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Knowledge about and Attitude towards Science of First Year Medical Students

Ivana Vodopivec, Ana Vujaklija, Maja Hrabak, Ivan Krešimir Lukić[1], Ana Marušić[1], Matko Marušić[1]

Medical students, and [1]Croatian Medical Journal, Zagreb University School of Medicine, Zagreb, Croatia

Aim. To assess the knowledge about and attitude towards science of students entering medical school, and to find out whether these parameters are influenced by their high school education, sex, place of residence, and rank achieved on the admission test.

Methods. A total of 193 (82%) students who enrolled at the Zagreb University School of Medicine in 2001 filled out an anonymous questionnaire at their first lecture. The questionnaire consisted of demographic data, 20 statements on science adapted to a 1-5 Likert scale, and 8 multiple-choice test questions on knowledge of scientific research.

Results. The students' knowledge of scientific research was poor (out of 8 answers, 2.2 ± 1.2 were correct) in spite of their positive attitude towards science (75 11 on a 20-100 scale). Higher ranking students at the admission test showed more positive attitude (Spearman's rho = -0.157, p = 0.003). There was no interdependence between other personal data (sex, high school, and place of residence) and opinion/knowledge about science.

Conclusion. In Croatia, first-year medical students are not familiar with basic facts about the scientific methods and communication in medicine, but they have positive attitude towards scientific research. The only factor associated with more positive attitude towards science is higher rank at the admission test.

Key words: *attitude; education, medical; students, medical; knowledge; questionnaires; science*

Understanding and use of scientific methods is an important component of medical profession (1). Practicing physicians may benefit from the principles of scientific research, skills of collecting, analyzing, and evaluating data, as well as performing and presenting their own research. Furthermore, they are faced with the abundance of information published in medical journals and need to be able to evaluate and select relevant articles.

We assessed medical students' attitudes towards science, as an indicator of their readiness to accept medicine as a science-based profession. We also investigated whether medical students possess knowledge of scientific methods and communication at the start of their professional education. High school curriculum in Croatia does not include education on scientific methodology and we expected students' knowledge about science to be poor.

Zagreb is the capital and academic center of Croatia, and the Zagreb University School of Medicine is the oldest and largest medical school in Croatia. Students from all over the country apply for admission to the school. The candidates also come from different types of high schools ranging from general grammar school to schools with special programs, such as program in mathematics or classical languages. We assessed the influence of these factors on students' attitudes toward science, as well as the possible influence of their rank at the admission test, which was found to be a good predictor of students' academic performance (2,3).

Subjects and Methods

Study Sample

The questionnaire was distributed to first-year students who attended the introductory lecture at the beginning of the academic year 2001. Out of 241 potential respondents, 197 fulfilled the questionnaire (response rate 82%). Four questionnaires (2%) were partially completed and therefore excluded from the analysis. The total number of valid questionnaires was 193.

Variables

The towns where students finished high school were divided into three groups according to the number of inhabitants: cities with >200,000 inhabitants; towns with 20,000-200,000 inhabitants, and towns with <20,000 inhabitants. The only city in the first group was Zagreb, with the population of approximately one million.

The types of high schools were divided into five groups: 1. high school of natural sciences and mathematics ("prirodoslovno-matematička gimnazija"), 2. high school of modern languages ("jezična gimnazija"), 3. high school of classic languages ("klasična gimnazija"), 4. general high school ("opća gimnazija"), and 5. vocational school of nursing and midwifery ("srednja medicinska škola").

In Croatia, high school education lasts four years. The schools are divided into general high schools (*gymnasiums*), which provide general education, and vocational schools, which provide profession-oriented training. General high schools teach 15 mandatory subjects and offer elective subjects.

Testing Attitude toward Science

Item generation. To obtain a psychometric instrument to measure the attitude of medical students towards science we chose a Likert-type scale because the construction and use of such scale is relatively easy, and the interpretation of the results is straightforward (4). To create an initial set of candidate items for the scale, we organized a brainstorming session with students majoring in psychology (Division of Psychology, Zagreb University Faculty of Philosophy). The students (approximately 50 of them) were asked to generate Likert-type statements on scientific research in medicine. We collected a total of 99 positive and 100 negative statements. The psychology students were chosen because it was necessary to avoid any possible bias that people with medical background might have and because they were familiar with the construction of valid Likert-type statements. The questionnaire statements addressed both the attitude toward science as systematic knowledge and the attitude toward scientific research as a method of testing hypotheses and acquiring knowledge. The term "science" in this manuscript describes both types of attitudes.

Item validation. To ensure the validity, eight independent observers with a university/college degree were asked to select 60 (30 positive and 30 negative) most relevant statements out of initial 199. The items chosen by at least four observers were included in the questionnaire.

Questionnaire. The questionnaire was composed of three parts: 1. student's personal data, 2. Likert-type statements on attitude toward science and research, and 3. evaluation of knowledge. Personal data included student's sex, rank at the medical school admission test, town where student had finished high school, and the type of high school. The second part consisted of 30 positive and 30 negative randomly ordered items with Likert-type scale responses: 1 – strongly disagree, 2 – disagree, 3 – undecided, 4 – agree, and 5 – strongly agree. A 1-to-5 response scale was chosen because the school grades in Croatia range from 1 to 5, and we presumed that the students would be most familiar with a 5-level scale. The last part contained 8 multiple-choice questions about scientific research.

Item selection and reliability analysis. We decided to select 20 items (10 positive and 10 negative) for a final questionnaire, on the basis of item discrimination and item-total correlation. First, we created a new variable (ie, "total"), which was the sum of all the individual items for each student (N = 193). After that, we selected the quarter of the students with the highest and the lowest *total* (n = 49 for each group) and calculated the average rating for each item in both groups (ie, top and bottom quarter). We compared the average ratings of the top and bottom group on each item, using the Student's t-test. The difference between the top and the bottom group was not significant at 0.05 level for four items. Those items were considered to be poor discriminators and were eliminated from further analysis. To select the items with high item-*total* correlation, we calculated the correlation matrix. The items correlating with the total score less than 0.4 (n = 36) were also eliminated. Therefore, the final questionnaire was composed of 10 positive and 10 negative items. The average item-total correlation of 20-item scale was 0.471. The average score for the scale was 75 with the standard deviation of 11. The average score on an item was 3.7 with the standard deviation of 0.5 and the range of 1.9 (Table 1). The standardized Cronbach's of the final scale was 0.848.

For the purpose of this report, an independent English tutor translated the items into English. After that, we asked another translator to put them back to Croatian. We compared the original and the back-translated statements. To improve the validity of translation, we rephrased eight English statements.

Testing Knowledge on Scientific Research

To evaluate the first year students' knowledge on research in medicine, we used the simplified version of the written exam for the second-year mandatory course "Principles of Scientific Research in Medicine" at the Zagreb University School of Medicine. The teachers of the course regularly compose multiple-choice questions based on the mandatory textbook (5). To insure the content validity of the questions, each question is first peer reviewed by a group of teachers and scientists. If the members of the group agree that question is valid (in either original or revised form), the question is added to the database. Furthermore, after every exam, the questions with poor psychometric characteristics (ie, difficulty index and discrimination) are removed from the database.

For the purpose of this research, we decided to select eight questions from the database, two from each of the main sections of the textbook (ie, principles of scientific research, collection and presentation of data, medical bibliographic databases, and principles of assessing and writing a scientific article). Although the number of questions may be considered insufficient, we felt that

Table 1. Attitudes of first-year medical students toward science and scientific research

Statement	No. (%) of students who disagreed (1 + 2)[a]	No. (%) of students who agreed (4 + 5)[a]	No. (%) of students who were undecided (3)[a]	Average score (mean ± SD)
Science has prolonged human life.	9 (5)	178 (92)	6 (3)	4.6 ± 0.9
There would be no progress of humankind without the progress of science.	15 (8)	170 (88)	8 (4)	4.3 ± 1.0
Valid discoveries are impossible without scientifically sound research.	15 (8)	164 (85)	14 (7)	4.2 ± 0.9
Science gives us better understanding of the world.	12 (6)	158 (82)	23 (12)	4.2 ± 0.9
Scientific approach facilitates better understanding of problems.	16 (8)	153 (79)	24 (13)	4.1 ± 1.0
Use of scientific methodology is the basis of medical progress.	8 (4)	146 (76)	39 (20)	4.0 ± 0.8
Every physician has to be well acquainted with the scientific methodology.	10 (5)	142 (74)	41 (21)	4.0 ± 0.9
The knowledge of scientific methodology is essential for obtaining accurate and objective data.	17 (9)	139 (72)	37 (19)	3.9 ± 1.0
A fact can be established only by a scientific approach.	20 (10)	129 (67)	44 (23)	3.8 ± 1.0
Scientists are creative and interesting people.	28 (15)	131 (68)	34 (17)	3.8 ± 1.1
Physicians believing only in science are small-minded.	57 (30)	97 (50)	39 (20)	3.3 ± 1.3
Scientific approach limits a physician's choices.	77 (40)	64 (33)	52 (27)	2.9 ± 1.1
Science is the main cause of ecological catastrophe we face.	73 (38)	69 (36)	51 (26)	2.9 ± 1.2
If science continues in the same direction it has so far, it will lead to the destruction of the humankind.	80 (41)	60 (31)	53 (28)	2.8 ± 1.3
Scientific approach lacks humanity.	91 (47)	57 (30)	45 (23)	2.7 ± 1.1
Scientific methods impose unnecessary rules.	93 (48)	39 (20)	61 (32)	2.6 ± 1.1
Scientific methodology only makes the implementation of medical research more difficult.	117 (61)	22 (11)	54 (28)	2.3 ± 1.0
Negative effects of science exceed positive ones.	99 (51)	32 (17)	62 (32)	2.3 ± 1.1
If there were no science, we would lead less troubled and healthier lives.	122 (63)	29 (15)	42 (22)	2.2 ± 1.2
Scientific way of thinking is dull and boring.	139 (72)	31 (16)	23 (12)	2.1 ± 1.1

[a]Numbers indicate answers on the scale from 1 (complete disagreement) to 5 (complete agreement).

a larger number (for example, 30 questions) would make the questionnaire longer and thus less stimulating for the respondents. In addition, our aim was not to quantify the student's knowledge on research, but to confirm the hypothesis that, on average, first-year students of the Zagreb University School of Medicine have very limited knowledge about scientific research in medicine. The reliability of the knowledge test was 0.52, as determined by the Kuder-Richardson Formula 20 (4).

For each student, we summed up the number of correct answers and compared the result with the score that would be obtained by random guessing (1.6 out of 8, or 20%).

Statistics

Student's t-test was used to analyze the discrimination of the items. The correlation matrix based on Pearson's product-moment correlation was used to analyze the item-*total* correlation. One-sample Student's t-test was used to compare the average attitude with the neutral value of the attitude score (60, in the middle between the lowest score of 20 and the highest score of 100), as well as the average score on the knowledge test with the score expected to occur by chance. The statistical significance of the difference in the attitude and knowledge between students from different types of high schools and different places of origin was evaluated by Kruskal-Wallis test, and between sexes by Mann-Whitney U-test. The statistical significance of the correlation between rank at the admission test and attitude toward science was analyzed by Spearman's rho nonparametric correlation analysis. All the tests were two-tailed. The -level was set at 0.05. The statistical analysis was performed by use of SPSS 7.5 for Windows (SPSS, Inc., Chicago, IL, USA).

Results

A total of 193 students were included in the study (response rate 82%). The total mean attitude test score was 75 11 out of maximum 120 points and indicated a positive attitude toward science and scientific research (Table 2). It differed significantly from the neutral score (60 on a range from the minimum of 20 to maximum of 120) ($t_{192}=19.366$, $p<0.001$, mean difference 15). The analysis of the students' individual statement scores on the attitude test (Table 1) showed that they had the most positive attitude toward the role of science in the improvement of human life and health. They were less positive about science as the only way of obtaining facts, and to scientists as creative and interesting people. The statement on the creativity and appeal of scientists got the lowest score among the 10 positive statements, and the negative statement on the small-mindedness of physicians using scientific approach in their work got the highest score among the 10 negative statements (Table 1).

The knowledge test asked about the basic principles of scientific research, characteristics of experimental samples and measuring methods, medical bibliographic databases, and structure of a scientific article (Table 3). The average number of correctly answered questions was 2.2 1.2 (28 16%) out of eight answers (Tables 2 and 3). This was significantly higher from the score expected by chance ($t_{192}=6.877$, $p<0.001$, mean difference = 0.6).

We also examined if the sex, place of origin, type of high school from which the students graduated or their rank on the admission test had any influence on the scores on the attitude or knowledge test (Table 2). The only statistically significant correlation (Spearman's rho = -0.157, $p=0.003$) was found between the rank on the admission test and student's attitude toward scientific research, with higher ranked students showing more positive attitude. Compared to other high-school backgrounds, students from a vocational type of school (schools of nursing and midwifery) had the lowest attitude score (Table 2). This difference was not significant, probably because of a small number of students coming from this type of school.

Discussion

Our study showed that high-school graduates entering medical school had positive attitude toward scientific research despite their lack of knowledge on the scientific method and communication in medicine. We performed a MEDLINE search of published work, combining the terms "attitude", "medical student", "science", and "research", and found a single study that investigated the attitudes of medical students toward research (6). The study from the National University of Mexico also found positive attitude of medical students from the 1st and 4th/5th year.

Students' sex, place of origin, or the type of high school they attended, ie, the type of pre-university curriculum, did not influence their positive attitude toward science. Although there is a common belief that the high school students with a background in natural sciences have better chances for enrolling in a medical school (7), a number of studies have shown that there was no relationship between the type of pre-medical curriculum and performance in medical schools (3,8,9). Our study also suggests that students' educational background does not influence their attitudes toward science. There are two types of high general school curricula in Croatia – one based on mathematics and natural sciences and the other

Table 2. Students' attitude toward and knowledge about science and scientific communication according to their sex, place of origin, and type of high school they finished

Independent variable		No. of students	Attitude (mean ± SD)	Knowledge (mean ± SD)
Sex	male	70	76 ± 10	2.1 ± 1.2
	female	123	74 ± 11	2.3 ± 1.3
Place of origin (No. of inhabitants)	Zagreb (> 200,000)	85	75 ± 10	2.2 ± 1.3
	20,000-200,000	68	75 ± 13	2.2 ± 1.3
	< 20,000	40	74 ± 8	2.2 ± 1.2
High school	high school of natural sciences and mathematics	49	75 ± 10	2.1 ± 1.4
	general high school	102	75 ± 10	2.3 ± 1.3
	high school of modern languages	17	78 ± 11	2.3 ± 0.9
	high school of classical languages	18	74 ± 10	2.0 ± 0.8
	vocational school of nursing and midwifery	7	68 ± 25	2.0 ± 1.3
Total		193	75 ± 11	2.2 ± 1.2

Table 3. Students' knowledge about scientific research and communication in medicine[a]

Question	No. (%) of answers
1. How would you define the scientific truth:	
a. the truth that will be reached through scientific research	147 (76)
b. absolute truth	5 (3)
c. consensus of competent experts*	41 (21)
d. fact that can be found in the textbooks	0
e. facts that your professors teach you	0
2. The essential characteristic of science is:	
a. all scientific conclusions are temporary*	46 (24)
b. scientific theory cannot merely explain natural phenomena, but must somehow also exert influence upon them	23 (12)
c. rather obvious scientific conclusion, does not have to be testable	13 (7)
d. an experiment is not an objective model of the nature but serves as an introduction into real research of natural phenomena	93 (48)
e. some natural phenomena need not be measured but it suffices that a researcher notices them on time	18 (9)
3. A scale from 1 to 5 (like grades on an examination) is called:	
a. ratio scale	45 (23)
b. nominal	55 (28)
c. ordinal*	22 (11)
d. interval	14 (7)
e. it is not a scale	57 (30)
4. Representativeness is a key characteristic of a:	
a. scientific paper	56 (29)
b. professional paper	22 (11)
c. scientific research	37 (19)
d. sample*	64 (33)
e. population	14 (7)
5. MEDLINE is:	
a. the first and best known "on-line" medical journal	95 (49)
b. international association of medical informaticians	20 (10)
c. printed form of the Excerpta Medica	9 (5)
d. abbreviation (acronym) that lists the parts of the research article	6 (3)
e. medical database*	63 (33)
6. In the previous year you have published a paper in the prestigious Journal of Immunology. Now you want to check the number of citations your paper has received. The best way to do it would be to search the:	
a. author index of the MEDLINE database	82 (42)
b. corporate index of the Science Citation Index database	19 (10)
c. author index of the Current Contents database	10 (5)
d. citation index of the Science Citation Index database*	50 (26)
e. author index of the Science Citation Index database	32 (17)
7. The part of a scientific paper is:	
a. author's curriculum vitae	9 (5)
b. letter to the editor enclosed with the paper	6 (3)
c. the statement on the lack of conflict of financial interests	2 (1)
d. acknowledgment to persons who assisted you during the research*	35 (18)
e. a chapter "Aim and Purpose of the Study"	141 (73)
8. All listed rules apply to the process of writing an Introduction section of a scientific paper EXCEPT:	
a. clearly state why the research has been started	8 (4)
b. do not explain textbook facts	32 (17)
c. do not explain words from the title of the paper	22 (11)
d. make it longer rather than shorter*	107 (55)
e. clearly define the question to which your research aims to provide an answer	24 (12)
No. (%) of correct answers (mean ± SD)	2.2 ± 1.2 (28 ± 16)

[a]Asterisk indicates the correct answer.

based on humanities, as well as vocational schooling. Students had similar scores on the science attitude test irrespective of curriculum of high school they attended. It would be interesting to see if the attitude toward scientific research could be a predictive factor for the admission to medical school, as was shown in the study of Norway students entering medical school (10).

Another interesting finding of our study was that students had more positive attitude toward science in general than towards scientists as persons. The students highly regarded the role of science in prolongation of human life and general progress of the humankind, but were not so enthusiastic about scientists as creative and interesting people. It is difficult to explain this finding, but it may be related to the differences in the perception of science and scientific research in general and the perception of individual persons as bearers of scientific progress – the common perception of a scientist is that of an introvert, confused, and potentially dangerous individual. However, it is important to note that this "dichotomy" may imply that our scale was two-dimensional and that the scores on the attitude scale should be interpreted with caution in relation to this dichotomy.

The only factor related to the positive attitude toward science was the rank on the medical school admission test, although the correlation of -0.157 is usually interpreted as "poor". Rank at medical school admission test has been shown to be a predictive factor of student's academic performance both in Croatian (2) and other university settings (3,11). Better attitude toward research in higher ranking students entering medical school could be a predictor of their future academic performance and eventual success as researchers. A study of 70 Croatian medical graduates who went for a postdoctoral research position in research laboratories in Germany and USA showed, by multivariate analysis, that higher examination grades were among factors predictive of their success as researchers (12). It would be interesting to follow the cohort of students from this study and see if their attitude would change during the studies and be related to their academic performance.

There are several possible limitations of the study. It was designed as a cross-sectional survey and as such did not allow any causative conclusions. However, it was a relatively large nation-wide study with applicants coming from different social and educational backgrounds. Another limitation of the study could be the length of the attitude questionnaire: it originally contained 60 statements, from which we chose 20 for the analysis. It is possible that students become wearied after a number of questions and did not concentrate on the answers by the end of the test. This possibility may be associated with a relatively low item-total correlation of the test. Although there is no fixed cut-off point for excluding the candidate items with low item-total correlation, the recommended value is 0.6 (13). Since only a few of our candidate items had item-total correlation greater than 0.5, we decided to set the cut-off value to 0.4. Finally, the reliability of the test of knowledge (0.52) was

rather low. One possible explanation is that the conditions of the testing were not optimal, ie, we asked almost 250 students to fill out the questionnaire at the end of their introductory lecture. Although we were aware of this bias, it was the only occasion where the whole class of 2001 was gathered together. Another explanation is that the Kuder-Richardson Formula 20 is proportional to the number of test items (4). Therefore, the inclusion of additional test questions would improve the reliability.

With these limitations in mind, we believe that our study provides evidence that students entering medical school have positive attitude towards science in spite of their lack of knowledge on the scientific method and scientific communication in medicine. We also showed that the score on the admission test directly correlated with the attitude toward scientific research. In the view of previous findings that the admission score correlated with future academic performance (2) and that academic performance was predictive of a success in a future research career (12), improving the attitude toward scientific research may improve the scientific, ie, evidence-based approach to medicine. One of the ways to improve the attitude toward science could be by increasing knowledge in research methodology. Scientific methodology, and scientific communication in particular, are not a usual part of the medical curriculum, although the need for such education has been recognized as a crucial step in the development of a young scientist (14). The Zagreb School of Medicine offers a mandatory second-year course on the principles of scientific research (15). The aim of the course is to introduce the students to the principles of scientific research in medicine through a problem-solving teaching approach and by providing them with skills for evaluating research articles published in medical journals, as well as by encouraging them to perform and publish their own research (5). Moreover, we hope that the course will prevent the loss of interest in science and research, observed in senior students at the School (16). We are investigating the influence of the course on the students' attitudes toward scientific research in medicine, and hope to get an insight into the value of such programs in promoting scientific research and evidence-based medicine.

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Correspondence to:
Ivan Krešimir Lukić
Department of Anatomy
Zagreb University School of Medicine
Šalata 11
10000 Zagreb, Croatia
iklukic@mef.hr