

Scholarly Activity of Radiation Oncologists in High-Income Developing Countries: Saudi Arabia as an Example

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PURPOSE To examine the trends and quality metrics of publications by radiation oncologists in Saudi Arabia.

METHODS PubMed was searched using names of all Saudi radiation oncologists to retrieve published articles between January 2010 and December 2019. International collaboration, journal impact factor and country of origin, and number of citations were collected. Each article was assessed for epidemiologic type and independently assigned a level of evidence (LOE) by two authors. The trend in publications was examined and compared in the first and second 5-year periods (2010-2014 and 2015-2019) using relevant parameters.

RESULTS A total of 186 publications were found and included. The most common type of research was cohort studies followed by case reports and case series in 24%, 14%, and 13% of all publications, respectively. Dosimetry, clinical, and preclinical studies formed 7%, 8.6%, and 7.5% of the total publications, respectively. The LOE was I, II, III, IV, and not applicable in 8.6%, 22%, 25.8%, 29%, and 14.5% of the included publications, respectively. Comparing the first and second 5-year periods, there was an increase in international collaboration ($P < .001$) in the second period. The number of citations ($P < .001$) and journal impact factor ($P = .028$) were lower in the second period. LOE and publications in international journals were not statistically different between the two periods.

CONCLUSION Although radiation oncology research activity in Saudi Arabia has gained momentum in terms of volume and international collaboration over time, the LOE has not improved. This calls for a national effort to make the contribution to the literature a priority, allocate adequate resources, and apply appropriate measures to enhance research productivity and quality.

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INTRODUCTION

Radiation therapy is an essential treatment modality for patients with cancer. Around 50% of all patients with cancer require radiation treatment during their disease trajectory.¹ The global increasing incidence of cancers is also observed in Saudi Arabia (SA).² Between 1994 and 2000, a total of 39,209 incident cancer cases were reported during the 6-year period according to the first national cancer registry report.³ More recently, a total of 16,210 patients were diagnosed with cancer over a 1-year period according to the most recent report in 2015.⁴

As cancer incidence, natural history, and outcomes vary between countries, it is imperative to study cancers in the local population.⁵ Furthermore, the engagement of developing countries in oncology research may facilitate research collaboration with developed countries and ultimately improve patient enrollment to clinical trials.⁶ However, the availability of

oncology research infrastructure in these countries is often limited.⁷

SA represents a unique country in that it is considered a developing country yet classified as a high-income country by the World Bank.^{8,9} The improving health-care system in SA provides better research opportunities, especially for cancer.^{10,11}

A recent study found that the quality of oncology research in SA did not change over time despite the overall increase in the number of publications.¹² In this study, we aimed to examine the research productivity specific to radiation oncology in SA and compare some quality metrics over time.

METHODS

A list of the names of all practicing Saudi radiation oncologists (ROs) was obtained from the Saudi Assembly for Radiation Oncology (SARO). We searched PubMed for all studies published in English by at least one Saudi RO between January 1, 2010 and December

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CONTEXT

Key Objective

What are the quantity and quality of radiation oncologists' (RO) contribution in developing countries to the literature?

Knowledge Generated

ROs in Saudi Arabia (as an example of high-income developing country) contributed to the literature by publishing 186 studies over a 10-year period.

Despite the increase in the publication volume and international collaboration over time, the level of evidence remained the same.

Relevance

This study may serve as a benchmark for research activity of ROs in developing countries, and it calls for improving research quality in these countries through more effective national and international collaborations.

31, 2019. This study was associated with minimal risk and did not require full institutional review board approval.

All abstracts were assessed by two authors of this article, and all types of publications were included except editorials, duplicates, and commentaries. All included publications were thoroughly reviewed, and information about articles and authors were collected, including the study title, date of publication, journal impact factor and country of origin, authors' affiliations, presence of international collaboration, and number of citations. Journal impact factor at the time of publication was extracted from the journal website or Google Scholar, if not available in the website. Number of citations was retrieved from Google Scholar as of June 10, 2020.

Level of evidence (LOE) was independently assessed by two authors using the 2011 Oxford Center of Evidence-Based Medicine (OCEBM) LOEs.¹³ Additionally, each study was examined for epidemiologic type by the same two authors. Dosimetry and preclinical studies were classified as separate study types. All discrepancies in LOE or type of study were resolved through discussion or by consulting an expert in epidemiology.

Additionally, Hirsch index (H-index) was retrieved from ref. 14 for all currently practicing Saudi ROs.

The trend in publications was examined and compared in the first and second 5-year periods (2010-2014 and 2015-2019). The comparison of the two time periods was performed using chi-square tests for independence for categorical variables (international collaboration [present v absent], LOE [I/II v III/IV], and country of journal [Saudi v international]) and a Mann-Whitney test for continuous variables (journal impact factor and citations) as these data were not normally distributed.

$P < .05$ was chosen as the level of statistical significance, and SPSS software (version 22, IBM Corporation, Armonk, NY) was used for analyses.

RESULTS

We found a total of 186 publications. The most frequent types of studies were cohort studies (45 [24%]), case

reports (26 [14%]), and case series (25 [13%]). Dosimetry, clinical, and preclinical studies formed 7%, 8.6%, and 7.5% of the total, respectively. Clinical trials were 16 in total: two phase I, 11 phase II, and three phase III clinical trials. Only five trials were conducted in a randomized fashion. In total, there were 14 prospective studies. Types of studies are summarized in Figure 1. The overall median journal impact factor and number of citations were 1.14 and 6, respectively. Most of the publications were from two cancer centers: 24.7% from King Faisal Specialist Hospital and Research Center and 24.4% from King Fahad Medical City. International collaboration was observed in 100 publications (54%). A total of 169 studies were published in international journals (91%).

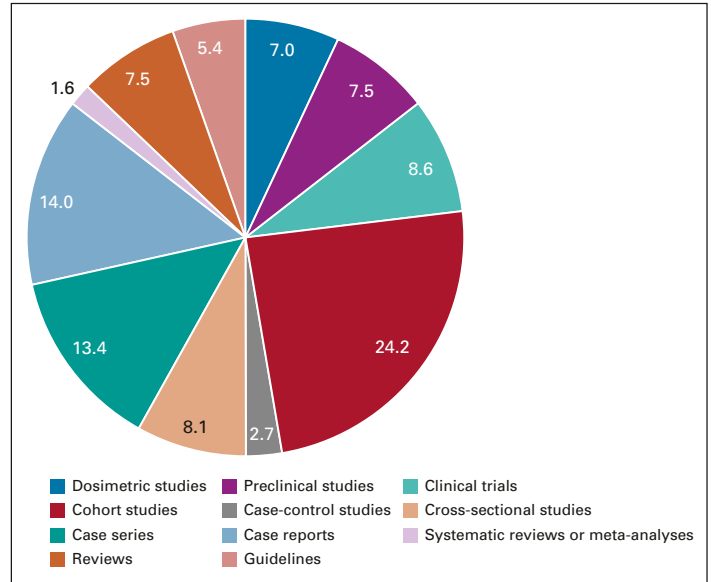
In regard to LOE, it was I, II, III, IV, and not applicable in 16 (8.6%), 41 (22%), 48 (25.8%), 54 (29%), and 27 (14.5%) of the included publications, respectively.

The overall trend of publications over time is shown in Figure 2. Clinical trials were two in the first period and 14 in the second period. Comparing the two periods, there was an increase in international collaboration in the second period ($P < .001$). However, the number of citations and journal impact factor were lower in the second period, with $P < .001$ and $P = .02$, respectively. LOE (I/II v III/IV) and publishing in international journals versus Saudi journals were not statistically different between the two periods. This comparison is shown in Table 1. In addition, the type of research was not statistically different between the two periods ($P = .29$).

Furthermore, a higher LOE ($P = .02$) and more publications in international journals ($P < .001$) were observed when international collaboration was present. In contrast, journal impact factor and number of citations were not statistically different in regard to the presence or absence of international collaboration ($P = .11$ and $P = .46$, respectively).

The Saudi ROs' H-index mean (standard deviation) and median (interquartile range) were 2.84 (2.68) and 2 (0-12), respectively.

FIG 1. Study types, %, of all publications by Saudi radiation oncologists (2010-2019).



DISCUSSION

Healthcare facilities in SA, including cancer care, have expanded significantly over the last 2 decades.^{10,11} Despite the significant expansion, many challenges are being faced.^{15,16} The national vision of 2030 has recognized the major shortcomings and opportunities in healthcare system and prioritized specific healthcare reforms toward achieving a goal of 6-year gain in life expectancy at birth.¹⁷ Cancer incidence in SA is estimated to rise by 63% in 2030.¹⁸ The associated economic burden will likely be significant.¹⁸ Notably, about 58% of Saudi nationals are age <30 years, which predicts an increasing demand for cancer care facility expansion in the future.¹⁹

Improving research collaboration between developing and developed countries is generally encouraged to expand

enrolling patients to clinical trials.^{5,7,20} It requires adequately advanced research facilities in developing countries to accomplish this task.²⁰ SA is a strong candidate to play the role model for this collaboration, especially with improved research funding.²¹

In this study, we aimed to examine the research productivity of ROs in SA (as an example of a developing country). Overall, we found 186 articles published by at least one Saudi RO over a 10-year period from 2010 to 2019. Only 16 clinical trials were found. Most of the publications came from only two hospitals. Unsurprisingly, these two hospitals have dedicated and well-developed research centers that provide required expertise and funding for cancer research. Furthermore, we found that about 31% of these two hospitals' publications included at least one statistician or

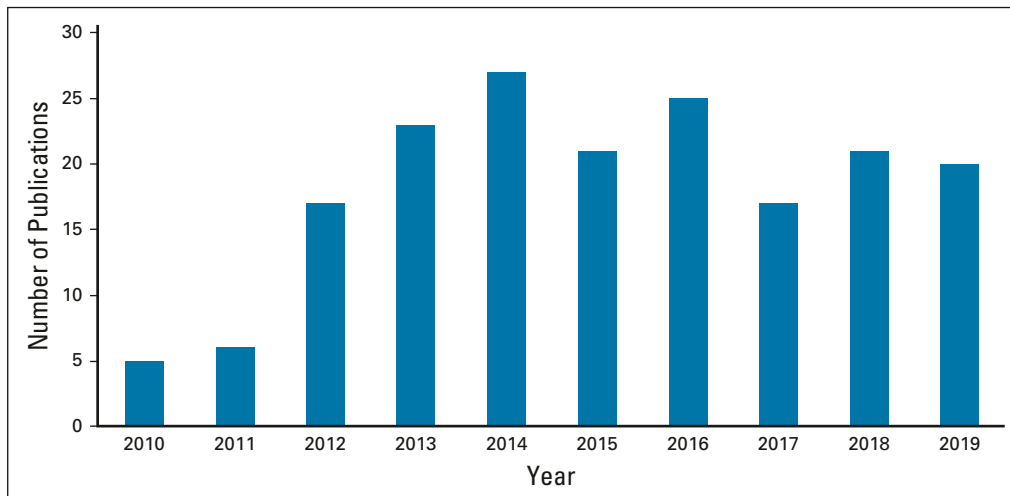


FIG 2. Publications by Saudi radiation oncologists (2010-2019).

TABLE 1. Comparison of Quality Parameters for Publications by Saudi Radiation Oncologists Between 2010-2014 and 2015-2019

Parameter	2010-2014	2015-2019	P
LOE			.24 ^a
I/II	19	38	
III/IV	48	54	
NA	11	16	
International collaboration			< .001 ^a
Yes	30	70	
No	48	38	
Journal			.13 ^a
Saudi	10	7	
International	68	101	
Citations (median)	9	4	< .001 ^b
Impact factor (median)	1.47	0.92	.02 ^b

Abbreviation: LOE, level of evidence.

^aChi-square test for independence.

^bMann-Whitney test.

epidemiologist as a co-author compared with 9% in publications from other hospitals. In regard to quality metrics, only international collaboration increased over time. This may reflect the increase in the number of practicing ROs in SA from < 20 in 2010 to 46 (according to SARO) in 2020, who were trained abroad and established connections with international research groups. This finding was also observed for overall oncology research in SA.¹² Additionally, higher LOE and more publications in international journals were observed in the presence of international collaboration. On the other hand, number of citations and journal impact factor were higher in the first period. The higher number of citations in the first period may be explained by the longer time that these publications have for possible citations compared with publications in the second period. Furthermore, the lower journal impact factor in the second period may be partially explained by the increase in the number of international and national open access journals. Moreover, LOE was not different comparing the two periods, which was also observed in all oncology publications in SA.¹² In India, another rapidly growing developing country, there were 109 studies published by ROs over a 7-year period.²² However, that study was conducted in 2004 and has not been updated. No other data specific for ROs' publication productivity were found in the literature from other developing or developed countries for comparison.

The mean and median H-indices of Saudi ROs were 2.84 and 2, respectively. In contrast, the mean and median H-indices of academic ROs in the United States were 14.4 and 9, respectively.²³ Some of the factors associated with higher H-index among academic ROs in the United States included being a senior RO and practicing in a larger department.²³ Conversely, most of the ROs in SA are

currently junior nonacademic staff with 5 years of practice or less and most radiation oncology facilities are not affiliated with universities and are relatively new and small (according to SARO).

Our findings should be interpreted in the context of existing radiotherapy and research facilities in SA. According to SARO, the total number of radiotherapy centers increased from two in 1980 to 12 in 2020. The current number of linear accelerators in SA is 32. This translates into one linear accelerator per 627,549 nationals, considering the total Saudi population of 20,081,582 according to the 2016 report by General Authority for Statistics.¹⁹ This figure is far less than the estimate of required linear accelerators in Europe at 5.9 machines per one million.²⁴ However, the cancer incidence in SA differs significantly from that in Europe, which may likely affect the adequate number of required linear accelerators.

Research facilities vary between hospitals but largely depend on the department and hospital resources. Some of the difficulties in conducting healthcare research in SA are concerning funding and availability of biostatisticians.²⁵ Moreover, cultural beliefs in regard to cancer and its treatment represent a challenge to patients in accepting a standard cancer treatment.²⁶ Thus, investigational treatment is unlikely to be accepted by patients. However, there may be a relatively significant proportion of patients with cancer willing to participate in clinical trials if presented in the right setup.²⁷ Nevertheless, overall healthcare and oncology research productivity have increased in SA over time.^{12,28} The strategies that could improve the quality metrics of RO research such as LOE, journal impact factor, and number of citations in SA should include better interdisciplinary, national, and international collaborations. These levels of collaborations may be achieved through motivating ROs to engage in research activities and providing dedicated research staff, better logistics, and more funding.

Limitations of this study include its retrospective design, unavailable information in regard to individual ROs' research background, or institutional research resources or funding. The possibility of missing some publications is another limitation. Additionally, the manual collection of impact factor and number of citations was prone to error. Although Oxford Center of Evidence-Based Medicine LOE is commonly used, it cannot be considered a stand-alone measure of publication impact and quality. There are more robust but less practical measures.²⁹

In conclusion, radiation oncology research in SA improved over time in terms of quantity and international collaboration. However, LOE did not change. Furthermore, only a few clinical trials were found. These findings warrant the application of more measures to improve radiation oncology research in SA. Nonetheless, the improving research funding and increasing number of ROs create potential opportunities for research.

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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Open Payments is a public database containing information reported by companies about payments made to US-licensed physicians ([Open Payments](http://www.openpayments.org)).

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