prince et al., 2003, 2005; Older, 2004, Hinduja et al., 2005; Pryde and Black, 2005; Waterston and Stewart, 2005; Patel and Moxham, 2006; Moxham and Plaisant, 2007; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). Indeed, both professional anatomists and medical students (at various stages of their course) in different parts of Europe possess very positive attitudes toward the clinical relevance of gross anatomy (Patel and Moxham, 2006; Moxham and Moxham, 2007; Moxham and Plaisant, 2007; Kerby et al., 2008; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). To date, however, we know much less about the perceived importance of microscopic anatomy in the medical curriculum.

Institutional and national reviews of the medical curriculum have led to significant decreases in the time allotted to the biomedical sciences and particularly for some anatomical sciences. However, Drake et al. (2002, 2009, 2014) have reported that the number of hours devoted to histology in US medical schools has not changed significantly from 2002 to 2014. They found that in 2014 the average histology course lasted 72 hr (range 4–142 hr) compared with 79 hr (range 20–160 hr) in 2002. However, in terms of teaching methodologies, significant changes have also been reported and there are marked differences in the organization of academic departments teaching microscopical anatomy. Indeed, the anatomical sciences are divided in some medical schools into separate departments of gross anatomy, histology, and embryology, with each department providing separate courses to the students. Elsewhere, the anatomical sciences are integrated and/or integrated with the rest of the medical curriculum such that histology courses are not “stand alone.” Drake et al. (2002, 2009, 2014) have highlighted the changes in the teaching of histology in US medical schools. They reported that, by 2014, on average a school delivered 31 hr of histology lectures (range 0–97 hr) and 33 hr of histology practicals (range 0–69 hr). This compares with 51–60 hr of practicals in 2002 (range 0–100 hr), representing >50% of the total course hours. It is thus noteworthy that some courses give neither lectures nor practicals. Furthermore, only 36% of courses were stand-alone, 52% existed in an integrated curriculum, and 12% in a mixed curriculum. The greatest change seen relates to the use of microscopes. In 2014, 82% of courses relied upon extensive use of virtual microscopy and this compares with 71% in 2009 and only 14% in 2002.

As a contribution to the debate on the importance of the anatomical sciences in medicine, in this article, we report on an assessment of the attitudes of medical students toward the clinical relevance of histology since, to understand best how to deal with the teaching of microscopic anatomy, it is necessary to evaluate the attitudes of students, academics, and clinicians (perhaps even Deans and medical educationalists). This is

<table>
<thead>
<tr>
<th>Country</th>
<th>n</th>
<th>Attitude scale (range)</th>
<th>Attitude scale (mode)</th>
<th>Embryology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria (Innsbruck)</td>
<td>187</td>
<td>2–9</td>
<td>4</td>
<td>2–10 (4 mode)</td>
</tr>
<tr>
<td>Czech Republic (Prague)</td>
<td>253</td>
<td>1–9</td>
<td>3</td>
<td>1–9 (4 mode)</td>
</tr>
<tr>
<td>France (Paris, Sorbonne)</td>
<td>265</td>
<td>2–8</td>
<td>4</td>
<td>NK</td>
</tr>
<tr>
<td>Germany (Erlangen)</td>
<td>165</td>
<td>2–9</td>
<td>4.5</td>
<td>NK</td>
</tr>
<tr>
<td>Greece (Thessaloniki)</td>
<td>151</td>
<td>2–10</td>
<td>4.5</td>
<td>2–9 (5.5 mode)</td>
</tr>
<tr>
<td>Italy (Padova)</td>
<td>119</td>
<td>2–11</td>
<td>4</td>
<td>NK</td>
</tr>
<tr>
<td>Malta</td>
<td>185</td>
<td>2–10</td>
<td>2 &amp; 8 bimodal</td>
<td>1–9 (6 mode)</td>
</tr>
<tr>
<td>Portugal (Lisbon)</td>
<td>109</td>
<td>2–8</td>
<td>3 &amp; 6 bimodal</td>
<td>1–8 (5 mode)</td>
</tr>
<tr>
<td>Romania (year 1) (Bucharest)</td>
<td>109</td>
<td>2–8</td>
<td>3.5</td>
<td>Combined 2–8 (5 mode)</td>
</tr>
<tr>
<td>Romania (year 2) (Bucharest)</td>
<td>92</td>
<td>2–10</td>
<td>3.5</td>
<td>NK</td>
</tr>
<tr>
<td>Serbia (Nis)</td>
<td>183</td>
<td>2–9</td>
<td>2 &amp; 4 bimodal</td>
<td>NK</td>
</tr>
<tr>
<td>Spain (Madrid, Leioa)</td>
<td>172</td>
<td>2–9</td>
<td>4</td>
<td>NK</td>
</tr>
<tr>
<td>U.K. (Cardiff)</td>
<td>156</td>
<td>2–9</td>
<td>5</td>
<td>2–9 (modes 3.5/6)</td>
</tr>
<tr>
<td>Total</td>
<td>2146</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

TABLE 1. Summary Statistics of the Attitudes of Medical Students Toward the Clinical Relevance of Histology at the Universities Surveyed (Alphabetical Order)
Although Histology is interesting, the subject needs selective understanding in the clinic

Histological terminology develops the vocabulary of Medicine

Histology is a useful tool for satisfactory medical practice

Histology is a “necessary evil” in Medicine

Histology is of some use in the clinic, but its importance may be exaggerated

Histology is only of benefit in certain medical specialities

Histology is so old-fashioned that it has no importance in contemporary Medicine

Histology is time wasted in the medical curriculum

Histology needs to modernise if it is going to be really useful in Medicine

Every doctor must have a good knowledge of Histology

If alternative and Eastern Medicine can do without Histology, so can Western Medicine

It is impossible to conceive of good medical training without a major Histology component

It is not possible to make a reasonable medical diagnosis without Histology

Medicine could not exist without Histology

Most medical conditions do not require a great knowledge of Histology

Of all the basic sciences, Histology is the most clinically relevant

Only a limited histological knowledge is required for satisfactory medical practice

Rather than learn Histology, medical students should concentrate on clinical sciences

The principles of Medicine are not founded on histological knowledge

Without a knowledge of Histology, the doctor is of limited effectiveness

<table>
<thead>
<tr>
<th>Question</th>
<th>Tick Box</th>
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<tbody>
<tr>
<td>Although Histology is interesting, the subject needs selective understanding in the clinic</td>
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</tbody>
</table>

**Fig. 1.** The Thurstone and Chave attitude questionnaire used in the survey.

Methods

Research was undertaken under the auspices of the Trans-European Pedagogic Research Group (TEPARG).
Medical students who were at early stages in their education at the Medical University of Innsbruck (Austria), Charles University Prague (Czech Republic), Université Paris Descartes, Sorbonne Paris Cité (France), the Friedrich Alexander University of Erlangen-Nürnberg (Germany), the Aristotelian University of Thessaloniki (Greece), the University of Padova (Italy), the University of Malta, the NOVA University of Lisbon (Portugal), C. Davila University Bucharest (Romania), the University of Niš (Serbia), Complutense University, Ciudad Universitaria at Madrid and the University of the Basque Country (Spain), and Cardiff University (U.K.) took part in the survey. In total, 2,146 students responded and Table T1 records the numbers of respondents at each participating university. It was deemed useful, for the purposes of comparison, to have a variety of universities that adopt different approaches to the teaching of histology (see Discussion).

Ethical approval for the study was obtained from the ethics committee at the Cardiff School of Biosciences, Cardiff University to ensure that the surveys were conducted anonymously, that the data remained strictly confidential, that no vulnerable groups were included, and that participation in the survey was voluntary.

The questionnaire provided to the medical students was brief, essentially comprising a Thurstone and Chave attitude protocol (Fig. 1) whose phraseology was similar to that used previously to assess the attitudes toward gross anatomy and embryology (e.g., Moxham and Plaisant, 2007). In conformity with the principles devised by Thurstone and Chave (1951), 20 statements concerning the clinical relevance of histology were devised for the analyses that cover the range from very pro-sentiments to very anti-sentiments (and with a series of more neutral statements). These statements were randomly arranged in the questionnaire and required the participating student to only tick those statements with which she/he was in full agreement. Prior to conducting the investigation a group of 50 "judges" were asked to score each statement on a scale of 1 to 11, where 1 represents a very pro-sentiment and 11 a very anti-sentiment (with the complete range of scores in between to represent the various shades of opinion). The median scores of the "judges" provided a numerical value for each of the statements in the questionnaire that could subsequently enable quantitative data to be obtained for each student and each cohort of students.

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**Fig. 2.** Histogram showing the results obtained from the students at Innsbruck (Austria) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

**Fig. 3.** Histogram showing the results obtained from the students at Prague (Czech Republic) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

**Fig. 4.** Histogram showing the results obtained from the students at Paris, Sorbonne (France) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

**Fig. 5.** Histogram showing the results obtained from the students at Erlangen (Germany) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.
To analyze the data statistically, Microsoft Excel was employed for creating graphs and conducting simple calculations. MINITAB, SPSS, and SAS were used to test for normality of datasets and to run statistical tests, including ANOVA and t-tests. To make comparisons between each country’s data, following ANOVA, a Tukey test was employed for post-hoc analysis.

RESULTS

Figs 2–14 display histograms that record the students’ attitudes toward histology according to Thurstone and Chave (1951) scale of 1 (extremely positive attitude) to 11 (extremely negative attitude). The ranges and mode scores for each university/country are shown in Table 2.

Statistical analyses show that data from Greece, France, Austria, Portugal, Romania, Germany, Spain, Italy, and Serbia are alike whereas variance analyses ($F = 9.05; P = 0.00$), and the Tukey test, indicate that there are significant differences for the data from the UK, Czech Republic, and Malta ($P < 0.03$).

DISCUSSION

The findings overall are not consistent with our initial hypothesis that medical students at the early stages in their training appreciate well the clinical importance of histology. Although most data remain on the positive side for the attitude scale employed (i.e., central tendencies for the data ranging from 2 to 8), the students show more scepticism about histology’s relevance than seen for the attitudes toward the importance of gross anatomy using the same Thurstone and Chave (1951) methodologies (Patel and Moxham, 2006; Moxham and Moxham, 2007; Moxham and Plaisant, 2007; Kerby et al., 2011; Olowo-Ofayoku and Moxham, 2014). However, the data is more positive than those previously reported for the clinical relevance of embryology in the European medical curriculum (Moxham et al., 2016). Indeed, a highly significant statistical difference was found between the data for histology and embryology ($P = 0.00$). Figure 15 provides a comparison graphically between data for histology, embryology, and gross anatomy, where the mode for gross anatomy is 3 on the attitude scale compared with a mode of 5 for embryology and 4 for histology. It can thus be concluded that, while there is no need to “propagandise” the importance of gross anatomy to newly recruited medical students, there is a need to strengthen the teaching of histology.
medical students who are well aware of the importance of the discipline to their clinical training, there certainly is a need to instruct and inform the students about the importance of studying histology. To histologists, the relevance of the discipline to such clinical areas as pathology is obvious but it is clearly not so obvious to the students. Indeed, many of the students had yet to undertake or complete their histology courses and so students’ attitudes toward histology were not always influenced by the teaching of histology at the medical school itself, but by their pre-university education, mainly in biology classes. We assume that, although there is some histology taught, at least to some extent, in secondary school, histology, unlike gross anatomy, is not anchored in the general population’s mind as crucial for medical education.

With the exception of the universities at Cardiff, Prague, and Malta, a consistent pattern was seen across the other European medical schools surveyed. This was surprising given the great variation in the courses and methods of examination employed at the various medical schools surveyed. Table 2 shows that the number of hours devoted to the teaching of histology ranged from 40 hr to 180 hr. Furthermore, while some of the schools had histologists incorporated within a unified department of anatomical sciences, many had separate departments devoted to histology (or histology and cell biology and/or embryology) and separate from departments of gross anatomy. Five medical schools had independent histology course whereas the remaining eight schools had integrative courses (either just with anatomy or with the whole medical course). Most of the courses occupied timetable slots in Year 1 of the medical curriculum but several extended across into Year 2 or even Year 3. Four schools effectively had no clinically qualified teachers while the others had variable numbers of clinical teachers. It can also be seen that there is variability in the use of clinical cases within the histology courses but nearly all the courses relied upon the continuing use of microscopes and not virtual microscopy. Great variation was also discerned for examinations, ranging from oral examinations, to essay writing, to evaluation of clinical cases, to practical tests, to MEQ tests. Compared with the histology courses for medical schools in the USA (see Drake et al., 2002, 2009, 2014), where the average histology course lasts 72 hr (range 4–142 hr), where most courses are integrative, and where 82% of courses rely on virtual microscopy (see also Cotter, 2001; Blake et al., 2003; Bloodgood and Ogilvie, 2006), many histology courses in Europe remain “stand alone,” with more hours of tuition and little use as yet of virtual microscopy.

Thus, in view of the consistency of attitude found in this survey, we can suggest that the slightly less positive attitudes toward histology compared with gross anatomy relate not to teaching methods but to the difficulties faced in persuading students of the discipline’s relevance because of the attitudes they bring with them from their pre-medical school experiences or assumptions. Overall, we can conclude that teachers of histology must be aware that their students do not naturally see the clinical relevance of the subject and consequently its importance must be stated explicitly at the start of their course and must be often reinforced. We would therefore recommend that histological topics should be reintroduced at various stages of medical education. In addition, ways must be found to improve the general population’s perception of histology’s

![Fig. 10](image1.png)  
**Fig. 10.** Histogram showing the results obtained from the students at Bucharest Year 1 (Romania) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

![Fig. 11](image2.png)  
**Fig. 11.** Histogram showing the results obtained from the students at Bucharest Year 2 (Romania) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.

![Fig. 12](image3.png)  
**Fig. 12.** Histogram showing the results obtained from the students at Nis (Serbia) where a score of 1 indicates an extremely favorable attitude toward the clinical importance of histology and a score of 11 an extremely unfavorable attitude.
relevance and, difficult and time-consuming as it might be, should encourage the teaching of some histology in secondary schools.

The question should here be addressed as to why the results for Cardiff, Malta, and Prague differed from the other schools surveyed. Without further objective investigation, the definitive answers will not presently known but we can offer some pointers now. For Cardiff, the poor attitudes might be related to the lack of a defined histology course and the low number of hours given over to the subject (note that the 40 hr figure given in Table 2 overestimates time dedicated to histology since topics often just feature as part of pathophysiology presentations or merely as an adjunct to other material in the integrative course). It might also be suggested that the low numbers of dedicated histologists and participating clinicians has a contribution. However, the explanation probably lies in the way histology is examined at Cardiff, since teachers are all too familiar with the way students learn strategically for examinations. It was discovered that histology at Cardiff is assessed in Year 1 by means of single best answer questions and, at the summative papers at the end of the year, out of 240 questions, there are 12 histology-based items. Thus, histology comprises just 5% of the total material examined and, given that there is no requirement to pass these questions, it could be argued that there is little incentive for the students to study the subject in depth. For Malta, also providing a very negative attitude toward histology’s relevance, other than the same limited number of teaching hours and examination questions devoted to the subject, there is little else to offer in terms of explanation. Nor at this stage, can an explanation be found for the very positive attitudes expressed by the students at Prague, although it is clear that the course is fulsome and well structured with dedicated teachers. Indeed, in addition to lectures, material is available electronically on the web and the lecturers are available for consultations.

In view of our findings, a few general comments can be made that are pertinent to understanding how students’ attitudes might be improved. First, we would argue that there is a need to ensure that the teachers of histology are clinically qualified, persons with whom the students can empathise and who can clearly point out medical evidence by giving appropriate clinical examples. Second, sufficient time should be found in the medical curriculum to ensure that histology is correctly positioned in the curriculum since students are quick to spot whether organizational and logical issues impinge upon the importance given by a course director to different disciplines and topics. Furthermore, if historical topics are too dispersed in an integrative course then the students might again lose sight of the discipline’s importance and get little feel for the “wholeness” of the subject. Third, gross anatomy, embryology, and histology in the past were often taught together and integrated. The “divorce” between these anatomical sciences has had several impacts. Most importantly, clinical scenarios for both gross anatomy and histology are more powerful when they are constructed together.
Fourth, histologists should agitate for the development of a core syllabus for the discipline that is internationally based. This is currently being organized by the International Federation of Associations of Anatomists (IFAA). Finally, in order to plead for the necessity of the survival of histology, directors of medical education frequently want to see, not only the clinical relevance of disciplines and topics, but also the research relevance. Accordingly, it could be significant that, not following the ethos within a university of taking students to the frontiers of knowledge, can lead to a poorer appreciation of the importance of histology in medical education.

REFERENCES


Thurstone LL, Chave EJ. 1951. The Measurement of Attitude; A Psychophysical Method and Some Experiments With a Scale for Measuring Attitude Toward the Church. Chicago, IL: University of Chicago Press.
AQ1: Please check whether the short title is OK as set.

AQ2: Please provide department/division name for affiliation 2.

AQ3: Kindly note that the author name in the reference citation is spelt as “Waterston and Stewart, 2005,” whereas in the list it is given as “Waterson and Stewart, 2005”. Please correct wherever applicable.

AQ4: Please confirm that given names (red) and surnames/family names (green) have been identified correctly.