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Original paper

Female medical physicists: The results of a survey carried out by the International Organization for Medical Physics

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ABSTRACT

Introduction: The gender composition of the existing medical physicist (MP) workforce around the world is basically unknown. The International Organization for Medical Physics (IOMP) performed a survey in order to investigate the number of MPs in countries around the world and the percentage of women MPs compared to total number of MPs.
Materials and methods: A simple online questionnaire prepared as a Google Forms survey asking the country, the total number of MPs, the number of female MPs and finally the gender of the person providing the data was sent in mid-March 2013 to six regional member organizations of IOMP, as well as contact points in many member countries.
Results: Sixty-six countries responded to the survey by mid-July 2013. Fifty two percent of those who filled the form were females, the rest males. The total number of MPs was 17,024, of which 28% were female (4807). The median values of percentages of females were 21% in the USA, 47% in Europe, 35% in Asia, 33% in Africa and 24% in Latin America.
Conclusion: This is the first international survey that investigates the number and percentage of female MPs around the world. There are European countries that are far away from the target set by European Commission (40%) whereas in countries in the Middle East and Asia, female MPs actually outnumber males. This study is the first step in a more in-depth study that needs to be taken in near future.
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Introduction

The International Organization for Medical Physics (IOMP) defines medical physics as a branch of applied physics, pursued by medical physicists (MPs), that uses physics principles, methods and techniques in practice and research for the prevention, diagnosis and treatment of human diseases with a specific goal of improving human health and well-being [1]. For the purpose of providing clinical professional services, a Qualified Medical Physicist (QMP) is an individual who is competent to independently provide clinical professional services in one or more of the subfields of medical physics [2]. Furthermore, the new European Basic Safety Standards (BSS) Directive (Directive 2013/59/EURATOM) defines the Medical Physics Expert (MPE) as " an individual or, if provided for in national legislation, a group of individuals, having the knowledge, training and experience to act or give advice on matters relating to radiation physics applied to medical exposure, whose competence in this respect is recognized by the competent authority" [3]. Medical physics may be classified into various fields involving ionizing radiation such as radiation oncology, nuclear medicine, diagnostic and interventional radiology, as well as radiation protection and fields that involve alternative radiation such as non-ionizing radiation (magnetic resonance imaging and ultrasound) and physiological measurements. The medical physics profession contributes significantly to the safety of healthcare providers, patients and the public. The imperative role in radiation shielding design and construction of facilities, in patient and staff monitoring, in the safe handling and disposal of radioactive sources as well as development of new methods and precise planning to treat cancer is well known in the hospital environment [4]. The well respected role of MPs in many developed countries and their contribution to unsurpassed clinical service is not apparent in developing countries. The differences between continents are quite large with Africa

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having the lowest level of medical physics services around the world [5].

Moving one step further, the gender composition of the existing MPs around the world is basically unknown. There is an enormous literature that deals with the representation of women in the professional environment in general [6–13]. There are also attempts to explain the lack of women in science specifically, such as societal discouragements, innate differences in ability between the sexes, or differences in aspirations [14]. There is even an association of women in science open to all women and men who support equality for women in science, technology, engineering and mathematics [15]. The most complete reports on this issue are the "She Figures" reports produced by the European Commission (EC) [16–19]. The reports are based on data collection undertaken every three years as a joint venture of the Scientific Culture and Gender Issues Unit of the Directorate-General for Research of the European Commission and the group of Statistical Correspondents of the Helsinki Group on Women and Science. The reports are focused on human resource statistics, indicators in the research and technological development sector and on gender in equality in science. The latest 2012 update [19] shows that despite progress, gender inequalities in science tend to persist. Moreover, the proportion of women is the smallest at the top of the academic hierarchy, falling back to just 18% of highest academic staff.

Acknowledging the need to advance medical physics practice worldwide and making efforts to disseminate both scientific and technical information and to help the creation and establishment of medical physics societies in countries around the world, the International Organization for Medical Physics (IOMP) has taken a number of initiatives in this direction [1,20]. IOMP has developed policy statements on the role and responsibilities of MPs and also on basic requirements for education and training of MPs [1]. Further, IOMP has successfully pursued with International Labor Organization (ILO) to have inclusion of medical physics in "The International Standard Classification of Occupations (ISCO-08)". IOMP provides travel support to young MPs from many countries for participation in IOMP conferences, endorses and sponsors training activities in many countries, gives awards in its triennial conferences and has started its own journal Medical Physics International [1,20]. IOMP was formed in January 1963, initially with 4 affiliated national member organizations. The Organization now has a membership of 84 national member organizations and 6 regional organizations and very recently has updated the communication between members by the use of electronic systems. A proposal was received for setting up a Task Group (TG) on female MPs based on similar activity in International Union of Physical and Engineering Sciences in Medicine (IUPESM). Before setting up a TG, it was deemed appropriate to collect preliminary information on the existing situation in large part of the world. As a result, a survey to investigate the percentage of women MPs in different countries around the world as compared to total MPs in each country was considered appropriate. It was expected that the survey would provide information on gender imbalance, if it exists, and provide a basis for establishment of a TG. Further, it will provide an opportunity for countries and IOMP for in-depth analysis and to deliberate on further actions. The results of this survey are presented here.

Materials and methods

A simple online questionnaire prepared as a Google Forms survey asking the country, the total number of MPs, the number of female MPs and finally the gender of the person providing the data was sent to six regional member organizations of IOMP and a major country, the USA, in mid-March 2013. The regional organizations were asked to distribute it among national member organizations (NMOs) and even to non-IOMP member countries. It takes many years of communication with countries before they become members of IOMP and thus communication line is maintained with non-member countries too. The response rate at the regional level was very poor as only the USA, the Middle East Federation of Organization of Medical Physics (MEFOMP) and the South East Asian Federation of Organizations for Medical Physics (SEAFOMP) could provide some data. It was decided to reach out to official contact points (Secretary or President) in national member countries. Repeated reminders were then sent between mid-April and mid-July 2013. Further, the Secretary-General of IOMP used his personal contacts in many countries to increase response. Both developed and developing countries were included in the survey. The responses received by the end of July were collated.

The analysis of the responses was simple as the survey only addressed the total number of MPs in each country (males + females) and total number of female MPs. The questions were unambiguous from the point of view of gender information as English is not the language used in most countries and there should be no chance of misinterpreting what was required. However, the term MP was left undefined. The percentage of female MPs was estimated.

The number of countries that responded was 66 in total. This number included 17 countries which are not direct members of IOMP. Although not belonging to IOMP directly, these 17 countries are members of a regional organization of IOMP. Fifty-two percent of respondents were females.

Tables 1a and 1b list the countries that provided data. From the 84 national member organizations that are part of IOMP, 49 countries provided data (58%) (Table 1a) and 17 countries that are not IOMP members (Table 1b). The number of countries

Table 1a
List of all countries that responded to the survey.

Number	Country		
1	Algeria	34	Mauritius
2	Bahrain	35	Mexico
3	Bangladesh	36	Mongolia
4	Brazil	37	Morocco
5	Brunei	38	Namibia
6	Bulgaria	39	Netherlands
7	Cameroon	40	Nicaragua
8	Chile	41	Nigeria
9	China	42	Norway
10	Colombia	43	Oman
11	Costa Rica	44	Panama
12	Croatia	45	Paraguay
13	Cuba	46	Philippines
14	Denmark	47	Qatar
15	Dominican Republic	48	Yemen
16	Ecuador	49	Senegal
17	Egypt	50	Serbia
18	El Salvador	51	Singapore
19	Ethiopia	52	Slovakia
20	France	53	South-Africa
21	Germany	54	Spain
22	Ghana	55	Sri Lanka
23	Greece	56	Sudan
24	Hungary	57	Syria
25	India	58	Thailand
26	Iraq	59	Tunisia
27	Ireland	60	Turkey
28	Italy	61	UAE
29	Kenya	62	Uganda
30	Saudi Arabia	63	Tanzania
31	Lebanon	64	USA
32	FYR Macedonia	65	Zambia
33	Madagascar	66	Zimbabwe

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