

## Publishing Scientific Papers Based on Master's and Ph.D. Theses from a Small Scientific Community: Case Study of Croatian Medical Schools

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**Aim.** To evaluate publishing activity of medical doctors after they have obtained Master's or Ph.D. degree at the Rijeka and Zagreb University Schools of Medicine in Croatia, and establish the number of journal articles based on these theses.

**Methods.** Data on Master's and Ph.D. theses defended at the Rijeka and Zagreb University Schools of Medicine in the 1990-1999 period were collected by hand-search of the archive. *MEDLINE* and *Current Contents* databases were searched for journal articles resulting from the theses.

**Results.** During the 10-year period, 1,535 Master's and 634 Ph.D. theses were defended at the Rijeka and Zagreb University Schools of Medicine (253 Master's and 138 Ph.D. theses from Rijeka and 1,282 Master's and 496 Ph.D. theses from Zagreb). There were 201 (14%) Master's and 218 (34%) Ph.D. theses that resulted in articles published in journals indexed in *MEDLINE* (13% of Master's and 11% of Ph.D. theses from Rijeka, and 14% of Master's and 41% of Ph.D. theses from Zagreb). Also, 97 (6%) Master's and 129 (20%) Ph.D. theses that resulted in articles published in *Current Contents* journals (8% of Master's and 6% of Ph.D. theses from Rijeka, and 6% of Master's and 24% of Ph.D. theses from Zagreb). There was no significant difference between the two Universities with respect to published articles based on Master's theses, but there were significantly more articles from Ph.D. theses in Zagreb ( $p < 0.001$ ). Most of the theses resulted in a single publication (95%), 19 (5%) in 2, and 2 in 3 publications. Out of all 453 journal articles, 31% were published in Croatian and 69% in international journals.

**Conclusion.** Most Croatian Master's and Ph.D. theses are not made available to the scientific community. There should be more institutional effort directed at the stimulation of postgraduate students to publish their scientific work.

**Key words:** Croatia; dissertations, academic; education, medical; publication; publishing; schools, medical; universities

Undergraduate medical education mostly prepares medical students for medical practice, whereas postgraduate education prepares them for the world of science. Scientific research is an integral part of postgraduate studies, aimed at teaching future scientists how to determine a problem, choose a proper scientific approach, present research data, and reach clear and simple conclusions (1-3).

After finishing a postgraduate program in Croatia, students conduct a research project and prepare their Master's thesis (4). After defending Master's thesis, a student continues the research to prepare a Ph.D. thesis, which presents a comprehensive scientific research conducted after M.S. degree has been obtained.

Research data have to be presented to the scientific community for critical assessment and evaluation (5,6). However, only research results published in relevant literature, ie, journals indexed in widely available bibliographic databases, are accessible to a wider

scientific community. Publication of a thesis in the form of scientific article, although not officially required by any statement or regulation during the study period, is the best test available for the quality of performed research work (7,8).

Scientific articles published in relevant journals are the main source of scientific information (5,8-10). However, as the number of published articles and journals is constantly increasing (11), especially in the field of medicine, bibliographic databases help scientists find the appropriate information by a simple search process (9,12,13). Recent developments in the Internet technology and creation of electronic databases available on the Web made searching process even simpler, faster, and more efficient. Therefore, publications now considered relevant are those indexed in databases that can be retrieved via the Internet. The two most respectable biomedical databases, *MEDLINE*, created and distributed by the US National Library of Medicine, and *Current Contents*

of the Institute for Scientific Information (ISI) (10,13, 14), can be searched through the Ovid Technologies system, an Internet-based tool for scientific database search, which offers access to 90 bibliographic databases in different research areas. Both databases are available to the academic community in Croatia through its national academic network CARNet free-of-charge.

There are four University schools of medicine in Croatia: Osijek (founded in 1998), Rijeka (founded in 1955), Split (founded in 1997), and Zagreb (founded in 1917). Since Zagreb and Rijeka University Schools of Medicine are the oldest, we used their databases on Master's and Ph.D. theses for our study. Osijek and Split University Schools of Medicine were excluded because they were founded less than 5 years ago, and the research included all theses published in the last 10 years (1990-1999).

The aim of this study was to evaluate and compare the scientific activity during the last decade at both Universities and examine how much of that research became visible to the international scientific community.

### Material and Methods

The data on Master's and Ph.D. theses defended at the Rijeka or Zagreb University School of Medicine and published in the 1990-1999 period were collected from the Medical Schools' archives, which warranted the completeness of the documentation needed for the study. Data on postgraduate students were retrieved from Universities' register office databases. The following variables were collected: candidate's full name, full title of the thesis, and date of defense. We estimated that a 10-year period would provide enough data to test our hypothesis.

Using Ovid (Version 7.8, rev. 1.303, Ovid Technologies Inc., New York, NY, USA; via Ruđer Bošković Institute, Zagreb, Croatia), we searched *MEDLINE* and *Current Contents* for scientific articles published between January 1990 and December 1999 by authors who defended their Masters' and/or Ph.D. theses in the investigated period. *MEDLINE* database is widely recognized as the prime source of bibliographic and abstract coverage of biomedical literature. It covers about 4,200 to 4,500 biomedical journals since 1966 and can be accessed via PubMed free of charge. *Current Contents* database is more exclusive and provides access to bibliographic data from the world's leading research journals in biomedical sciences, social sciences, arts, and humanities. The number of papers published in journals indexed in *Current Contents* is the main criteria for academic promotion in biomedicine in Croatia (15). Since *Current Contents* data before January 1993 are not available through Ovid in Croatia, we did not include articles in *Current Contents* published before that period.

The publications of an author were retrieved by entering the author's last name and first initial and obtaining a full match. The author's position in the list of authors of the article was not important. The idea in the title of the theses (in Croatian) had to match the idea in the article title, rather than the exact translation, for the two publications to be treated as identical (ie, reporting the same research results).

We used MedCalc for Windows (version 4.10 for Windows, MedCalc Inc., Mariakerke, Belgium) for data analysis (16), and proportions and chi-square test for comparisons. P value <0.05 was considered statistically significant.

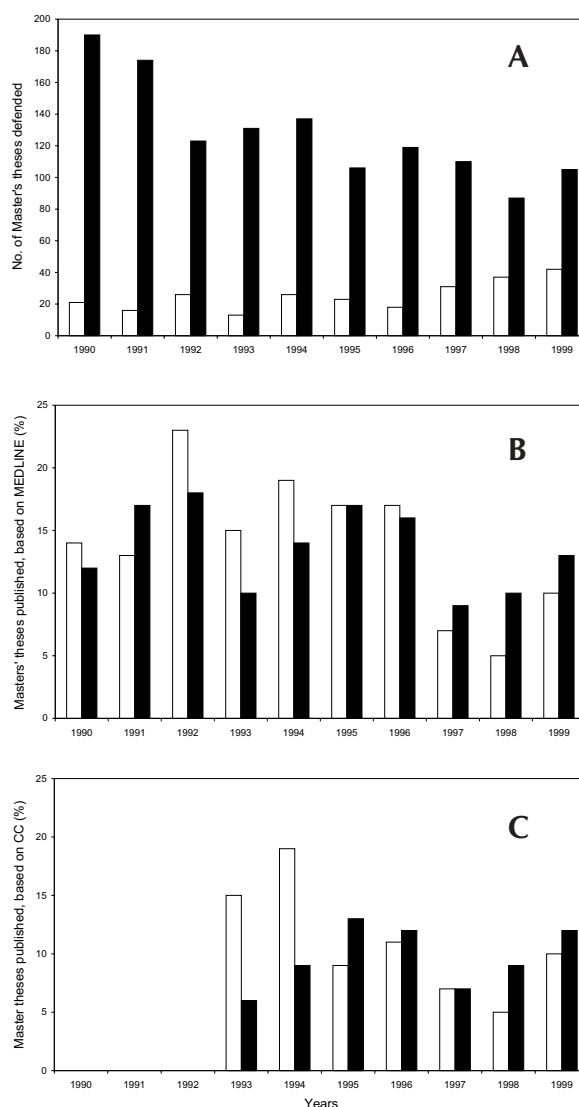
### Results

During the 10-year study period, a total number of 1,535 Master's theses and 634 Ph.D. theses were defended at both Zagreb and Rijeka University

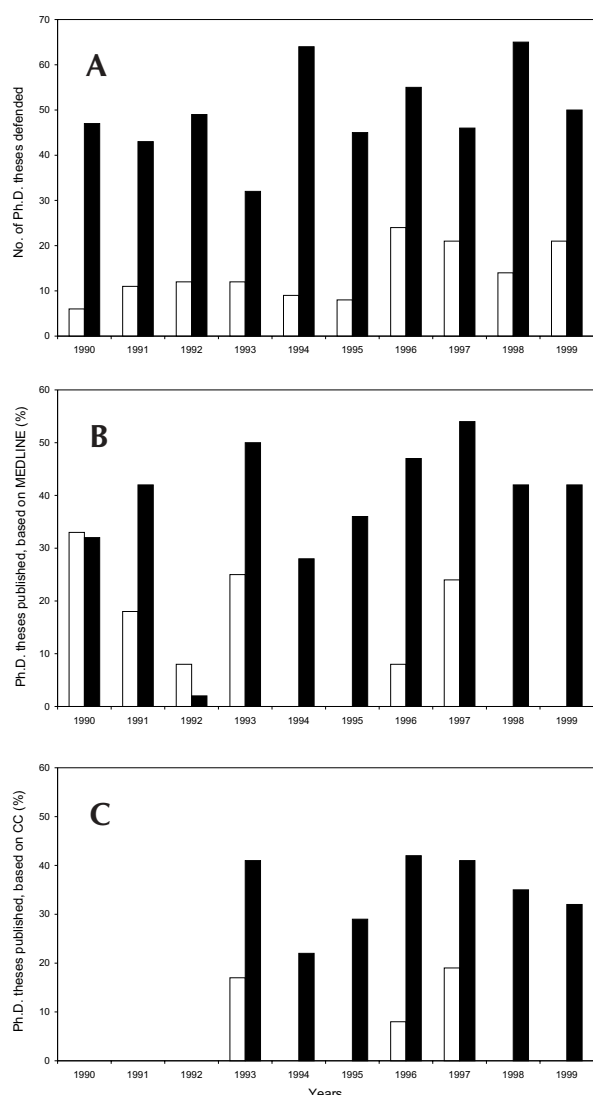
Schools of Medicine. The average ratio of Master's theses defended in Rijeka to those defended in Zagreb was 1:5.1, ranging from 1:2.4 in 1998 to 1:10.1 in 1993 (Fig. 1A). The average ratio of the Ph.D. theses defended in Rijeka to those defended in Zagreb was 1:3.6, ranging from 1:2.2 in 1997 to 1:7.8 in 1990 (Fig. 2A).

Out of all defended theses at both Universities, 201 (14%) Master's theses and 218 (34%) Ph.D. theses were revised and published in the form of a scientific article in journals indexed in *MEDLINE*, and 97 (6%) Master's and 129 (20%) Ph.D. theses were revised and published in the form of an article in journals indexed in *Current Contents*.

Out of 253 Master's theses defended at the Rijeka University School of Medicine, 13% were



**Figure 1.** Number of Master's theses defended at Rijeka (open bars) or Zagreb (closed bars) University School of Medicine during 10-year period (1990-1999) (A). Percentage of Master's theses published in a form of a scientific article in journals indexed by *MEDLINE* (B) and *Current Contents* (*Current Contents* data presented for 1993-1999 period) (C).



**Figure 2.** Number of Ph.D. theses defended at Rijeka (open bars) or Zagreb (closed bars) University School of Medicine during the 1990-1999 period (A). Percentage of Ph.D. theses published in a form of scientific article in journals indexed by *MEDLINE* (B) and *Current Contents* (*Current Contents* data presented for the 1993-1999 period) (C).

published in journals indexed in *MEDLINE*, and 8% in journals indexed in *Current Contents*. Out of 1,282 Master's theses at the Zagreb University School of Medicine, 14% were published in *MEDLINE*-indexed journals and 6% in journals indexed in *Current Contents*. There was no significant difference between Rijeka and Zagreb Universities in the number of articles resulting from Master's theses, as found in *MEDLINE* ( $p=0.753$ ) and *Current Contents* ( $p=0.294$ ). Also, there was no significant difference between the two Universities when each year was analyzed separately (Fig. 1B and 1C).

However, significant difference between the two Universities was found when articles resulting from the Ph.D. theses were compared ( $p<0.001$  for both *MEDLINE* and *Current Contents* database). According to the database search, out of 138 Ph.D. theses de-

fended at the Rijeka University School of Medicine, 11% were published in journals indexed in *MEDLINE* and 6% in journals indexed in *Current Contents*. At the Zagreb University School of Medicine, out of 496 defended Ph.D. theses, 41% were published in journals indexed in *MEDLINE* and 24% in journals indexed in *Current Contents*. The differences between the two institutions were mainly caused by the differences in their publishing activity in the last four years (1996-1999) (Fig. 2C). The exception was 1997, when significant difference between the Schools was found in the number of articles in *MEDLINE* (Fig. 2B,  $p=0.044$ ). We could not find any Ph.D. thesis defended at the Rijeka University School of Medicine that was published as an article in the last two study years.

Four hundred twenty-eight authors published 453 articles based on their Master's and Ph.D. theses in journals indexed in *MEDLINE*: 407 authors published a single article, 19 published 2, and 2 authors published 3 articles (Table 1). According to the *MEDLINE* search, most articles were published in international journals: 139 out of 453 (31%) articles were published in Croatian and 314 (69%) in international journals (Table 2). Papers based on Master's theses at the Rijeka University School of Medicine were published in foreign journals more often than those at Zagreb University ( $p=0.019$ , Table 2).

**Table 1.** Master's and Ph.D. theses defended at the Zagreb and Rijeka University Schools of Medicine in the 1990-1999 period, and articles resulting from these theses published in journals indexed in *MEDLINE* database

School	Theses type	No.	No. (%) of <i>MEDLINE</i> -indexed publications based on a single thesis			
			total	one	two	three
Rijeka	Master's	253	33	29 (88)	4 (12)	0 (0)
Zagreb	Master's	1,282	177	169 (96)	8 (4)	0 (0)
Total	Master's	1,535	210	198 (94)	12 (6)	0 (0)
Rijeka	Ph.D.	138	15	9 (27)	4 (60)	2 (13)
Zagreb	Ph.D.	496	203	200 (98)	3 (2)	0 (0)
Total	Ph.D.	634	218	209 (96)	7 (3)	2 (1)
Total	Total	2,169	428	407 (95)	19 (5)	2 (0.4)

**Table 2.** Scientific articles resulting from Master's and Ph.D. theses defended at the Zagreb and Rijeka University Schools of Medicine in the 1990-1999 period, which were published in Croatian and international journals indexed in *MEDLINE* database

Theses	School	No. (%) of papers published in		Statistics	
		Croatian journals	international journals	chi-square	p
Master's	Rijeka	7 (18)	31 (82)	5.72	0.019
	Zagreb	75 (41)	110 (59)		
Ph.D.	Rijeka	2 (8)	22 (92)	2.97	0.089
	Zagreb	55 (27)	151 (73)		
Total	Total	139 (31)	314 (69)	-	-

### Discussion

In our effort to evaluate the international visibility of biomedical Master's and Ph.D. theses from the two Croatian University Schools of Medicine, we found that only a small fraction of Master's theses, 13% in Rijeka and 14% in Zagreb, were published in scientific journals indexed in *MEDLINE* and half of it

(8% in Rijeka, and 6% in Zagreb) in journals indexed in *Current Contents*. In this respect, there was no difference between the Universities. Although the purpose of doing a Master's thesis is primarily educative, it is still scientific research and should make its way to the scientific community. Such a low percentage of theses published as scientific articles makes their quality disputable.

The fraction of the published Ph.D. theses was considerably greater in Zagreb (41% in *MEDLINE* and 24% in *Current Contents*) than in Rijeka (11% in *MEDLINE* and 6% in *Current Contents*). Our findings are consistent with the data of Jonjić and Lučin (13), who found that the scientific work at all other University Schools of Medicine in Croatia falls significantly behind that at Zagreb University. However, overall scientific productivity of Ph.D.s in all fields in Croatia is rather low (17).

The low percentage of published papers based on the theses is not exclusive feature of Croatia, which has a small scientific community and belongs to the scientific periphery (1). The data for France show that only 17% of medical Ph.D. theses result in publication of an article (8). It seems that theses are rarely used as reference literature, although they can be cited in scientific papers (18).

Although recognized by the scientific community as official scientific documents, theses are rarely read by more than a few scientists, because they are usually available only in University libraries in Croatia, written in Croatian language only, and not indexed in international databases. The real value of scientific work can be appreciated only when research results get published in relevant literature, and become visible and easy accessible through secondary publication to all scientists (5,6,11).

Whereas most authors did not publish their theses at all, we found that some authors had published more than once: 19 authors published two, and 2 authors published three publications. Multiple publications originating from a single research project might be considered repetitive publications or "salami science", and thus present scientific misconduct (19). However, since we compared the publications only by their titles, we cannot say whether or not the multiple publications found in our study were repetitive publications or publications related to parts of the theses.

The main limitation of this study was the comparison of the titles in two different languages (Croatian vs English), which could have led to possible confusion on papers' issue.

Choosing the right journal for submitting the scientific paper is also important. We discovered that most papers resulting from the theses were published in foreign journals, probably because of the small number of Croatian biomedical journals indexed in these two databases. Among 43 scientific biomedical journals in Croatia, only two are indexed in *Current Contents*, and only six in *MEDLINE* (10). Perhaps some of the theses were published in journals not indexed in bibliographic databases we searched. Even

if this was the case, they would still remain mostly invisible to the scientific community.

There is no difference between the two University Schools of Medicine regarding Ph.D. theses published as articles in foreign and Croatian journals, but at the Rijeka University School of Medicine, articles based on Master's theses were more often published in international journals. In absolute numbers, there are fewer articles published on the basis of Master's theses in Rijeka, indicating that these authors made the effort of publishing papers in international journals. Low percentage of published theses rises the question of their scientific and educational value (8,17,18,20).

The science does not exist until it is published (5). Although the theses are, by definition, a form of scientific work, they cannot be considered as such if left unpublished.

In conclusion, the low percentage of defended Master's and Ph.D. theses published as scientific papers in relevant biomedical journals should be increased. Scientists should publish their theses because unpublished research remains hidden to and unrecognized by broad scientific community. Universities should make efforts against this sort of publishing idleness and stimulate young researchers to publish the results from their Master's and Ph.D. theses.

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