

Letter to the Editor

The effect of International Scientific Summer School research training on scientific productivity of trainees



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Scientific publications are the standard way for communicating research results and ideas to the scientific community, and thus contribute to the progress in knowledge [1]. They are also one of the principle measures of research outcomes that are used as a criterion to evaluate the quality of research organizations, universities, post-graduate programs, and performance of faculty members and residents [2,3].

Universities not included in the list of top 500 institutions are dominantly “discipline” oriented, and the need of skills like research project designing, critical appraisal skills and academic writing skills are not sufficiently recognized or they are even ignored in their curricula [4,5]. As a result, manuscripts submitted to international scientific journals are rejected since they do not reach the required quality. Consequently, the results of research are not recognized and the researchers/authors become frustrated and demotivated [5].

It is known that the curricula of continued medical education are usually based on intensive clinical training and does not necessarily include development of scholarship skills, which are increasingly included in the resident's program requirements [5]. It has come to common acceptance that research training and understanding of research principles are necessary for physicians to understand evidence-based medicine and sustain improving their professional knowledge [6]. Few reports on outcomes of different methods of development of research skills in residents of clinical disciplines have been published so far, including research rotations, research courses and mentoring [7–10].

However, the knowledge on the outcomes of research training and which type of training is most efficient is still limited.

Recognizing this problem, a group of three scientific medical journals has initiated an international training initiative, based on training in the form of interactive workshops – “The International Scientific Summer School” (ISSS) [11–19]. The main ISSS objectives are: [1] to develop skills to carry out research projects, based on a practical, problem-based approach; [2] to increase communication skills, including the skills in argumentation, negotiation and critical appraisal; [3] to develop skills in international research team building and networking, and establish enjoyable cross discipline/cross cultural collaboration; and [4] to encourage researchers to publish scientific papers. Since the year 2006 already eleven ISSSs have been organized.

The aim of this study was to evaluate the performance of ISSS trainees in the years 2006 to 2011, and to compare scientometric data of participants before and after ISSS training.

The study was designed as an interventional longitudinal study.

The study population consisted of all 168 trainees who attended the ISSSs from 2006 to 2011. Selection of participants was done on rolling basis of applications made directly by participants upon the announcement of ISSSs in the organizing journals, suggestion of candidates from the academic institutions of the editors of the organizing journals, and suggestion of candidates by the participants of previous ISSSs. The selection was administered by the Faculty of ISSS in order to attain the international diversity of participants with the aim to develop the international collaboration skills.

Participants had a diverse biomedical specialty background: cardiology, electrophysiology, oncology, surgery, anatomy, pediatrics, nursing, biophysics, biomedical engineering, IT professionals, biology, genetics, pharmacology and economics. Participants were from different countries (Table 1).

The basic teaching methods used in ISSS are “problem-based” and “learning-by-doing” processes. The course consists of four workshops and is based on the Research Practicum of the Duke University, Durham, NC, USA [11]. It combined project development and class presentation, plenary and small group discussions, and discussion on publishing scientific papers with representatives of medical scientific journals.

The participants were working in groups. Each group selected a research topic of a common interest, framed the topic of the group research project, and assigned responsibilities of the group members for particular research practicum tasks. The participants experienced two parallel processes: (a) developing a research study protocol and (b) the international team building.

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Table 1

The list of participants' country of residence (in alphabetic order).

Albania	Estonia	Macedonia	Slovakia
Austria	Georgia	Netherlands	Spain
Bosnia and Herzegovina	Greece	Poland	Sweden
Brazil	Hong Kong	Portugal	Turkey
Croatia	Hungary	Romania	Ukraine
Czech Republic	Kyrgyzstan	Russia	USA
Egypt	Lithuania	Serbia	

Data of 123 participants of 2006–2011 summer schools were available for analysis. Analysis of scientific productivity of participants before and after ISSS (2007–June 2013) was performed by searching articles published in peer-reviewed journals indexed in PUBMED and SCOPUS databases.

Search was performed using “author search” tool, with matching of records in PUBMED and SCOPUS databases by country and affiliation of participant in ISSS database. Publication records for each participant were sorted out according to the articles published before ISSS, if present and starting 1 year after participation in ISSS till June 2013. Participants with publications after ISSS were included in the comparative analysis of a number of publications before and after ISSS training.

The following scientometric data were retrieved:

- number publications before and at least 1 year after participation in ISSS,
- number of citations, and
- Hirsch index for articles published after ISSS.

The variables:

- Proportion of participants with publications before and after ISSS,
- Total number of publications before ISSS,
- Total number of publications at least 1 year after ISSS till 2013,
- Number of publications where the ISSS participant was the 1st author for previous and after ISSS publications,
- Number of research articles and reviews,
- Number of citations and Hirsch index for articles published before and after ISSS,
- Productivity index. The productivity index indicates the total number of publications corrected for the time after ISSS, calculated as the total number publications/total number of years after ISSS participation, and
- Citation index – number of citation corrected for time passed after ISSS.

Statistical analysis was performed using IBM SPSS software version 20 (IBM SPSS Inc., Chicago, IL) and MedCalc software (MedCalc Software bvba, Ostend, Belgium). The data are presented as mean (SD), median (range), and number (percentage). The D'Agostino–Pearson test was used for normality of distribution analysis. Comparison of proportions before and after ISSS was performed using McNemar's test for matched samples. Comparison of continuous variables before and after ISSS was done using Wilcoxon test. Comparison of productivity and citation indexes between different years of ISSS was performed using Kruskal–Wallis test. Correlation analysis was performed using Spearman correlation analysis. The $p < 0.05$ value was accepted as significance level.

Among 123 participants of 2006–2011 ISSSs 69.92% (86 participants) published articles indexed in international databases (Fig. 1) and 45.53% (56 participants) had no previous research experience (Fig. 2).

As can be seen from Table 2, of 123 participants, 86 (69.9%) participants have published 695 articles in peer-reviewed journals after participation in ISSS, among them 57% served as the 1st author of the manuscript, 94.2% published research articles and 81.4% have owned cited publications. Of 695 publications, majority were research articles,

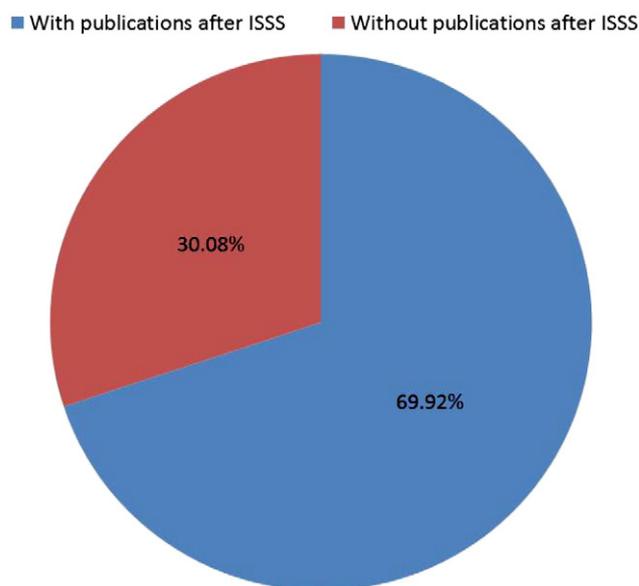


Fig. 1. The proportion of participants with publications after ISSS training.

comprising 67.3% of all publications, while 5.5% were reviews and 27.2% were other types of articles (case reports, technical notes, editorials and letter). The mean number of publications was 8.08 ± 10.47 (1–68) per participant, mean number of citations was 17.1 ± 34.46 (0–231) per participant and mean Hirsch index of trainees was 1.61 ± 1.44 (0–7).

Comparison of the publication indicators before and after ISSS training (Table 3) demonstrated significant ($p < 0.001$) increase in number of articles published after training as compared to the pre-ISSS number of publications. Especially, markedly higher number of research articles and articles with participants as 1st authors were published after ISSS ($p < 0.001$ for both). There was also a significant rise in proportion of participants who published research articles (60.5% to 94.2%, $p < 0.001$), as the 1st principal investigator (38.4% to 57%, $p = 0.009$) and number of trainees with citations (66.3 to 81.4%, $p = 0.024$) after ISSS training.

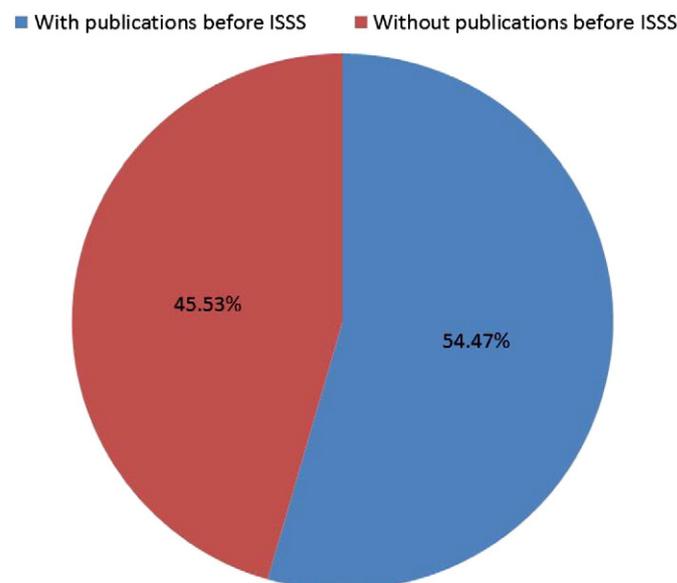


Fig. 2. The proportion of participants with and without publication previous publication experience.

Table 2
Indices of scientific productivity of participants after ISSS training.

Variable	n (%)	Mean (SD)	Median (range)
Total number of participants with publications	86 (69.9)	–	–
Number of publications	695	8.08 (10.47)	4 (67)
Number of publications as 1st author	213	2.47 (3.89)	1 (18)
Proportion of participants with articles as 1st authors	49 (57)	–	–
Number of research articles	468 (67.3)	5.44 (6.37)	3 (32)
Proportion of participants with research articles	81 (94.2)	–	–
Number of reviews	38 (5.5)	0.44 (0.91)	0 (4)
Number of other types of articles (case reports, letter, editorials, note)	189 (27.2)	2.19 (5.37)	0 (38)
Productivity index	–	1.84 (2.24)	1.15 (11.19)
Number of citations	1485	17.26 (34.43)	5 (231)
Proportion of participants with citations	70 (81.4)	–	–
Hirsh index	–	1.61 (1.44)	1 (7)
Citations index	–	3.25 (5.46)	1 (33)

Data are presented as number (percentage), mean (SD) and median (range) values.

Comparison of productivity and citation indexes for a particular ISSS year showed no significant difference ($p = 0.109$, $p = 0.58$) (Fig. 3).

Correlation analysis (Table 4) revealed significant positive associations of total number of publications with number of research articles ($r = 0.916$, $p < 0.001$), number of articles with trainees as the 1st authors ($r = 0.741$, $p < 0.001$), number of citations ($r = 0.683$, $p < 0.001$) and Hirsch index ($r = 0.729$, $p < 0.0001$) after ISSS training.

Using bibliographic data from the PUBMED and SCOPUS databases we found that after participating at the International Scientific Summer School program, the number of publications by trainees increased significantly as compared with the period before the training. The increased number of publications correlated significantly with number of articles with trainees serving as the 1st authors, the number of research papers, the number of citations, and the Hirsh index.

Although 45% of ISSS participants had no previous experience with publishing, after attending the ISSS 70% of trainees published articles in journals indexed in international databases. ISSS provides an interdisciplinary international environment for training skills required for preparing research study protocols, scientific manuscript and

international collaboration. The participants experience a process of elaborating and presenting common research project. This process includes defining a research topic of common interest; selecting an adequate study design; selecting an adequate method of data collection, analysis and interpretation; and developing a feasible study plan and timeline for the project, including the preparation of a research paper. The need of interdisciplinary research was previously recognized, and it was suggested to allocate more time to the interdisciplinary group assignments [20].

The average number of published paper was 8.08 per participant. However, the range of the number of publications ranged considerably from 1 to 68, reflecting probably the variability of the previous research/publication experience of the participants. The ISSS invites not only the young less experienced researchers, but also senior researchers/mentors, who are interested in experiencing the ISSS training methods. This is because of the importance of senior and junior scientists' mobility that should be acknowledged and encouraged by the research institutions and universities, particularly in developing countries [21].

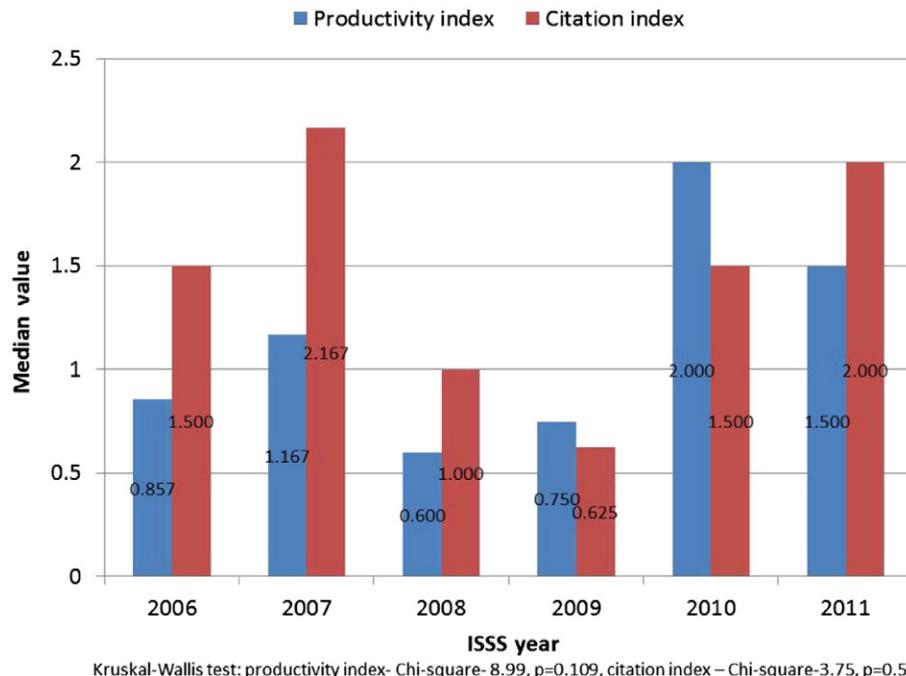


Fig. 3. Median values of publication productivity and citation indexes for each ISSS year.

Table 3
Comparison of scientometric data before and after ISSS.

Variables	Before ISSS	After ISSS	p
Number of publications:			<0.001
Sum	491	695	
Mean (SD)	5.7 (10.46)	8.08 (10.47)	
Median (range)	2 (53)	4 (67)	
Proportion of participants with publications as the 1st author: n (%)	33 (38.4)	49 (57)	0.009
Number of publications as 1st authors:			<0.001
Sum	106	213	
Mean (SD)	1.23 (2.37)	2.47 (3.89)	
Median (range)	0 (11)	1 (18)	
Number of research articles:			<0.001
Sum	343	468	
Mean (SD)	3.98 (7.9)	5.44 (6.37)	
Median (range)	1 (39)	3 (32)	
Proportion of participants with research articles: n (%)	52 (60.5)	81 (94.2)	<0.001
Proportion of participants with citations: n (%)	57 (66.3)	70 (81.4)	0.024

Data are presented as number (percentage), mean (SD) and median (range) values. Wilcoxon rank test and McNemar's test for comparison of data before and after ISSS.

The analysis showed in half of the published papers that the trainees served as the 1st authors, the increase of the 1st authorship significantly increased as compared to the pre-ISSS period. The ISSS workshops devote considerable time for discussions in groups as well as for general discussion, and each participant is encouraged to contribute by her/his input. The limited number of participants (up to 20, maximum 25) provides therefore conditions for intensive interaction between the faculty and participants. This arrangement led to an increased confidence of participants in expressing their thoughts.

We observed an increased proportion of research articles comprising 67.3% of all publications, as compared to review papers, case reports, technical notes, editorial and letter to the editor. The training program of the ISSS is focused on the preparation of the research study protocol, i.e. on preparation of a research study protocol for a hypothesis based, doable research. The topic of the research is defined and agreed by the group, in this way the elaborated research study protocols are of interest of each member of the group. Each individual thus benefit from the input from different professionals, with different background experiences and from different countries [22]. Progressing through the workshops with extensive discussion and feedback, the participants become familiar with the process of understanding the principles of preparing not only the research study protocols but also with preparing detailed outlines for the project related publication.

From the total number of 86 publishing trainees, articles of 70 (81%) trainees were cited. Citations in peer-reviewed journals mean an international recognition and this finding reflects the quality of published articles. Since the secondary aim of the ISSS is to familiarize the participants with the peer-review process in the editorial office, the process of communication with editor and how to deal with reviewers' comments, these could be also additional factors contributing to the successful rate of publishing.

Table 4
Correlation analysis of publication experience after ISSS and indicators of research quality.

Variables	Number of publications after ISSS
Number of research articles after ISSS	r = 0.916 p < 0.001
Number of articles as 1st author after ISSS	r = 0.741 p < 0.001
Citations to articles after ISSS	r = 0.683 p < 0.001
H-index for articles after ISSS	r = 0.729 p < 0.001

Spearman correlation analysis.

The correlation analysis revealed highly significant correlations between the number of published articles after the ISSS training and the parameters under study: the number of research articles; the number of articles with trainees as the 1st authors, the number of citations and Hirsch index. As it can be expected, the increasing number of published paper in peer-reviewed journals contributes to the international recognition of the authors.

Our study results on the increase of number of publication after ISSS research training are in agreement with previous studies that used, however, different methodological approaches [7–10].

Kanna et al. [7] studied the effects of research rotation of residents in internal medicine on the number and structure of publications and number of projects after training. They found residents, who underwent a 2-week research rotation, who publish significantly more articles, including research articles and letter to the editor as compared to the residents without rotation ($p < 0.001$ for all), which proved that research training contributed to the development of research skills on the preparation of scientific project and publication of its results as well as skills on the scholarship dissemination – discussing and evaluating studies in the form of the letter to the editor. Research rotation included the attendance of the lectures on research methodology, biostatistics, publication ethics, writing manuscripts and 2-week work on project preparation, literature search and research, and consultations with mentor. In another study of Vinci et al. [8], on outcomes of research rotation it has been found that the success of training—increase in number of publications—was dependent on the type of research project and funding, being 3 times higher for clinical, healthcare or basic research projects and funded projects.

Another type of training incorporated in the clinical training program of one clinic was reported by Basu Ray et al. [9]. Their research program for residents included mentoring, attendance of research club bimonthly for lectures on research methodology, biostatistics, attendance of courses on medical writing and a 2-week half day involvement in work on research projects of department-evidence-based medicine training. Authors compared the number of abstract submissions and presentation at congresses in 2-year periods before and after implementation of the training program and demonstrated 110% increase in scholarly activity. Thus, research training appeared to have positive influence on scholarship application skills. Similar results were reported by Penrose et al. [10], who evaluated effects of mentoring of residents in the development of research skills.

Our study extended previous knowledge on the topic by demonstrating that research training is associated not only with increase in number of publications but also with their quality reflected in the increase in the number of citations and Hirsch-index of participants.

However, we have to acknowledge the differences between the research training in our study and above-mentioned programs.

This study has limitations related on its design:

- The design of the study did not enable to use a suitable control group. We analyze the data before and after the training/intervention. However, too many factors can be involved and the increase in the scientific performance could be also a natural development.
- The results could be biased by selection of participants, since the participants were mostly motivated people willing to attend the course and recommended by their mentors. It should be also noted, that though majority of participants were fellows and residents in training, postgraduate students relatively, small proportion of participants were holding position of the junior faculty member at their institutions.
- No publications in national languages were included.
- Only biomedical bibliographic databases were searched. The ISSS is an oriented interdisciplinary program; the publications in other professional journals were not included.
- Relatively short period of follow-up for evaluating a longer-term impact.

In spite of the limitations, it was shown that the ISSS training is associated with an identifiable increase in scientific publication activity. Additionally, the ISSS model provides a basis for creating an international networking framework for young scientists and their mentors; a flexible format of informal international collaboration and training. Further prospective controlled studies are required to assess the effects of the ISSS training on research performance of the trainees.

Conflict of interest

None to declare.

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