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Research

Mapping the Colorectal Cancer Screening Scientific Landscape in South Africa: A Bibliometric Analysis to Identify Inequalities

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ABSTRACT

Background

This paper maps scientific publications to identify areas of CRC screening that are currently receiving greatest emphasis in South African research, as means, to identify the inequality in CRC screening research. Reviewing the publications can assist to identify research funding and research capacity gaps. It can also identify potential for collaboration of authors and institutions to reduce the inequalities.

Methods

We used bibliometrics to identify and map the scientific publications on CRC screening related to South Africa (SA).The search utilised three databases, namely: Web of Science, Scopus and PubMed to identify articles published between January 2000 to August 2020. We identified the document by type, research areas, journal type, affiliated countries and research organisations, authors with most publications, and funding sources.

Results

Forty-eight of the 368 publications were included for bibliometric analysis. Of these, there were 88% original articles; 6% were reviews; 4% were books and 2% were abstracts of meetings. The top CRC screening research areas were oncology (21%); gastroenterology and hepatology (13%), public, environmental, occupational health (13%) and genetics and heredity (13%).The top four journals that have published the CRC screening related to South Africa were the South African Medical J. Surgery (10%); South African Medical Journal (7%); Clinical Genetics (5%) and Colorectal Diseases (5%). 19% of articles were published in 2019. There were 28 (58%) articles with first authors from South Africa. There were ten publications without funding declared (21%). The top five research organisations from South Africa that published the most CRC screening research were University of Witwatersrand (36%); University of Western Cape (18%); University of Pretoria (14%); University of Cape Town and KwaZulu-Natal (11%).

Conclusion

Research and development of novel CRC screening technologies cannot be overemphasised, as catalyst for diverse screening alternatives that are less invasive, affordable and accessible to all those in need to expand access, coverage and increase uptake at local level.

Keywords: *Colorectal cancer; Bibliometric; Screening; Colonoscopy; Scientific landscape; Inequalities; Cancer; South Africa.*

INTRODUCTION

In 2000, the World Health Organization promoted Health for all to reduce global inequalities in health.[1] Health inequalities, as defined by Whitehead (1992) are "*systematic, avoidable and unjust differences in health and wellbeing between different groups of people*".[2] The factors associated with the inequalities in health include interplay of personal, social, economic and environmental factors.[3-5]

Colorectal Cancer (CRC) affects most people from the low-socio-economic background and racial groups, as stated by Carethers and Doubeni 2020.[5] They also mention that the differences in risk exposure, access to health services including treatment contribute towards differences in CRC incidence and outcomes. The disparities including gender and ethnicity coupled with the social determinants of health have different impact on individuals, service providers, health systems including policy development.[2,6-8]

The interventions that address structural issues as means to reduce inequalities instead of individual behaviours have been proven to be most effective. Twenty-seven of the 43countries (27 of 43) in Sub-Saharan Africa (SSA),[9] have functional cancer registration systems to appropriately conduct colorectal cancer surveillance. The colorectal burden in some countries from this region, notable, South Africa, has been reported to be rising over the past decade, as reported by GLOBOCAN 2018.[10]

The rising burden is attributable to the recent economic and social transition, as reported by the Global Burden of Disease Cancer Collaboration in 2019.[9-12] In addition, it is estimated that the majority of deaths related to colorectal cancers are reported from the low- and middle-income countries. The WHO and country policy makers, over the years, have used the results of the global burden of disease study to inform national and local cancer control strategies to improve cancer care and reduce inequities in cancer care.[9-12]

Regardless of this global commitment to reduce inequalities in health, individual countries, based on their budget and unique CRC burden have made difficult choices in terms of prioritising investment in health, including cancer control, in an attempt to reduce disparities in health. As advocated that prevention is better than cure, most countries have focused on investing in prevention as means to promote healthy lifestyles and the quality of life. With prevention, especially for cancer, the benefits of the screening programmes include early detection of disease, provides an opportunity for early treatment, thus improve health by reducing long term morbidity and mortality rates.[13]

Ladabaum (2020) stated that screening has proven to reduce colorectal cancer (CRC) incidence and mortality. The most common CRC screening strategies are those that are stool based including guaiac-based faecal occult blood tests (gFOBTs), Faecal Immunochemical Tests (FITS) and screening colonoscopies and multi-target stool DNA (mt-sDNA) test. Other strategies use direct visualization tests, including the flexible sigmoidoscopy and Computed Tomography Colonography (CTC).[14] Each of these tests have strengths and limitations in terms of specificity, sensitivity, method of testing, frequency of testing, patient preferences, provider competencies and quality of evidence regarding impact on incidence and mortality. Although colonoscopy has been identified as a gold standard and is associated with improved survival.[15] However, it is invasive and a call for novel effective non-invasive methods could offer better alternatives to lower incidence and mortality and is acceptable.

Applying the definition of inequalities in health to colorectal cancer screening continuum, we therefore define it as unequal distribution, availability, and accessibility of CRC screening services, facilities and personnel across population in the country. Availing various methods of CRC screening programmes cater for the individual preferences and present options for individuals to choose screening methods that are less invasive and affordable based on their circumstances. Hence it is important to identify research and focus areas that will inform the CRC screening methods in future.

Noting that colorectal cancer is 5th most frequent cancer in South Africa. The Global Cancer Observatory (2018), stated that colorectal cancer incidence rate, in South Africa, is 14.4 per 100,000 populations. The report also estimated a 40% increase in new CRC cases from 2498 per 100,000 in 2018 to 3495 by 2030. Currently, it was reported that South Africa has the CRC age standardised (world) incidence rate (ASIR) estimates that exceeds the Southern African United Nation's regional ASIR. (14.4 *versus* 13.4 per 100000) respectively.[10]

Regardless of this data, South Africa does not have a national CRC screening programme in place, as stated by Lambert (2009) that mass screening may not be necessary inmost developing countries with low burden of CRC considering limited resources.[16] Hence it is vital to support research and development that provides diverse options for CRC screening best suitable across socio-economic status and burden of disease in different countries.

Aim

To map the scientific landscape related to CRC screening in South Africa with the purpose to identify health inequality in CRC screening research.

Objectives

The study objectives are to:

- Quantify the number of publications produced in the past 20 years on the topics from South Africa and outline the frequency of publication per year.
- Determine which areas of colorectal cancer screening are currently receiving greatest emphasis in South Africa by assessing the research areas addressing CRC screening from South Africa.
- Identify the volume of publication by year and journal sources.
- List the most productive authors, content analysis, journal sources with impact factor and number of citations.
- Inform the future research on CRC screening in South Africa and in other countries with similar conditions and burden.

MATERIALS AND METHOD

We analysed data using bibliometric analysis approach to identify and map the scientific publications on CRC related to South Africa. Scientific publications were identified, collected and reviewed from Thomson Reuters' Web of Science Core Collection (WoS), PubMed and Scopus, for bibliometric analysis.[17,18]

This paper describes the evolution of scientific publications in English produced on CRC-screening related to South Africa between January (Jan.) 2000 and August (Aug.) 2020 in view of the CRC burden

in South Africa.

The search was carried out in August 2020 using the advanced search mode of WoS and the following query: (CRC = (Colorectal cancer or C=colon and R=rectal cancers) and cu = (South Africa or "*Republic of South Africa*") AND DOCUMENT TYPES: (Article) Indexes=SCI-EXPANDED Time span=2000-2020.

The selected CRC descriptors were from the medical subject headings (MeSH) of the National Centre for Biotechnology Information (NCBI). To exclude articles whose focus was not CRC, the search used the title (ti) field rather than the topic (ts) field. The ts field encompasses articles' titles, abstracts, and keywords (from authors and keywords plus) and abstracts and keywords (from authors and keywords plus). "*Keywords plus*" is based on WoS editorial readings of the titles of the articles' bibliographic references, which can create a source of possible "*garbage*" in the analysis. We restricted our query to only "*document type*" articles because these are usually more complete and relevant to advanced stages of research.[17,18]

We selected the "*citation indexes*" Science Citation Index Expanded index (SCI - EXPANDED) to narrow the focus on research related to biomedical science to avoid publications indexed in social sciences, arts, and humanities (Social Science Citation Index Expanded). Our period of analysis began in January 2000 as this data is available on the WHO Global Observatory for Cancer report that provides global CRC incidence and mortality data.[10]

The search identified 80 records from WoS; 191 from Scopus and97 from PubMed of CRC related to South Africa. We imported the raw data from the three databases into the Microsoft Excel 97-2003template. To build the specific reference database related to CRC screening, of the identified references related to CRC in South Africa the three main terms of interest were used: colonoscopy, CRC screening and risk factors. The electronic search was limited to original articles, review articles, formal letters or guidance, books and conference abstracts that contained at least one of the aforementioned terms in the titles, abstracts or keywords to exclude papers on CRC not related to screening.

We also removed duplicates using the validation and remove duplicates command tool and deleted "*Research Areas*" on topics not related to the aims of this work (such as treatment, skin, HIV related cancer, HPV, gynaecological or cervical cancer).

Table 1. Publication inclusion and exclusion process

Data based Searchers	Number of publications identified on CRC South Africa	Number of publications duplicated between databases	Balance after removing duplications	Excluded based on focus area	Analysed
PubMed	97	71	26	18	8
Scopus	191	143	79	64	15
WoS	80	0	80	55	25
TOTAL	**368**	**214**	**185**	**137**	**48**

After removing 214 publications due to duplication, we also excluded 137 publications without any of the following words in abstract, expanded key words: screening, prevention, risks, biomarkers assessment. The following were excluded:

Reason for Exclusion of Publications

- Countries excluding SSA or South Africa
- Focused on treatment or drugs, radiology including palliative care or therapy or plant sciences
- Focus on analysis of burden of diseases, only

Forty-eight publications remained and were included for further bibliometric analysis. We used the filter tool on Excel to cluster components for analysis including "*Document Type*"; "*Year of Publication*";"*Abstract*" and "*Research Area/WoS Category*" indexed in WoS to classify articles by subject (Web of Science Core Collection Research Area). This filtering enabled us to get the total number of articles, manually create tales for further synthesis of data to enable correct interpretation.[17,18]

We focused on descriptive indicators by identifying the volume of publications and number of citations of most productive authors. We used the relational indicators to outline "*Author Affiliations using (Organisation and City and Country)*"; addresses; collaborations between authors and affiliations and citation practices. Qualitative indicators are based on the keywords as well abstracts provided for each selected article using content analysis to identify prominent research focus areas. We also used sort (highest to lowest") to identify the highest numbers of publications and manually capture the number per category; identify blanks and outliers to clean the data (Table 2 below).

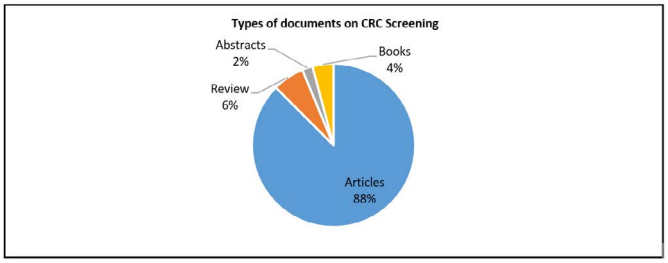
Table 2. Type of variables analysed from the SA publications on CRC screening

Variable	Description
Publication	Number of publications Type of publication: review, article, book, abstract, consensus paper
Focus Area	Classification/ Subject analysis
Source	Journal Type Quantity per journal type
Publication year	January 2000- August 2020
First Author Country of Origin	Name of affiliation and co-authors affiliated institution Countries listed with affiliated institutions Address of correspondence
Author	Number of authors Productivity per author per focus area
Funding Source	Type of funding

RESULTS

Figure 1 presents the type of publications produced related to CRC screening in South Africa. Between January (Jan) 2000 and August (Aug.) 2020, there were 88% original articles; 6% were reviews; 4% were books and 2% were abstracts of meetings. The production of original articles in South Africa indicates an interest to learn more about CRC and better ways to identity risks in order to inform screening approaches and tools in South Africa.

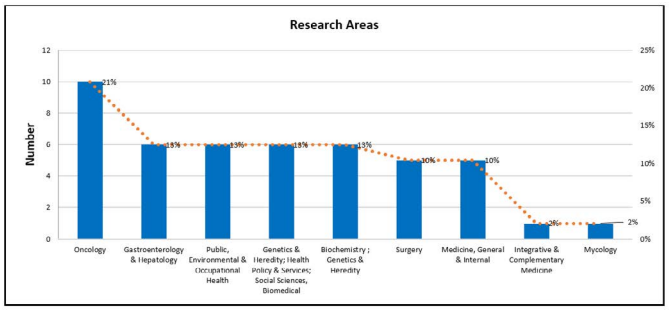
Figure 1: Type of documents on CRC Screening related to South Africa published: Jan 2000-Aug.2020



Our analysis identified the following top CRC screening re-

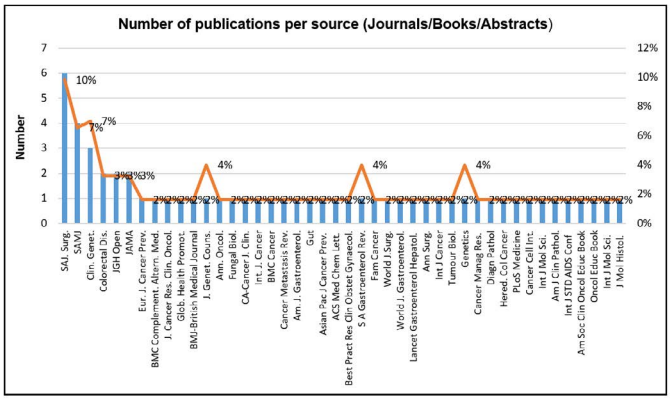
search areas: oncology (21%); gastroenterology and hepatology (13%), public, environmental, occupational health (13%) and genetics and heredity (13%); Surgery (10%) and medicine, general and internal (10%) and less so on integrative and complementary medicine and mycology (2%) (Figure 2). There were two articles related to costing and incentives related to the use of CRC screening tools published on South Africa. Limited publications on cellular or molecular or biomarkers aspects of screening were identified over the period of analysis. The diverse research areas on CRC screening indicate great efforts towards exploring the subject to learn more about CRC to inform the development of diverse screening tools that are specific and sensitive. The availability of funding, authorship backgrounds and interests is also related to the research areas.

Figure 2: Research Areas of publications on CRC screening related to South Africa: Jan 2000-Aug.2020



The South African Medical J. Surgery (10%) was the journal which has the largest number of publications on CRC screening; followed by the South African Medical Journal (7%); Clinical Genetics (5%) and Colorectal Diseases (3%); Journal of Global Health Open and Journal of American Medical Association (JAMA,3%)v (Figure 3). The variety of journals that published the SACRC screening articles are

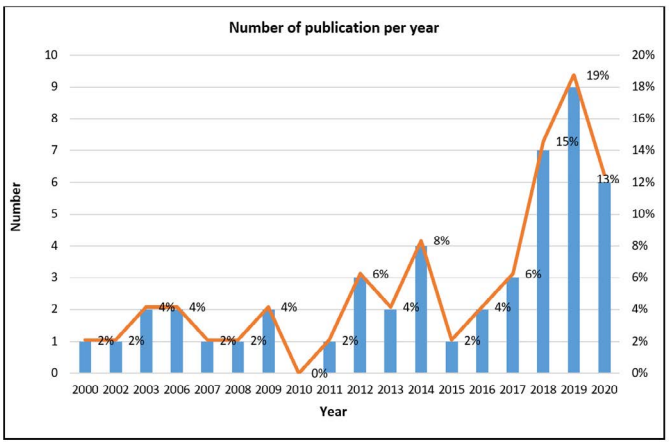
Figure 3: Proportion of publications by journal title (CRC screening research related to South Africa) published: Jan 2000-Aug.2020



located in South Africa and based internationally. This observation may be influenced by the authorship affiliations, author networks; institutional networks and approved journal for manuscript submission to obtain funding. Other journal related factors may include the impact factor, author guidelines, journal accessibility (open access status); awareness of journal by its reputation.

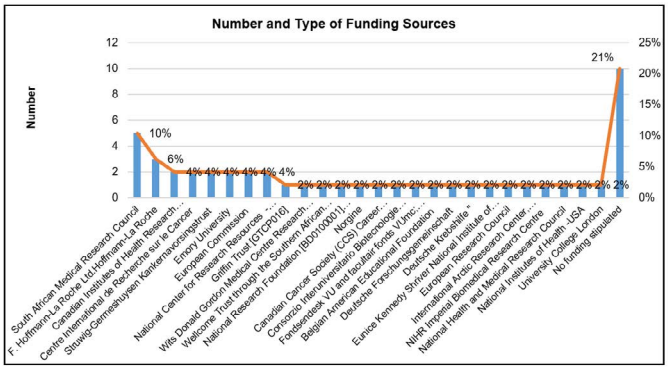
The majority of articles were published in 2019 (19%); 2018 (15%); 2020 (13%), and 2014 (8%) (Figure 4). The sporadic pattern of publications is shown by the trend line presented in Figure 4. However, an increase in publications is notable especially in the last three years. Availability of funding, the increasing number of researchers interested in the CRC; increasing awareness of CRC cases in South Africa and authorship could be factors contributing to an increase in the number of publications.

Figure 4: Number of publications per year on CRC screening related to South Africa published: Jan 2000-Aug 2020



There were ten publications related to CRC screening without funding declared (21%) suggesting that the majority of CRC research activities are conducted out of strong commitment and interests of authors. For the publications that had declared funding, our analysis identified the following types of funding sources, namely; the South African Medical Council (n=5,10%); and F. Hoffmann-La Roche Ltd (n=3,4%) and European, Canadian and French funding sources were also declared. Some publications had received funding from the following countries, the United States of America (USA), Europe, Germany and United Kingdom (UK) (Figure 5). This illustrates diversity of

Figure 5: The most funding sources supporting CRC screening research related to South Africa funded between: Jan. 2000-Aug. 2020



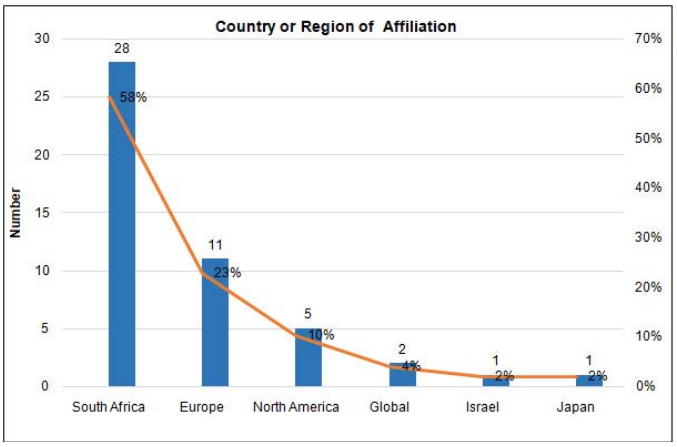
investment for research and development. However, it also reflects limited funding for CRC in South Africa when compared to other types of cancers in South Africa, such as breast, cervical funded by the Cancer Association of South Africa between 2018 and 2019. This finding highlights the importance of balancing research development investment

across cancer types in South Africa, as CRC is one of the top five cancers attributable to the rising mortality and morbidity rates in the country and globally.[8,19]

Among the 48 articles, related to CRC screening in South Africa, there were 28 (58%) related to first authors from South Africa; 11 (23%) related to first authors from Europe, mainly Belgium, France and the UK; five (10%) related to first authors from North America, mainly USA. Two (4%) of the publications were related to global authorship collaboration as part of WHO initiatives (Figure 5). A similar pattern was also identified with other diseases such as Tuberculosis (TB).[20] This demonstrates existence of North-South collaboration and capacity development in global CRC research as discussed by Atkins in 2016 and Katsidzira in 2017.[21,22] This enables policy planning and innovation through knowledge generation.

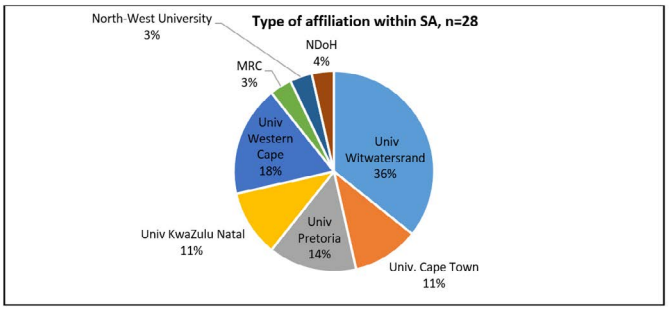
Only two articles related CRC screening were published by authors from South Africa and Zimbabwe, reflecting a collaboration within the Southern African region. The limited number may be due to low burden of CRC in SSA and Southern African region.[22,23] None of the publications related to CRC screening were related to authors from other known key players in global health such as BRICS.[21] This highlights opportunities to expand strategic partnerships on health, as CRC Age standardized (World) incidence rates (ASR) is rising, especially in South Africa and Brazil and both countries have been reported to have high income and health inequalities (Figure 6).[8,18,19,23]

Figure 6: Country or Region of Affiliation of authors of publications on CRC screening related to South Africa: Jan. 2000-Aug.2020



Among the 48 publications analysed, the primary affiliation was considered. With authors that have multiple affiliations, the first listed affiliation was considered first. We identified 28 58%) publications on CRC screening affiliated to research organisations from South Africa, including: University of Witwatersrand (36%); University of Western Cape (18%); University of Pretoria (14%); University of Cape Town and KwaZulu-Natal (11%) presented in Figure 7. These institutions have the highest research productivity. They also have a higher degree and frequency of collaboration associated with Europe, Northern America and selected countries located in Asia and Middle East. Moreover, the institutions are reported to have strong research capacity in terms of research facilities, experts, and receive most funding. Furthermore, the academic institutions are ranked among the top 100 academic institutions in the world because of their scientific expertise and outputs.[24-26]

Figure 7: Type of Research Organisations in South Africa that produced scientific publications on CRC screening: Jan.2000 - Aug.2020



The vast majority of authors produced only one original article, in the period of analysis, related to CRC screening. Only seven authors, as listed in table 3 below, had more than one publication (with a total of 16). Six original of the 16 articles were published in 2019 and oncology was the main research area. Fadaka A.O, was the most prolific author, with four articles produced over two years (in 2018-2019). Almost all original articles were published in international journals, with an exception of one that was published by the South African Medical Journal in 2013, produced by Adonis. Bruwer (2013); McCabe (2019); and Bruwer (2013) had the highest number of citations linked to their publications (65, 53 and 48) respectively. Mehta (2019) and Bruwer (2013) had published the two original articles in the same year. There may not have been many publications produced on CRC screening that were highly cited, but the quality of these is shown by the journal sources and impact factor which over shadows the volume of publications. Furthermore, the journals listed in Table 3, used by the most productive authors on the topic of CRC screening research were among those with the highest impact factors.

Table 3. List of most productive authors, by journal source, publication year, research area, number of citations and Impact Factor (IF): Scientific Publications, Jan.2000-Aug. 2020

Authors with two or more papers	Journal Title	Publication Year	Focus Research Areas	Times Cited, WoS Core	IF (year of publication or the most recent or first year of IF recorded per journal)
Fadaka AO, Pretorius A, Klein A	Cancer Control	2019	Oncology	0	1.85 (2018)
Fadaka AO, Ojo BA, Adewale OB, Esho T, Pretorius A	Cancer Cell Int.	2018	Biochemistry & Molecular Biology; Endocrinology & Metabolism	0	3.63
Fadaka AO, Pretorius A, Klein A	Int J Mol Sci.	2019		0	4.21 (2018)
Fadaka AO, Klein A, Pretorius A	Tumour Biol.	2019		0	3.32 (2018)
Adonis, Leegale; Basu, Debashis; Luiz, John	Global H. Action	2014	Public, Environmental & Occupational Health	5	2.55
Adonis L., An R., Luiz J., Mehrotra A., Patel D., Basu D., Sturm R	South African Medical Journal	2013	Oncology	0	1.20
Anderson, D. W.; Goldberg, P. A.; Algar, U.; Felix, R.; Ramesar, R. S.	Colorectal Disease	2007	Gastroenterology &Hepatology; Surgery	11	None

Authors with two or more papers	Journal Title	Publication Year	Focus Research Areas	Times Cited, WoS Core	IF (year of publication or the most recent or first year of IF recorded per journal)
Anderson, WF; Umar, A; Brawley, OW	Cancer and Metastasis Reviews	2003	Oncology	53	None
Bruwer, Z; Futter, M; Ramesar, R	Patient Education and Counselling	2013	Public, Environmental & Occupational Health; Social Sciences	7	None
Bruwer, Z; Futter, M; Ramesar, R	J. Genetic Counselling	2013	Genetics & Heredity; Health Policy & Services	5	None
Katsidzira, Leolin; Gangaidzo, Innocent T.; Makunike-Mutasa, Rudo; Manyanga, Tadios; Matsena-Zingoni, Zvifadzo; Thomson, Sandie; Matenga, Jonathan A.; Rusakaniko, Simbarashe; Ramesar, Raj	European J Cancer Prevention	2016	Oncology	5	2.59
Katsidzira L, Gangaidzo I, Thomson S, Rusakaniko S, Matenga J, Ramesar	Lancet Gastroenterol-Hepatol.	2017	Gastroenterology &Hepatology; Surgery	7	8.85
McCabe, Michelle; Perner, Yvonne; Magobo, Rindidzani; Mirza, Sheefa; Penny, Clement	JGH Open	2020	Public, Environmental & Occupational Health	0	4.280 (2019)
McCabe, M; Perner, Y; Magobo, R; Magangane, P; Mirza, S; Penny, C	Scientific Reports	2019	Multidisciplinary Sciences	0	4.12 (2018)
Mehta SJ, Pepe RS, Gabler NB, Kanneganti M, Reitz C, Saia C, Teel J, Asch DA, Volpp KG, Doubeni CA.	JAMA	2019	Health Policy & Services	0	14.78 (2018)
Mehta SJ, Induru V, Santos D, Reitz C, McAuliffe T, Orellana C, Volpp KG, Asch DA, Doubeni CA.	JAMA	2019	Gastroenterology &Hepatology; Surgery	0	14.78 (2018)

STUDY LIMITATIONS

We cannot generalise the findings from this analysis as we did not analyse all databases and every abstract for this analysis. Excluding other databases may have prevented us to report on the complete CRC screening status in the country, as we may have missed other publications produced. Using the WoS, PubMed and Scopus, these databases are restricted to peer-reviewed articles published in academic journals, thus information from books and monographs was not included.

Searches in other databases such as Scival, Wiley and Clintrials.gov may have revealed different results, impacting on potential associations and trends. The data captured on citations was limited to only authors with more than one publication. We did not analyse citations to map the extent of interactions and collaboration among research institutions and authors within South Africa and between countries.

We also did not capture the journal impact factor in this analysis, as this may have influenced the author submission preferences. In addition, authors have distinct interest in specific journals and unique expertise, hence, this may have introduced bias in the type of the research areas published and analysed in this paper. The funding may also have informed the type of research area covered. The majority of authors have worked with more than one institution; however, we only focused our analysis on the first affiliation listed by the first author. We may have under reported the strength of networks, interactions and cross pollination of expertise between institutions and countries.

Value Added by the Study

- First study to analyse CRC screening publication status in South Africa using the bibliometric analysis methodology to identify inequalities in CRC screening research.
- Identifies CRC screening research area concentration and highlights gaps for future CRC screening research in South Africa, as a valuable tool for policy-makers.[27-29]
- Identifies authors, affiliated institutions and funding sources that support CRC screening research in the country.
- The study approach and the findings will be relevant not only to South Africa future research but also to other countries with similar socio- economic development and CRC burden.

Proposed CRC Screening Research Funding Principles

As stated by Ferrantes, 2013, the effectiveness of cancer screening, goes beyond the efficacy of the screening test.[30] Screening delivery options play an important role in screening test utilisation and adherence. Therefore, screening technologies should be informed by the root causes of low screening rates, including social determinants of health.[7,8,31]

The limited diversity of novel technologies for CRC screening still exists, regardless of the fact that more than half of all CRC cases and deaths are preventable through screening and surveillance.[11,25] Hence, based on the findings, we advocate for funding of innovative CRC screening research that covers innovative screening technologies, reports on patient, provider response and highlights potential policy responses. We further promote that the research is underpinned by the following principles:

- Capability to categorise or classify multifaceted exposure to risks and address causes of CRC;
- High sensitivity and specificity of screening technologies to ensure accuracy of test results
- Tests which function well and are easy to use and can be stored at multiple settings including primary health care level,
- Diverse platforms for testing (genetics, biomarkers, scans) and providing variety of options for clients based on choices to meet the needs and increase participation and adherence as a precursor to colonoscopy screening
- Better aligned to South African demographics and socio-economical context;
- Cost-effective and affordable for both clients, private insurance and public health system;

- Acceptable to both clients and service providers; and
- Easily layered with other screening tests for communicable and other non-communicable diseases.

CONCLUSION

The bibliometric analysis identified less publications related to CRC screening among peer-reviews publications in South Africa produced between Jan. 2000 and Aug. 2020 as compared to other focus areas. There were limited number of publications that covered molecular, cellular screening, biomarkers as well as costing screening strategies. Affiliations of authors were mainly located in big cities and the research conducted in regional and tertiary hospitals, highlighting the inequality of research capacity in other areas and unbalanced generation and management of knowledge. Hence, this study highlights the importance of conducting research in different settings involving multiple stakeholders to share lessons and transfer skills. Further, research and development of novel CRC screening technologies cannot be overemphasised, as catalyst for diverse screening tools that are less invasive, affordable and accessible to all those in need to expand coverage at local level.

CONFLICTS OF INTEREST

None.

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