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A SURVEY OF THE FACTORS INVOLVED IN THE EMIGRATION OF SOUTH AFRICAN RADIOLOGISTS

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A research report submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Medicine in Diagnostic Radiology

Johannesburg, 2017

Declaration

I, Halvani Moodley, declare that this research report is my own work. It is being submitted for the degree of MMed (RadD) at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at this or any other University.

Dr Halvani Moodley

On this 29 day of October 2017

Dedication

“A teacher affects eternity, he can never tell where his influence stops.”

Henry Brooks Adams

In memory of my beloved grandfather, Mr Chengiah Naidu (12/2/23 – 2/1/15), a brilliant, dedicated and humble teacher who served his community tirelessly and for always encouraging me to explore and grow.

Publications and presentations

This work has been presented at the RSSA BISSA Breast Imaging Congress on 22 August 2014 and has not been published.

Abstract

Introduction: The migration of doctors from developing to developed countries is a global trend, referred to as brain drain. The United Nations defined it as the unidirectional movement of highly skilled individuals from the developing to the developed world, such that only host countries profit. Medical brain drain is driven by a global shortage of healthcare workers, exacerbating the shortage in developing countries. There is a dearth of African literature about the intent of doctors to emigrate and the factors involved. No study about South African radiologists has been previously undertaken.

Aims: This study aimed to evaluate the demographics of South African radiologists with the potential to emigrate, their proposed destinations and intent to return. Push and pull factors, the role of teleradiology as an alternative to emigration and potentially modifiable push factors were assessed.

Method: The countrywide, voluntary, online, 13 question survey of radiologists and registrars from the RSSA member database in 2012, was augmented by paper questionnaire sampling at a congress in 2011 and by inviting prospective participants known by the researcher or supervisor.

Results: The response rate was 35% (190 from a sample of 550). 43% of South African radiologists had considered emigration, 19% desired to temporarily work or study abroad, whilst 4% were emigrating or had definite plans to emigrate. Australia and Canada were the most popular destinations (29% and 26% respectively). The major work related push factors were financial reasons and legislation (both 42%). The dominant socio-economic push factors were the high crime rate (71%), political (64%) and economic stability (54%).

Teleradiology was considered as a viable alternative to emigration by 64% of radiologists with no intention to emigrate.

Conclusions: 67% of South African radiologists have considered emigration due to push factors relating primarily to South Africa's socio-political and economic stability whilst radiological push factors have a secondary role. Teleradiology may be a viable alternative to emigration for almost two thirds of radiologists with no intent to emigrate.

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My family for inculcating my love of life-long learning and support throughout this academic endeavour.

Nomenclature

CMSA	Colleges of Medicine of South Africa
CT	Computed (axial) tomography
Donor (source) country	A country which either voluntarily or usually involuntarily sends its natives to a receiving or host country
Emigration	Permanent relocation of an individual to another country for 2 or more years.
Highly skilled migrant	An emigrant with tertiary education and/or with significant professional experience in a field
Host (destination) country	A country that receives emigrants from donor countries
HPCSA	Health Professions Council of South Africa
IOM	Internal Organisation for Migration
MRI	Magnetic resonance imaging
NHI	National Health Insurance (Act)
Non – response	A measure of failure of participants to answer a question
Radiologist	A medical doctor who has obtained a post graduate degree in diagnostic radiology and is a specialist in the field
Registrar/Resident	A medical doctor who is training under supervision to obtain a post graduate degree in diagnostic radiology
RSSA	Radiological Society of South Africa
Skip logic	Questionnaire option that directs the respondent to skip the irrelevant question and to answer the next applicable question
WHO	World Health Organization

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1. Introduction

1.1. Medical brain drain: the rationale for the study

The migration of doctors from developing countries to developed countries is a major global trend. This phenomenon is referred to colloquially as medical "brain drain" and was popularised by global media reports. The Evening Standard newspaper devised the term in response to the UK Royal Society's 1963 report on the mass emigration of UK scientists to the United States after World War II (1). The term has evolved to refer to the emigration of highly skilled people from the third world to the first world. Its modern meaning is embodied by the United Nation's definition as a "one way movement of highly skilled individuals from developing countries to developed countries", such that only the host country benefits (2).

There is a shortage of medical health professionals in South Africa such that the country compares poorly to other middle-income countries in terms of doctor to population ratios (3). Additionally many areas have no specialist medical or dental care available (3). Professor Z. van der Spuy, then chair of the Colleges of Medicine of South Africa (CMSA), stated in 2011 that were too few general practitioners and specialists in all medical disciplines with some disciplines being more disadvantaged than others (4). Additionally radiology was identified on the "danger list" of medical specialities (4). South African medical graduates are highly sought after in the international labour market and many first world countries actively recruit them due to their superior training and clinical skills. In the face of the current shortage of South African doctors the concomitant medical

brain drain has the potential to exacerbate this situation. The medical brain drain is also of such global importance that the World Health Organisation has acknowledged this by instituting a global code of practice on the international recruitment of health personnel in 2010 (5). International trade in health services has become so commonplace that in 1995 the World Trade Organisation included it in the General Agreement on Trade in Services (GATS) that regulates international trade.

The South African media have expressed their concern about the general brain drain for decades. Journal and newspaper reports about brain drain escalated by 400% in 1993, the transition year prior to the abolition of Apartheid, compared to lower levels in the early 1990s (6). The number of reports drastically declined in 1994, post abolition and gradually increased over the next 6 years to exceed the highest levels recorded in 1993 (6). This suggests that pre apartheid sentiments are not exclusively responsible for the on-going brain drain.

In 2002 The Citizen newspaper reported that then health minister Tshabalala - Msimang as proclaiming “if there is a single overall threat to our health effort, it is the continued outward migration of key health professionals” (7). Government has instituted various policies to curb emigration or counter its effects (6). A one year medical internship and two years of community service for doctors was implemented in 2001. The hiring of Cuban amongst other foreign doctors and the filling of vacant registrar posts were also employed to this end. Bilateral government agreements to halt brain drain, amnesty programmes offered for returnees and the ’Homecoming Revolution’ are other examples of these initiatives.

These initiatives have not caused a significant brain drain reversal. In January 2014, media reports based on Adcorp's (a human capital management agency) research touted a brain drain reversal, given the number (359 000) of South African expatriates migrating home after the 2008 global financial crisis (8). Hoppli, a critic of Adcorp's data argued that the brain drain, whilst losing momentum, had not reversed. He contended that the 359 000 returning South Africans were not all highly skilled (8). Furthermore, this number was quite a high estimate, given that the total number of South African expatriates was estimated at 758 000 in 2010 (8). The controversy remains, as there is little African research on brain drain. Hence it is not yet possible to accurately gauge if there is a reverse brain drain, let alone the magnitude of or trends in brain drain.

Brain drain is a longstanding and topical dilemma. Despite the nation being pre - occupied with the phenomenon and the continuing media debates, there is a paucity of comprehensive South African research about the driving factors and trends in brain drain. This shortage is particularly evident in the field of healthcare and the medical specialities. To the best of the author's knowledge, only one systematic data review about African health professional migration was published in 2008 (7). Whilst this purely empirical study provided a snapshot of the migration patterns, the research did not address the reasons for emigration, the expatriates' intention to return and modifiable factors in their home countries. The landmark South African Migration Project survey of South African professionals in 2000 addressed these latter factors, however only one other South African study has investigated this with respect to South African doctors (9). The dearth of large scale, comprehensive studies is chiefly due to the lack of systematic databases, universal definitions and metrics for studying healthcare worker migration (10). This

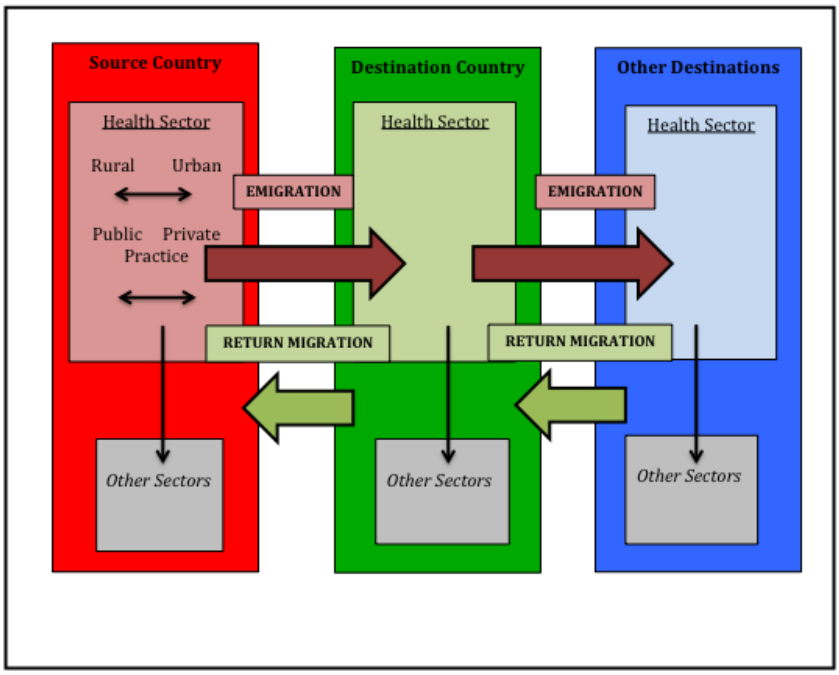
provided a departure point for this study, which sought to investigate the factors involved in the emigration of South African radiologists.

The rest of the introduction details fundamental concepts in migration theory, previous findings in the literature, the problems inherent in the study of medical brain drain and the objectives of the study.

1.1.1 The migration spectrum in healthcare

There are 3 subtypes of migration in the healthcare spectrum, namely internal, international and migration to other industries (10). Figure 1.1, modified from Diallo illustrates the relationships of these migration subtypes (10).

Figure 1.1 Migration subtypes in the healthcare field (10)



Internal migration refers to the movement of personnel within a country (10). In the healthcare field, internal migration occurs between rural and urban settings, public and private practice (10). In South Africa, as in most of the world, the gradient is often from indigent rural areas to wealthier urban areas. This results in an imbalance in healthcare worker numbers and therefore healthcare service quality and provision. A gradient from South African public medical practice to private practice also exists.

International migration refers to workers relocating temporarily or permanently abroad and is primarily due to problems in their native country (10). Emigration in the medical context therefore synonymously indicates the permanent migration of healthcare workers from their home country to a destination country. Whilst some countries voluntarily send their health personnel to foreign countries, the majority lose their

personnel involuntarily to host countries (10). Medical brain drain therefore occurs in the latter setting. The permanent and temporary relocation of healthcare workers abroad, implies a skills loss for the donor country over time. Emigration is of the utmost concern, as it implies a permanent loss of a country's work force and the sequelae thereof. Temporarily working or studying abroad may lead to permanently residing abroad and has the potential to perpetuate brain drain.

The least prevalent migration subtype is migration from the health industry to a non–related industry. This nonetheless results in a deficit in healthcare skills and has been termed "brain waste".

The term brain drain has fallen into disfavour in recent times due to its negative connotations. Its antonyms, "brain gain" and "brain circulation" document the spectrum of migration subsets that include recirculation or migration back to the country of origin. This demonstrates that in a global economy, there is constant economic migration on macrocosmic scales. Which way the scales are tipped remains a controversy and understudied field.

1.1.2 Definitions relating to the medical brain drain

There is no internationally accepted and applied definition for the term emigration; hence it is loosely referred to as the permanent relocation of an individual from their country of origin, to another country for a variable period of time. The International Organisation for Migration characterised emigration as "the act of departing or exiting from one state with

a view to settling in another" (11). The United Nations in 1998 classified this time period as at least more than a year to identify long term migrants (12). More recently, the definition was expanded to a two-year period (13).

With regards to emigrant doctors, the term highly skilled migrant is more applicable. The International Organisation for Migration characterised a skilled migrant as one whose skills or acquired professional knowledge may result in one's preferential selection and entry into a destination country (11). Various definitions are employed however; there is no international consensus on the exact definition of highly skilled migrants. The migrant's highest level of education is commonly used as a proxy. Doctors given their extensive tertiary education, especially for specialists and subspecialists, meet this criterion. Their high level of education is complemented by their specialized skills set and practical experience. Other factors may be desirable in a highly skilled migrant such as language proficiency in the destination country's language and post graduate qualifications that are equivalent to those of the prospective emigrant's destination country.

The lack of global consensus on the definition of brain drain hampers efforts to research it and compare studies on an international level.

1.2 The scope of the medical brain drain

There is a worldwide healthcare worker shortage. The World Health Organisation's World Health Report exemplifies this. In 2006 it highlighted the geographical imbalances of the world's healthcare workers, reproduced as Table 1.1. (14).

Table 1.1 Global healthcare worker numbers and density alongside proportional contributions to worldwide disease burden, healthcare workers and healthcare funding(14)

WHO Region	Healthcare Worker Number (millions)	Healthcare Worker Density (per 1000 population)	Worlwide Disease Burden (%)	Global Healthcare Workers (%)	Global Healthcare Funds (%)
Africa	1.6	2.3	24	3	1
Americas	21.7	24.8	10	37	50
Europe	16.6	18.9	-	-	-
World	59.2	9.3	-	-	-

The Americas accounted for the highest healthcare worker density per 1000 followed by Europe (14). Furthermore the Americas with only a tenth of the world's disease burden had more than a third of the global healthcare workforce (37%) and spent half of the global health funds (14). In stark contrast, Africa was cited as having 3 % of the worldwide healthcare worker pool to service 24% of the world's disease burden with 1% of the global health finances (14). The report concluded that Africa was at the epicentre of the international healthcare worker crisis, in part due to the migration of healthcare workers in the midst of dire healthcare demands (14).

Clemens and Pettersson determined that 65 000 physicians born in Africa were employed in 9 developed countries overseas in 2000 (7). This diaspora accounted for approximately one in five of African born doctors globally (7). Their study also found that the fraction of health professionals from African countries working abroad, varied considerably from 1% to 70%, depending on the country and profession (7). In South Africa's instance, over 20%

of South African born doctors were residing and working abroad in 2000 (7). Thirty seven percent of doctors working in Economic Co-operation and Development (OECD) countries were from South Africa (14).

Hagopian et al showed in 2002 that almost 86% of African physicians practicing in the USA were from 3 out of the 47 Sub Saharan countries: Nigeria, South Africa and Ghana (15). Surprisingly, 79% of these physicians were educated at only 10 of 87 medical schools in the region (15). Further analysis revealed that most of these doctors hailed from the University of Witwatersrand (ranked first out of the 10 Sub Saharan medical schools implicated above), the University of Cape Town (second) and the University of Pretoria (tenth) - all in South Africa (15). Nigeria accounted for 5 of these 10 medical schools whilst Ghana and Ethiopia were represented by one school each (15).

More recent evidence of the number of international medical graduates practicing abroad can be found in the censuses of destination countries. The data from North America and the UK are most useful as the bulk of migrant doctors favour these destinations. According to findings from the 2012 census of actively licensed physicians in the USA, international medical graduates constituted over a fifth (22%) while the majority of the rest (76%) came from a US or Canadian medical school. (16) Medical students from India accounted for the most international medical graduates (23%) (16). No specific mention of the number of African graduates was made, however all medical graduates hailed from 166 different countries, indicating the extent of the medical diaspora (16). Thirteen percent of US radiologists and 8% of radiology residents and fellows were constituted by foreign graduates in 2010 (17).

In 2012 in the UK, the international medical graduate doctors made up the following proportions: Wales (28%), England (26%), Scotland (12%) and Northern Ireland (7%) (18). The overall number of international medical graduates declined from 2007 to 2012 in the UK (18). This was ascribed to stricter immigration laws introduced in 2010, making it more difficult for foreign doctors to obtain work visas or enter into specialist training in the UK (18). Despite the declining numbers, foreign medical graduates still account for over a quarter of the staff in half of the UK countries (18).

Medical specialists such as radiologists are also subject to these trends. There is a shortage of radiologists in some first world regions. Diagnostic and interventional radiologists have been identified on the 2013 long term skills shortage list for New Zealand as an "absolute skills shortage" (19). The 2013 skilled shortage sensible for the UK and Scotland verified a shortage of radiologists in Wales, whereas this was not the case in England at the time (20). In 2010, the UK census of its clinical radiology workforce established that despite increased numbers of radiologists, these numbers did not match the ever increasing work demands (21). Therefore in relatively well-staffed regions, the radiological workload outstrips the available number of radiologists. One can infer that this will be more problematic in countries with a greater shortage of radiologists. An approximate idea of the inequity in the distribution of radiologists in host and donor countries may be garnered from the following statistics: there were 738 clinical radiologists and radiology registrars in 2010 in London alone, compared to an estimated 550 radiologists and registrars recorded on the 2011 RSSA database who were practicing countrywide in South Africa (21). Another measure is to compare the ratio of radiologists

to population. One study, reported a ratio of 1:100 000 for South Africa, compared to an estimated ratio of 1: 50 000 in the USA, Europe and Canada (22).

The general extent of migration of African radiologists is not known. With regards to Kenyan radiologists, a smaller scale of emigration is evident. In March 2014, Dr S. Vinayak, the head of the radiology department of the University of Aga Khan in Nairobi, indicated that there is approximately one radiologist for every 400 000 people in East Africa (23). He also commented that the department's training programme was of such good quality that their handful of graduates would be difficult to retain post qualification, as most relocated for international fellowships (23). Only 25 to 30 radiologists were trained by regional universities in Kenya per annum (23), therefore emigration of their top graduates would adversely affect the radiologist to population ratio, given the small number of specialists graduating per annum.

Global healthcare worker shortages are likely to worsen. The implementation of the Affordable Care Act in the USA is anticipated to assist a further 32 million Americans by 2019, thus increasing the demand for doctors (16). A shortfall of up to 130 000 US doctors by 2025 has been predicted (16). This may also be the case in South Africa when the National Health Insurance Act, which was designed to increase access to healthcare for more South Africans, will increase the demand on a limited supply of doctors. Another aggravating factor is the increasing geriatric population in the first world (16). With regards to healthcare worker shortages, indigent countries will experience the same problems as wealthier countries, if not on a larger scale (14).

In 2013, WHO promulgated universal access to healthcare and described the healthcare worker as a foundational element in the healthcare chain (24). It stands to reason a global shortage of healthcare workers will hamper the attainment of universal access of healthcare to all. This issue is compounded in donor countries and in the developing world with gross geographic inequalities in healthcare worker distribution in the rural versus urban setting. The medical brain drain is one of a host of factors that perpetuate the global imbalance in healthcare worker distribution.

1.3 The effects of brain drain

1.3.1 The negative effects

The traditional debate about the world's highly skilled migrant labour force has been about the negative impact on the donor countries. The economic considerations for donor countries are as follows: decreased economic productivity with a consequent impeded economic growth and a loss of the country's investment in the education of emigrant doctors (25). Mills and colleagues explored the latter factor (26). They calculated that South Africa invested up to $58 000 in subsidising a single doctor's education, with an estimated total loss of $1.38 – 1.44 billion due to medical brain drain (26). The ratio of estimated compounded lost investment over GDP was the highest for Zimbabwe and South Africa in this study of 9 African source countries (26). The UK and USA gained the most benefit from recruitment of doctors from donor countries, estimated at $2,7 billion and $846 million respectively (26). A third consequence is that a source country may not be able to advance technologically due to the loss of its most talented human capital (25). In academia, the medical brain drain may lead to decreased

quality and availability of training and research output. The best physicians tend to emigrate and therefore there is a loss of their clinical and academic intellectual capacity in their home country (27). The same push factors that have been implicated in emigration have been related to a lack of generating research capacity (5).

The impact on the healthcare system and healthcare delivery is substantial given that sub – Saharan Africa is plagued by trauma, TB /HIV/AIDS epidemics and a high mortality rate (22). In South Africa's instance, it has the largest HIV population globally and a high incidence of trauma (22). A deterioration in the quality and availability of general medical care results however the effect is particularly detrimental for the provision of specialized healthcare (28). In the South African national public sector the deficiency of psychiatrists, for example, has resulted in a doctor to patient ratio of 1:70 000. This deficiency has crippled the service in a country where almost 1 in 7 citizens, with a diagnosable psychiatric condition would never be diagnosed or receive specialist care (28). The loss of South African healthcare workers has also resulted in the termination of many health programs and closure of services (28).

The geographical inequity in healthcare worker distribution in rural and urban areas is also exacerbated by brain drain. South Africa has gross inequity in the distribution of healthcare workers in urban and rural environments (28). This is exemplified by the doctor to patient ratio of 180:100 000 in urban provinces, namely Gauteng and the Western Cape while rural South Africa (Eastern Cape and Northern provinces) had a ratio of 21 – 34: 100 000 (28).

In summary, brain drain serves to place already ailing sub–Saharan healthcare systems under further pressure with debilitating consequences.

1.3.2 The positive effects

In some donor countries, like Zimbabwe, remittances from health professionals abroad, contribute significantly to these individuals' family finances (28). When migrant doctors return to their native countries, they enable a cross transfer of skills and ideas. Clemens has proposed a paradigm shift in the traditional outlook on brain drain. He argues that skilled worker shortages in the developing world are not the product of migration but are due to structural causes such as war in the source country (29). His research counter intuitively suggests that emigration from Africa has spurred the production of more African healthcare workers (29).

1.4 Destinations

Several studies have analysed the destination countries of skilled migrant workers (9,13,25,28,30,31). The UK, USA, Australia, Canada and New Zealand have been consistently cited by most of these studies with varying frequencies. An analysis of emigrant South African professionals by destination over 3 decades (1970 – 2000) revealed Europe (45%) as the top destination, followed by Australasia (24%) and North America (10%) (25). Over two thirds of the group that emigrated to Europe chose the United Kingdom, whereas four fifths of those headed for Australasia chose Australia (25). North American destinations were evenly split between the USA and Canada (25).

1.5 Emigration potential

Special mention of the concept of emigration potential should be made in any attempt to study emigration trends. The intent to emigrate does not actually translate into emigration; hence the seriousness of the intent has to be taken into account. This factor has been explored by some authors (13,32). If the potential to emigrate is examined as a spectrum, then the weakest intent would be merely thinking of emigrating whilst the most concrete measure would be to assess actual steps taken towards emigration, such as application for a work permit (32).

The South African Migration Project survey in 2000 determined the emigration potential of South African professionals by stratifying the desire to emigrate and the projected time period abroad (13). Based on the index scores calculated, 6 emigration potential categories (very high -, high -, moderate -, low -, very low - and no potential) were identified (13). This was used this to extrapolate the potential brain drain. They reported in 2000 that 2% of the skilled South African population would be lost if those with high emigration potential were to leave within 5 years (13).

The emigration intent of health professionals can be considered as a measure of the 'first wave' of potential emigration. If healthcare students' intent to emigrate post qualification is assessed, this may give an indication of a 'second wave' of potential emigration. Crush and Pendleton surveyed the emigration intentions of healthcare students in 6 Southern African countries in 2003 - 2004 (32). Their findings compellingly point to a second wave of potential emigration as 60% of the students indicated that they were likely to have

emigrated within 5 years of qualifying and 40% of the students had taken definite steps towards emigration (32).

1.6 Push and pull factors

There are two fundamental concepts in migration theory: push and pull factors. Push factors are intrinsic factors within the emigrant's native country that are unattractive or unacceptable and encourage emigration. Pull factors are extrinsic factors in the destination country which are attractive for the prospective emigrant. Some authors advocate push factors are more important than pull factors for migrating workforces (33).

The WHO identified the following push and pull factors for healthcare workers, summarized in Table 1.2. (34).

Table 1.2 Push and pull factors (34)

Push Factors	Pull Factors
Low pay (absolute/ relative)	Higher pay, opportunities for remittances
Poor working conditions	Better working conditions
Lack of resources to work effectively	Better resourced health systems
Limited career opportunities	Career opportunities
Limited educational opportunities	Provision of post basic education
Impact of HIV/AIDS	Political stability
Unstable or dangerous work environment	Travel opportunities
Economic stability	Opportunities for AID work

A host of push and pull factors have been identified in previous studies in donor countries, including South Africa (2,9,13,27,30,31,33,35). These are concordant with those factors described by the WHO (14,34).

With regards to South African push factors, doctors' general dissatisfaction with their work environment may be instrumental. In the Medical Chronicles Provider Attitude Barometer survey of South African private practitioners in 2012, general practitioners and medical specialists showed a general dissatisfaction with their work (36). Over 45% indicated that that the future of South Africa's healthcare was not bright, that state practices in their area were ineffective in providing access to care (over 40%) and that NHI would be ineffectual in the delivery of healthcare in South Africa (over 50%) (36). Over 40% of South African specialists felt that they were not well paid and over 30% felt that

their discipline did not have a bright future (36). Whilst the survey only encompassed the views of private practitioners, those who work in state practice may share similar sentiments given the more challenging circumstances in which they practice. Less than half of all the general practitioners and specialists surveyed considered always practicing in South Africa (36).

Bezuidenhout et al, found that for South African expatriate doctors the top push factor was crime (75.9%) whilst financial motives (86%) and job opportunities (79.3%) were the top pull factors (9). Bezuidenhout et al also contended that crime and violence had escalated substantially over the six year period since a study by Awases et el (9,31). Awases demonstrated that better salaries (77.5%), a healthier work environment (67.8%), improved fringe benefits (66.4%), a more manageable workload (58.7%), upgraded facilities (57.8%), superior education and training (52.6%) and access to training (51.9%) were the factors considered by the majority of the South African cohort of healthcare workers in a survey of 6 African countries (31). The South African Migration Project survey (2000) when compared to the above findings, illustrates that South African professionals, whether based in healthcare or other industries, were consistently concerned about the same push and pull factors (13). Additionally, South African professionals' perceptions of life abroad, signified that they considered several factors such as personal and family security, standards of service, tax, medical services and their children's' opportunities in the destination country as far better (13).

The push-pull theory does not take into account the effects of globalization as impetus for migration (25). In a global economy, the highly skilled are valuable and many

international opportunities exist for furthering their careers. The healthcare field is no exception. The rapid expansion of the field, advent of telemedicine, competitive salaries/ job environments, the worldwide exportation of specialized health services and the entry of healthcare corporates into international markets may all perpetuate brain drain and the imbalance of healthcare worker distribution (5).

1.8 Radiology in South Africa

In order to understand the potential South African radiological push and pull factors, a discussion of the state of radiological practice is warranted.

In South Africa, radiology generally has a well-established service in urban areas and private practices. As up to 80% of the population is serviced by the public sector with constrained government funding and 20% by the private sector with medical scheme backing, there are inequities in the access to and distribution of radiological practices, staffing and equipment. This geographic and economic disparity is largely a relic of the Apartheid system. Whilst the post-Apartheid era has seen much transformation in these policies, universal access to quality healthcare remains a long term goal for the country.

1.7 The Chris Hani Baragwanath Academic Hospital Radiology Service

The challenges of practicing radiology in the public sector are exemplified by the case of the Chris Hani Baragwanath Academic Hospital (CHBAH) radiology service, a public academic service. It is the third largest hospital in the world, located in Soweto,

Johannesburg, that is responsible for most of the radiology registrar training in the country.

The staffing and equipment for the radiology department in November 2014 is summarised as follows (Hlabangana LT. Chief radiologist CHBAH. Personal communication, 3 November 2014).

The radiology department consisted of 11 full time radiologists and 1 sessional radiologist with 2 permanent staff members on extended leave. About 50% of the consultant posts were vacant. Over 6% of the full time radiologists had less than 4 years post qualification experience. The head of department post was vacant for 9 months and was filled in June 2014. There were 20 radiology registrars and 5 newly appointed medical officers. The radiographer component consisted of 63 radiographers and 41 radiography students. (Msibi BN. Radiographer CHBAH. Personal communication. 10 November 2014.) The average number of studies conducted in the department over a three month period was as follows: 2472 CTs, 381 MRIs, 11187 general radiographs, 4126 portable radiographs, 2589 ultrasounds (averaged over 2 months), 300 angiograms, 565 mammograms, 241 fluoroscopy and 390 interventional radiology cases. (Tsoeu N. Director of radiography CHBAH. Personal communication, 3 November 2014.)

Due to the shortage of radiology consultants, reporting of radiographs is only done when requested by clinicians. The amount of reporting requested by clinicians is negligible compared to the volume of radiographs taken. As radiographs account for the bulk of the departments' work, 35 - 71% of the total volume of all the radiological studies done are unreported on a daily basis.

The department building and infrastructure was upgraded in 2011. A PACS system was implemented in late 2012. Almost 2 years down the line, the PACS is not fully utilized with protracted down time due to a host of issues including regular power failures. The department has 2 CT scanners (64 and 128 slice) and although these are relatively new machines there is considerable down time (sometimes up to 4 months for one CT machine) due to after sales service and contractual issues that are commonly experienced by the public sector. (Tsoeu N. Director of radiography CHBAH. Personal communication. 10 November 2014.) The volume of CT scans is large and 48% of the scanning and reporting being accomplished by a single radiographer and registrar on call. There is a 9-year-old 1.5 T MRI unit which cannot cater for the hospital's enormous imaging needs. There is therefore a waiting list of at least 9 months for outpatients and 6 months for inpatients. (Tsoeu N. Director radiography CHBAH. Personal communication. 10 November 2014.) The rest of the department's equipment has fewer technical issues and therefore shorter waiting times for these units. There are 9 portable radiographic units, 6 C-arm units, 9 radiography units (3 computed radiography, 6 digital units, 1 Panelipse unit) and 9 ultrasound machines. (Msibi BN. Radiographer CHBAH. Personal communication, 10 November 2014.) There is limited access to Internet facilities and no separate computer room for research or study purposes.

All of these factors make the practice of radiology in a tertiary (academic) hospital an extremely challenging exercise. This results in a host of adverse outcomes: for patients and clinicians due to the long waiting times and lack of reporting of radiographs, for registrars as this impacts on the quality of their training and for radiologists who are predominantly junior, under staffed and in some circumstances not skilled enough to deal

with the demands of the ever increasing service.

The challenges outlined in the case study have been previously explored by Rabinowitz and Pretorius in 2004. Their census of a Ghanaian and two South African radiology post graduate training programmes revealed difficulties in obtaining and maintaining equipment, a decreased volume of studies for registrars and an insurmountable clinical workload for consultants compared to American faculties (37). Prior to 2004 there was a scarcity of MRI units, multislice CT scanners and PACS in parts of the public service. Whilst there was improvement in the rollout of PACS, multislice CT scanners, the installation of MRI machines and changes to the training curriculum over time, problems with purchasing and maintaining equipment and staff retention are still prevalent when CHBAH is compared to this study. No local fellowships were available in South Africa in 2004 (37), and 9 years later [2013] only 4 radiologists affiliated to the RSSA were undertaking a national fellowship. The high patient burden (compared to American faculties), coupled with teaching commitments results in an unreasonable workload for public sector radiologists. Public radiological services have to compete with private practice and international opportunities for radiologists (37). It was also found that South African radiology registrars had decreased exposure to nuclear medicine and that the enormous consultant workload adversely affected didactic and clinical teaching and also resulted in reduced clinical supervision (37). Whilst the HPCSA recommends a faculty to registrar ratio of 1: 4 (the case study indicates ratios beyond this), the ratio does not take into account the magnitude of the clinical service that radiologists have to provide simultaneously with their teaching and supervision responsibilities. Decreased exposure

to cross sectional imaging, mammography and interventional radiology training were evident (37).

South African staffing is the best in the sub – Saharan African continent. In 2011, there were 497 radiologists and 685 radiographers (22). Allied staff such as medical physicists are not widely available whereas information technologists and application specialists are more readily available.

The discipline is supported by the active participation of the Radiological Society of South Africa, and SORSA (The Society of Radiographers of South Africa), as well by the College of Radiologists, the country's independent examining authority (22). There are 8 radiology graduate programmes (22). There are few opportunities for national subspecialty training, currently offered in the fields of paediatric radiology, interventional radiology and MRI. Most post graduate education within the country is by means of the RSSA's continuing medical education programme (local congresses with international faculties and webinars).

Whilst South Africa boasts imaging equipment that is more modern and accessible than most of sub – Saharan Africa, there are discrepancies when compared to destination countries. Kabongo et al in their analysis of licenced diagnostic imaging equipment in South Africa found that South Africa's specialized radiological resources are closest to the UK and Chile, however the country's total imaging capacity is less than that of OECD countries (38). They demonstrated that radiography units were evenly distributed and accessible (34.8 units per million population) whilst a ten-fold discrepancy between the

best and worst resourced provinces for the majority of imaging modalities (fluoroscopy, mammography, CT and MRI) existed (38).

1.8 Teleradiology

Teleradiology refers to the acquisition of radiological images at a site with the electronic transfer of these images for remote viewing or consultation at another site (39). It is a sub application of telemedicine which broadly refers to the electronic provision of various medical services over distances (39).

The 1980s saw the advent of commercial teleradiology units (39). In the last decade, teleradiology has become more accessible and user friendly due to the use of cheaper communication technologies (Internet), inexpensive computers with higher processing capability, data compression and widespread use of PACS (Picture Archiving and Communication Systems) (39). Teleradiology accounts for 33% of global telemedicine and therefore has the highest rate of provision from all the telemedicine sub disciplines (40). It has been widely employed in the South African private sector for many years, for example to assist after hours reporting of multiple sites' workload by a single radiologist. No national teleradiology service in the public sector has been established since feasibility studies conducted in 2000. Teleradiology makes a significant contribution to the roll out of radiological services remotely in many countries such as private afterhours reporting services in the USA nicknamed 'Nighthawks' (41). It is anticipated that daytime teleradiological services will become more common practice, after the success of on call teleradiological coverage.

Teleradiology has the following advantages: provision of a specialized medical service to various regions despite diverse geographic locations, a single radiologist may report for more than one site without needing to travel from home to any of the sites.
Disadvantages include the initial setup and maintenance costs, each radiologist requires the appropriate software setup, and other technical factors related to the roll out of the service.

Teleradiology in the context of emigration may provide an alternative or a reason to stay in one's native country. A case in point is that of the buddy system employed by Stanford University for residents to report paediatric radiology studies from the developing world under consultant supervision. This ensured the provision of a paediatric radiological service in a developing environment with no prior access to such a service and a chance for residents training in a first world setup to gain exposure to third world pathology (42). A similar model can be implemented in South Africa in affiliation with international sites to promote post graduate training, including sub speciality training which is not currently widely available in South Africa and work opportunities to gain international experience whilst continuing to practice in the home country.
Russia's role out of a national teleradiology network serves as a model for South Africa. Russia consists of a large landmass with 11 time zones and teleradiology networks have started to make these services more accessible for the Federation (43). This is encouraging for South African practice as a teleradiology network may help to level the geographic inequalities in healthcare.

In the South African setting, teleradiology has many benefits. One radiologist may provide a service for multiple sites where a full time service is not required (39). Furthermore a radiologist with subspecialty expertise may provide a dedicated service for multiple sites from a single location (39). If this model is applied in the South African context, it can alleviate the general shortage of specialized medical services particularly in rural areas, obviating the need for patients to travel vast distances to an urban centre for the appropriate specialist care. Radiology has the ability to triage which patients need referral to other disciplines and the timing of these referrals. This ensures the most efficient utilization of limited specialized services and the timeous management of complex cases. In academia, specialist and sub speciality expertise can be provided remotely to various sites and this may assist not only with the reporting of studies but off site teaching and supervision. The exception to this would be interventional radiology as a radiologist is currently required to perform procedures on site. A second opinion for an interventional case may however be obtained via teleradiology. Teleradiology also has a role in double reading of complex cases, peer review, quality assurance of services and in the collection of clinical trial data for research (39). No studies have been published regarding the potential mitigating effect of teleradiology on brain drain in international and local settings.

1.9 Problems inherent in the study of the migrating medical work force

The empiric evidence for brain drain is weak or non - existent for two major reasons (10). The first is the lack of universal terminology for definitions such as 'emigration', 'highly skilled migrant', 'healthcare workers'(10). The second is the lack of comprehensive

comparable data sets (10). Migration data is often incomplete and inconsistent for various countries and is collected at different time frames, all of which confound comparative analysis (25,28). This is in part due to different data collection tools, and diverse potential data sources (28). Whilst immigration data is readily available and generally of good quality, the same does not apply to a country's emigration statistics. South Africa is a case in point. The reliance of emigrants voluntarily disclosing their intentions at one of three international South African airports on exit, results in an underestimate of emigration. The undercount of South African emigration statistics (Stats SA) has been gauged as 3 times less than receiving country data in Meyer, Brown and Kaplan's 2000 publication (25). Therefore a donor country's emigration statistics may only give an indication of trends but is not an absolute count (25). To compound matters, the Immigration Act of 2002, stipulated that data from South African self-declared emigrants would cease to be collected as of February 2004 (44). Therefore no data for stock flow analysis is available since 2004. Data obtained from professional registries is also often incomplete. The HPCSA, Department of Health, CMSA and RSSA do not have comprehensive statistics about the numbers of health professionals in active practice in South Africa or abroad (3). The RSSA database of radiologists does not make the distinction of how many South African radiologists are practicing abroad, therefore this number is unknown. Similar difficulties in accounting for South African graduates practicing internationally may be encountered by the HPCSA due to dual registrations.

Investigation into the causes for migration is not an easy task, as both qualitative and quantitative methods should be employed to assess the perceptions and motivations of

health professionals (10). The study of migrational work forces is in fact an imprecise science given all the above reasons (13).

1.10 A critique of the literature

A PubMed search using the key terms 'doctor', 'physician', 'migration', 'emigration' and 'brain drain' was performed. Few studies were found, two African, two South African and four international studies. This was augmented with a search of policy documents, working papers and grey literature employing Google. More has been written in policies and working papers than in journal publications as governments attempt to understand the complex interplay of factors affecting brain drain, to inform their policy making.

Overall there is a dearth of comprehensive comparable studies with regards to medical brain drain. Historically, stock flow studies of skilled migrants in South Africa relied on statistics collected by Stats SA. Analysis of this data for the emigration of South African professionals from 1970 to 2000 reveals general trends for South African skilled migrants (25). The emigration of South African professionals has occurred throughout the pre - and post-Apartheid eras with a consistent net overall emigration since 1994 (commencement of democratic period post abolition of Apartheid)(25). Whilst the data indicates a net outflow of professionals over 3 decades, the type of professionals emigrating was not recorded (25). Therefore no analysis of the types of skills lost can be performed.

The landmark publications on the migration of African health professionals by Clemens et al in 2008 and the South African Migration Project survey of South African professionals in

2000 are the only large scale systematic studies published to date (7,13). In the absence of further large scale systematic stock flow studies the trend in South African medical migration since 2000 remains undetermined. With regards to the push and pull factors for South African doctors, Bezuidenhout et al were the only authors who explored these factors for South African doctors (9). Due to the study being conducted on expatriates, emigration potential is not applicable and therefore could not be explored. Hence the magnitude of the potential brain drain could not be assessed. No South African specialists, including radiologists have been surveyed regarding their potential to emigrate and the reasons for it.

1.11 Study Aims

This study aimed to determine the profile and percentage of South African radiologists who have intentions of emigrating and their reasons for doing so.

1.11.1 Study objectives

The study objectives were to:

1. Determine the profile of surveyed South African radiologists (gender, age group, number of years of practice, sub – speciality and place of practice).
2. Determine the percentage of South African radiologists intending to emigrate and their destination country.
3. Determine the percentage of radiologists who intend to return to South Africa.
4. Determine and analyse the reasons for possible emigration.
5. Determine the role of teleradiology as an alternative to emigration.

6. Determine which factors, would encourage resident radiologists to continue practising in South Africa.

2. Materials and Methods

2.1. Study population

The study population was defined as South African radiologists or registrars registered with the HPCSA for the speciality of Radiology, who were practicing in South Africa at the time. Based on the RSSA member database, the population size was 550, including radiologists and registrars.

2.2 Inclusion criteria

Radiologists and registrars registered for the practice of radiology by the Health Professions Council of South Africa and in practice in South Africa at the time of the survey were included.

2.3 Exclusion criteria

Retired radiologists and radiologists practicing in other countries were excluded. Supernumerary registrars were also excluded, as they would return to their country of origin post qualification.

2.4 Sample size

Survey data is mainly based on the reporting of proportions; therefore the sample size calculation was based on the estimation of a 50% proportion (worst case scenario), 5% precision, 95% confidence interval and a finite population size of 550.

The estimated population size was 227. To obtain a response rate of 50%, the survey would have to be administered to twice the estimated population size (454 respondents). Since this approximated the population size (550), all of the potential respondents were invited to participate.

2.5. Response rate

The survey response rate was calculated as the percentage of number of respondents from the population size. The response rate was used to infer the generalizability of the study findings.

2.6 Non – response rate

The non – response rate gives an indication of bias and was calculated as the percentage of the number of participants who did not respond to a question from the total number of participants.

2.7 Survey design

In the absence of previous surveys of medical specialists or radiologists about emigration, the researcher designed a questionnaire. The questionnaire is reproduced in Appendix B. General factors such as demographics and some push and pull factors were used as cited

in the literature. No pilot study was done. The thirteen-question survey was refined based on input from the supervisor and the University of Witwatersrand Protocol Assessment Committee. The reliability and validity of the questionnaire was not determined. Skip logic was not employed, however applicable questions had 'opt out' components e.g. "have not considered emigration". Single answers were allowed for most questions; multiple answers for a few questions and open-ended responses were catered for under the option "other".

The rationale for the questionnaire format and content follows. The respondent demographic profile including gender, age group, years of practice, sub – speciality and place of practice were elicited in questions one to five respectively.
Emigration potential was assessed in question six. The top possible emigration destination was ascertained in question seven, based on destinations identified in the literature review. Question eight enquired about the likelihood of the respondent's return to South African practice post emigration. Question nine evaluated work related push and pull factors. Work factors peculiar to the radiology fraternity as well as general medical work factors detailed in Bezuidenhout's survey were included (9). Personal, social and economic related push and pull factors were detailed in question ten. Questions eleven and twelve explored the role of teleradiology in the context of emigration. Respondents were asked if they had considered teleradiology as a means for postgraduate study or work opportunities in question eleven. Question twelve evaluated if teleradiology was a viable alternative to emigration. Potentially modifiable push factors were assessed in question thirteen.

2.8 Ethical considerations

The study was approved by the Medical Human Research Ethics Committee of the University of Witwatersrand [Clearance certificate M110967, Appendix A]. For both the paper and e-mail based surveys prospective participants were given an introductory letter outlining the scope of the study and ethical considerations, illustrated in Appendices C and D respectively. Informed consent was assumed after participants read the introductory letter and then completed the survey. It was emphasized that participation was voluntary, all data was anonymously and securely collected. Additionally the participant could stop completing the questionnaire at any point. Participants were allowed to answer any or all questions due to the sensitive nature of the enquiry.

2.9 Survey administration

The survey consisted of a paper-based and an electronic version of the questionnaire. The paper-based questionnaire was distributed in the registration packs of delegates (RSSA members and non – members) attending a RSSA congress in Johannesburg in August of 2011. An introductory letter prefaced each questionnaire. The congress chair advertised the survey by making announcements throughout the congress.

Once participants had completed their questionnaire they posted their copies into a collection box in the demonstration hall, ensuring anonymity.

The electronic survey was executed on an online platform using SurveyMonkey, a web based survey company. This component of the survey was promoted by an introductory e – mail distributed by the RSSA secretariat to its member database and was conducted from 1 – 17 February 2012. The RSSA secretariat sent reminder e-mails to all prospective

participants 10 days after the initial invitation. Participants could access the questionnaire by clicking on the embedded link in the email invitation and then complete the questionnaire on the SurveyMonkey webpage. After the completion of these two legs of the survey, sampling was supplemented by paper surveys being distributed to radiologists and registrars known to the researcher or supervisor. Therefore, bimodal sampling, promotion of the survey and multiple sampling attempts were made in order to augment the overall expected low response rate for research of this nature.

The researcher was blinded to the respondent's identities, as the e-mail survey was conducted via a link. Participants' e-mail addresses were not recorded, as they only had to click on the link to access the survey. The RSSA did not make its database contact details available to the researcher and instead, the invitation letter and link, as well as the reminder were emailed on behalf of the researcher by the RSSA. Similarly, the paper questionnaire did not have any identifying data other than general demographic data. These measures ensured complete anonymity of the responses.

2.10 Data collection

SurveyMonkey provided a real time analysis of the online survey. After the closure of the online survey, the researcher manually entered the paper survey results into the SurveyMonkey database. The combined results were exported as an Excel spread sheet. Data cleaning and coding was done by the researcher.

2.11 Statistical analysis

The data analysis was performed using SAS, version 9.3 for Windows.

The 5% significance level was used throughout, unless specified otherwise.

The X^2 test was used to assess the relationships between categorical variables. Fisher's exact test was used for 2 x 2 tables or where the requirements for the X^2 test could not be met.

The strength of the associations was measured by Cramer's V and the phi coefficient respectively. For Cramer's V and the phi coefficient, the following scale of interpretation was used:

0.50 and above	high/strong association
0.30 to 0.49	moderate association
0.10 to 0.29	weak association
below 0.10	little if any association

The intent to emigrate was cross tabulated with the demographic data to elicit a profile of potential emigrant radiologists. Similar cross tabulations were performed to assess the intent to emigrate and destination country, likelihood of return, push and pull factors, teleradiology as an alternative to emigration and possible modifiable push factors.

The results are presented as tabulated or illustrated frequencies or percentages for categorical variables. A thematic analysis of the open-ended component of question thirteen was included.

3. Results

3.1 Quality measures of the survey

3.1.1 Response rate

One hundred and ninety two questionnaires were completed for both the paper and electronic surveys. Two paper survey responses did not meet the inclusion criteria (from a South African radiologist practicing abroad and a radiographer) therefore they were not considered further. The overall survey response rate was therefore 35% (190 respondents from a sample size of 550).

3.1.2 Non response rate

The non - response rate was less than 5% for all questions except question 6 concerning the prospective destination countries for emigrants (non – response rate of 6%) and question 7 regarding the likelihood of returning to SA post emigration (non – response rate of 8.9%).

3.2 Demographics of the sample

3.2.1 Gender

The proportion of female and male respondents is detailed in Table 3.1. There was a preponderance of male respondents (63%) whilst 2% declined to indicate their gender.

Table 3.1 Gender profile of respondents

Variable	Category	Overall (n=190)	
		N	%
Sex	Female	67	35.3
	Male	120	63.2
	No response	3	1.6

3.2.2 Age

The age profile of respondents is summarised in Table 3.2 below. The majority of respondents were aged between 39 and 49 years. The non – response rate was 1%.

Table 3.2 Age profile of respondents

Variable	Category	Overall (n=190)	
		N	%
Age	20-29y	10	5.3
	30-39y	81	42.6
	40-49y	46	24.2
	50-59y	35	18.4
	60-69y	15	7.9
	70y+	1	0.5
	No response	2	1.1

3.2.3 Years of practice

An analysis of the number of years in practice for respondents is listed in Table 3.3. The responses were fairly evenly distributed across the categories (except for < 1 year). Registrars and junior radiologists with up to 5 years experience accounted for almost half of the sample. The non - response rate was 3%.

Table 3.3 Number of years in practice

Variable	Category	Overall (n=190)	
		N	%
Years of practice	Registrar	50	26.3
	< 1y	6	3.2
	1-5y	38	20.0
	6-10y	21	11.1
	11-15y	25	13.2
	16-20y	15	7.9
	> 20y	30	15.8
	No response	5	2.6

3.2.4 Subspecialities

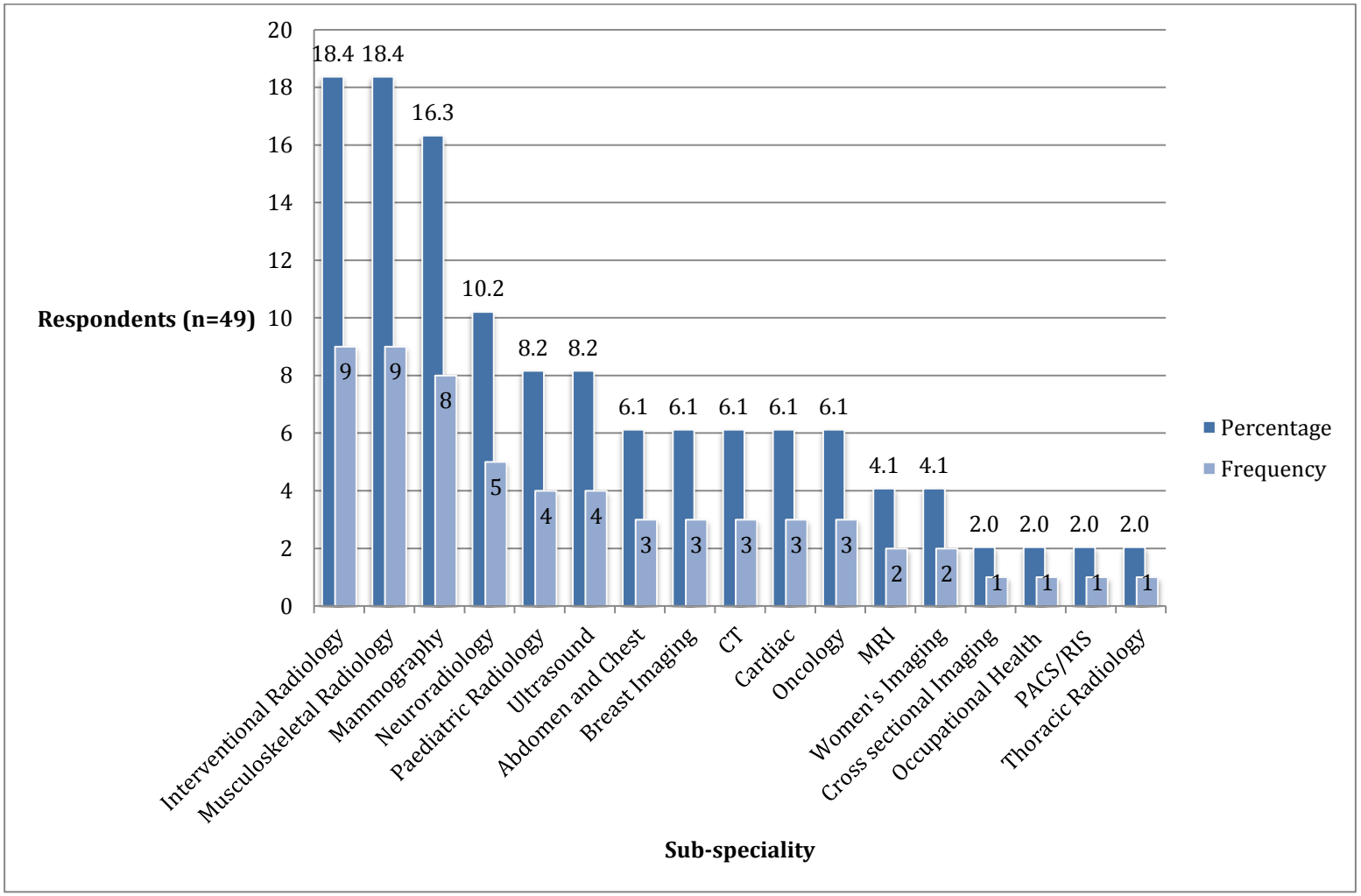
The prevalence of subspecialities is summarised in Table 3.4. A quarter of the participants had sub - speciality experience or qualifications and 4 % did not answer the question.

Table 3.4 Number of respondents with one or more subspecialities

Variable	Category	Overall (n=190)	
		N	%
Sub-speciality	Yes	49	25.8
	No	134	70.5
	No response	7	3.7

A further analysis of the different subspecialities is illustrated in Figure 3.1. Note that the percentages do not sum to 100% as some respondents selected more than one option. Interventional radiology, musculoskeletal radiology and mammography were the most popular subspecialities.

1 Figure 3.1 Proportions of respondents with one or more sub – specialities



2

3.2.5 Current place of work

The frequencies and percentages of the respondents' current place of work are detailed in Table 3.5. Respondents were fairly evenly split between public and private practice, with 13% serving in both. Two participants elected not to answer the question (non - response rate = 1%).

Table 3.5 Current work sector frequency distribution

Variable	Category	Overall (n=190)	
		N	%
Current place of practice	Public	86	45.3
	Private	78	41.1
	Both	24	12.6
	No response	2	1.1

3.3 Emigration potential

3.3.1 Intent to emigrate

The majority of respondents answered the question as a single best answer as intended, however six respondents chose two options as follows:

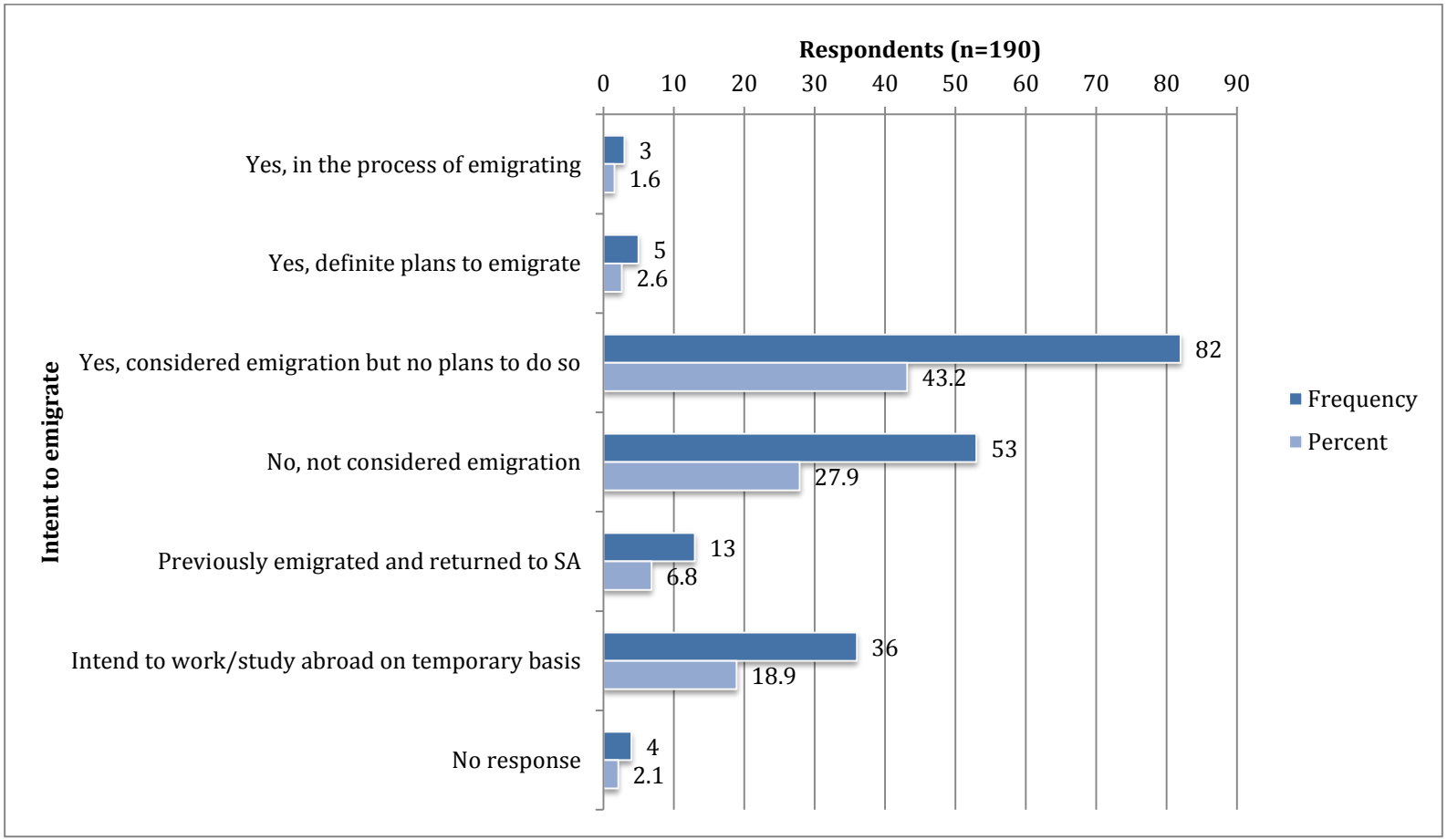
1. 'Previously emigrated and returned to SA' and 'Yes, considered emigration but no plans to do so' (1 respondent)
2. 'No, not considered emigration' and 'Intend to work/ study abroad on a temporary basis' (2 respondents)
3. 'Yes, considered emigration but no plans to do so' and 'Intend to work / study abroad on a temporary basis' (3 respondents)

The dual responses were recoded to facilitate analysis. Subset 1 was coded as 'previously emigrated and returned to SA'. Subsets 2 and 3 were coded as 'Intend to work and study

abroad on a temporary basis '. Analysis based on this regrouping yielded 123 respondents with varying intent to emigrate out of 190 respondents.

The non –response rate was 2 % (4/190). Frequencies and percentages for intention to emigrate determined for the 190 responses are depicted in Figure 3.2.

Figure 3.2 Proportion of respondents with intention to emigrate



Note that all the percentages do not sum to 100% due to multiple answers given by some respondents.

Only 4% of the respondents were in the process of / had definite plans to emigrate and a further 43% had considered emigration but had no plans to do so. Radiologists who considered temporarily working or studying abroad represented 19% of the sample. Thus 67 % of radiologists had considered emigration with varying intent to emigrate or were willing to study or work abroad temporarily which corresponds to a high emigration potential group. Only 28% had not considered emigration. Respondents who had previously emigrated and subsequently returned to SA accounted for 7%.

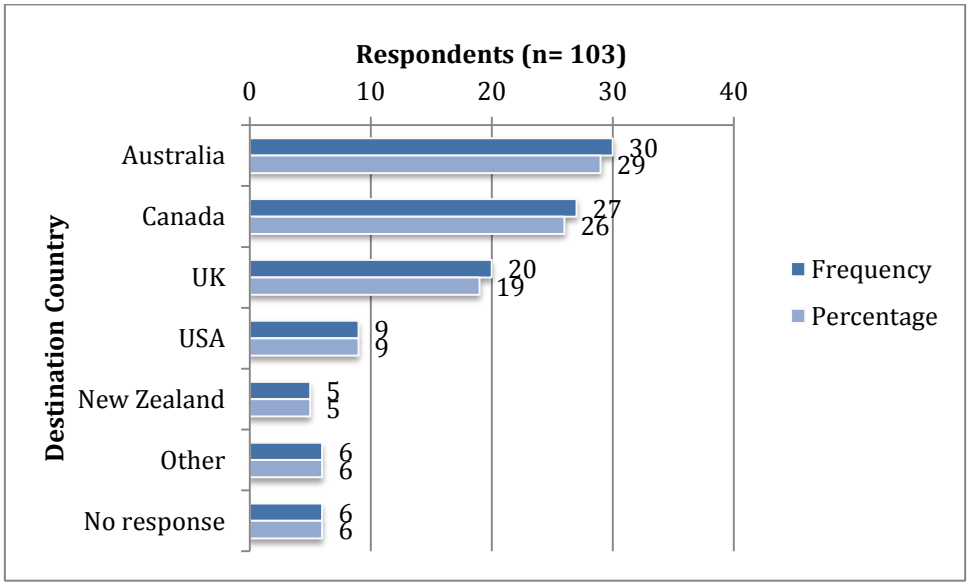
3.3.2 Profile of potential emigrant radiologists

There was no significant association between the participants' demographic factors and the consideration of emigration. Therefore, no profile of prospective emigrants could be elucidated from the data.

3.3.3 Destination country of choice

The prospective destination countries of those who expressed varying intent to emigrate were analysed as follows. Twenty of the 123 participants with varying emigration intent selected " Not applicable, as I do not want to emigrate" and contradicted their previous answer to question 6 (intention to emigrate). Their responses were therefore excluded from the analysis. The proportions of the selected destination countries for the remaining 103 participants with varying intent to emigrate are illustrated in Figure 3.3. The non – response rate was 6%.

Figure 3.3 Prospective destination countries for radiologists who had considered emigration

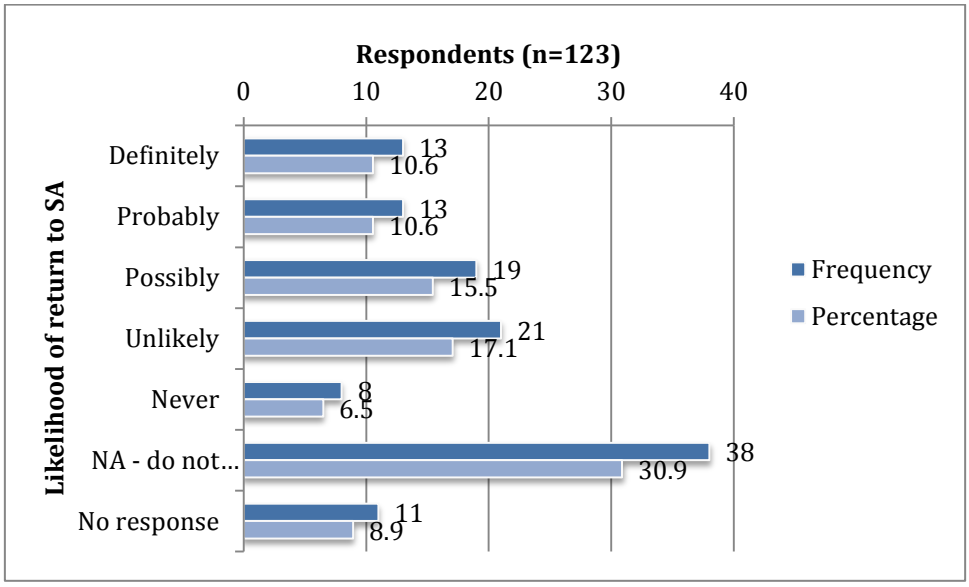


Australia and Canada were the most popular destinations. There was no significant association between the different destinations and sex, age, years of practice or place of practice.

3.3.4 Likelihood of return to South Africa

The 123 participants who considered emigration, had various plans to return to South Africa post emigration, as illustrated in Figure 3.4. The non- response rate was 9%.

Figure 3.4 Proportion of radiologists likely to return

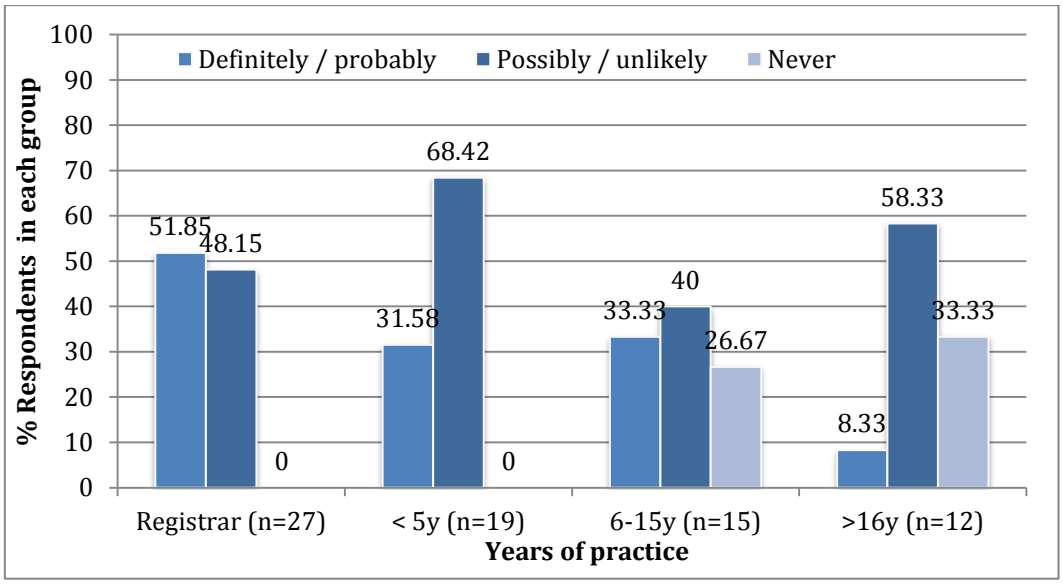


Thirty-one percent of respondents regarded the question as 'not applicable', which contradicted their response to question six (intention to emigrate).

Further cross tabulation of the subgroups with varying intent to emigrate yielded the following associations:

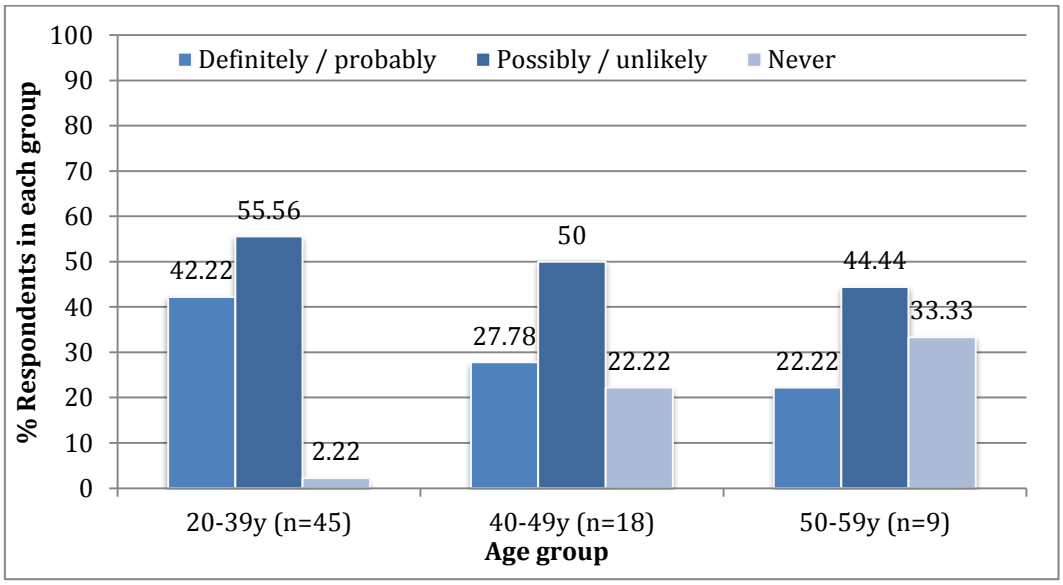
There was a significant, strong, association between the likelihood of return and years of practice (p=0.0021; phi coefficient=0.52). As shown in Figure 3.5, the likelihood of return decreased with increasing number of years of practice

Figure 3.5 Relationship between the likelihood of return and number of years in practice



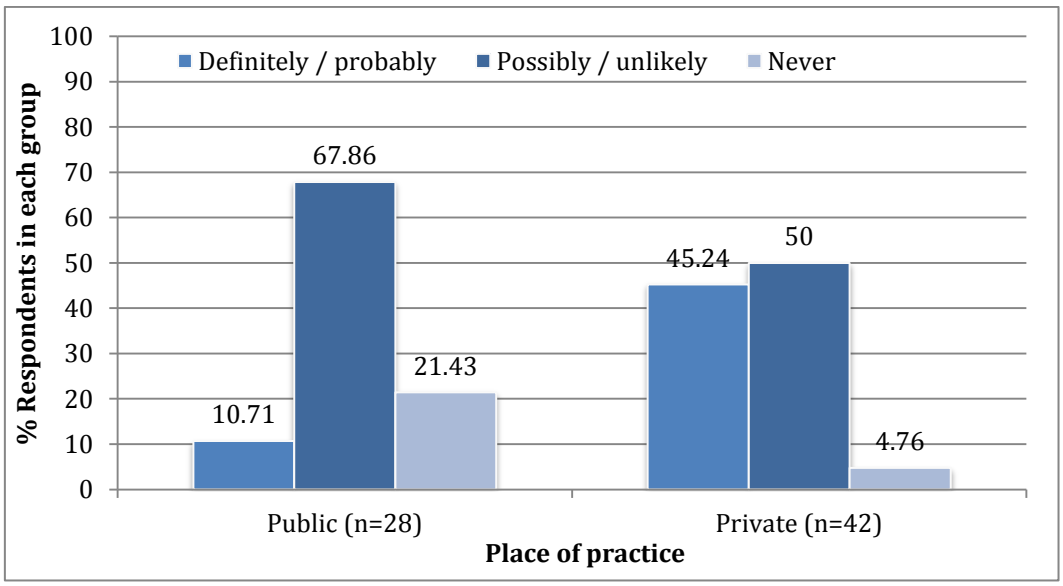
A significant, moderate, association between the likelihood of return and age (p=0.023; phi coefficient=0.39) was identified. The 60y+ age category (n=2) was excluded from this analysis. Figure 3.6 shows the relationship between respondents' ages and the likelihood of returning to SA. As illustrated, the likelihood of return decreased with increasing age.

Figure 3.6 Relationship between likelihood to return and age



Additionally, there was a significant, moderate, association between the likelihood of return and place of practice (p=0.0025; phi coefficient=0.40). The 'both' category (n=4) was excluded from this analysis. Figure 3.7 shows the correlation between the likelihood of return and respondents' place of practice with the likelihood of return being lower for those in public practice.

Figure 3.7 Relationship between likelihood of return and place of practice

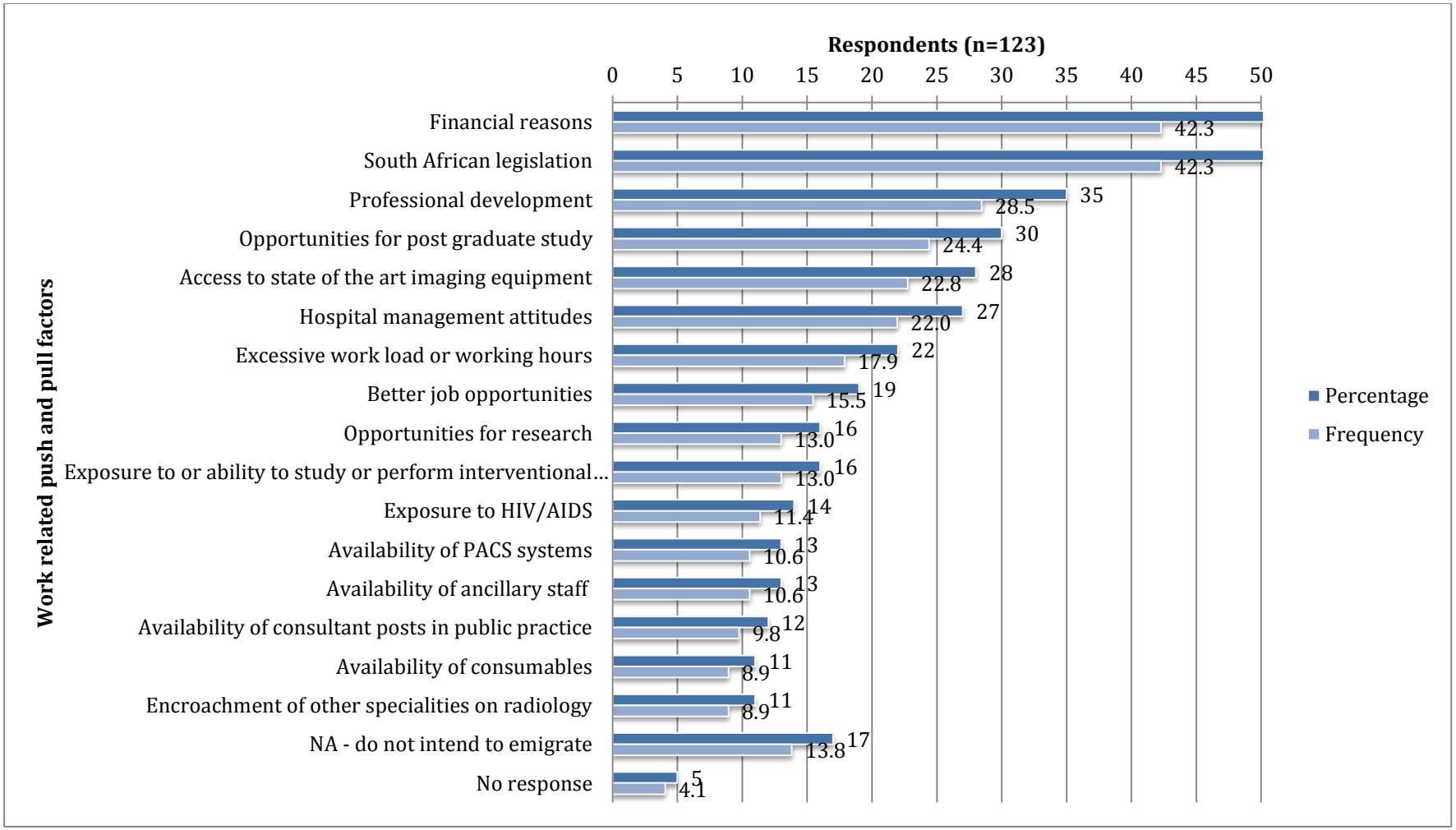


3.4 Reasons for emigrating (push and pull factors)

3.4.1 Work related push and pull factors

The participants who had varying intent to emigrate (123) cited the following work related push and pull factors illustrated in Figure 3.8.

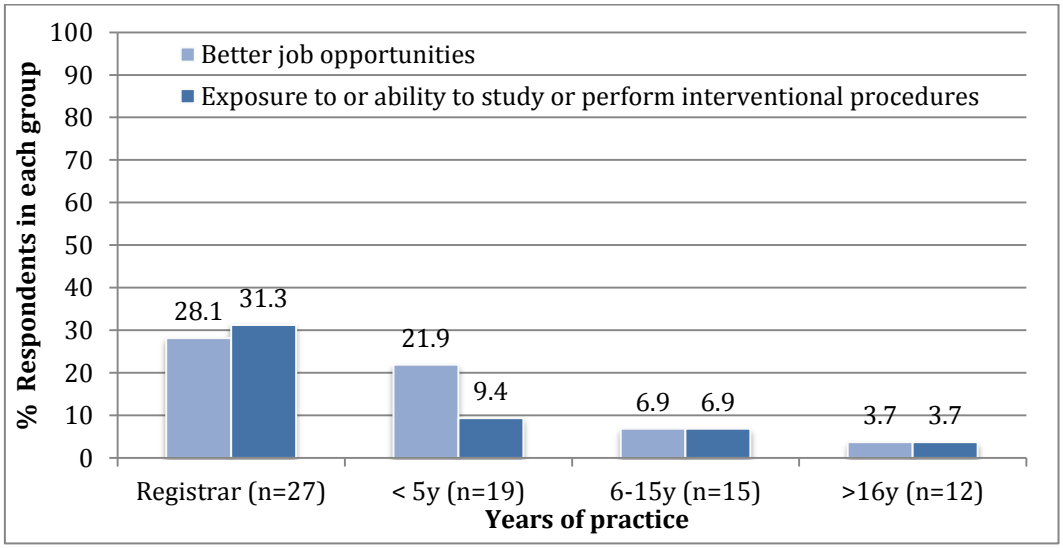
Figure 3.8 Work related push and pull factors for those with varying intent to emigrate



Note that percentages do not sum to 100% since some respondents selected more than one factor. The major factors were financial and legislative (both 42%).

There was no significant association between any of these factors and sex, or age. There were however significant associations between years of practice and better job opportunities (p=0.043; phi coefficient=0.28), and access to interventional procedures (p=0.022; phi coefficient=0.33). The following graph (Figure 3.9) shows that the proportion of respondents who selected this factor decreased as years in practice increased.

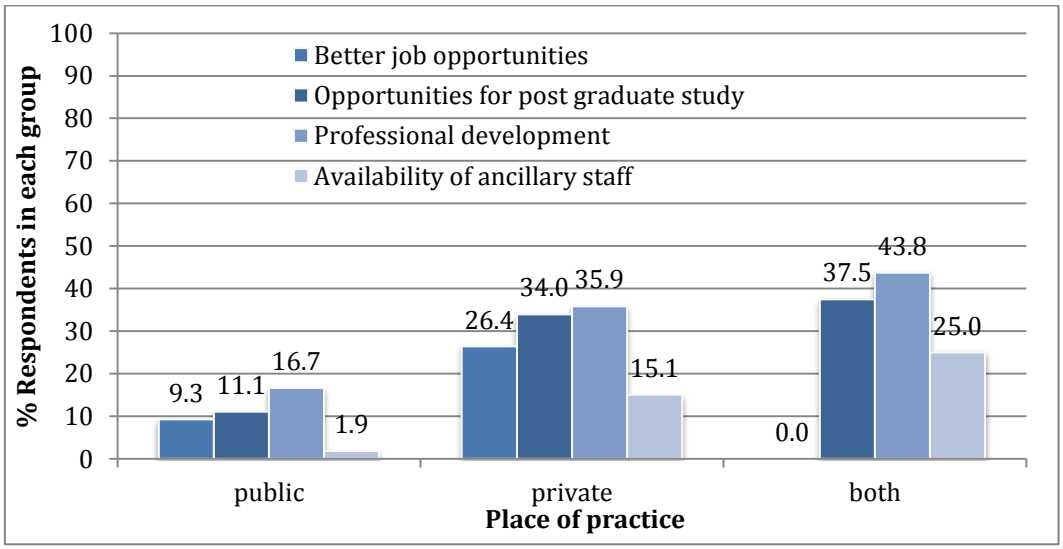
Figure 3.9 Association between job opportunities, interventional radiology exposure and years of practice



Significant associations between place of practice and better job opportunities (p=0.0090; phi coefficient=0.28), opportunities for postgraduate study (p=0.0057; phi coefficient=0.27), professional development (p=0.027; phi coefficient=0.24), and

availability of ancillary staff (p=0.0054; phi coefficient=0.27) were found. Figure 3.10 shows the proportion of respondents who selected these factors was higher for those in private practice compared to those in public practice.

Figure 3.10 Associations between some work related factors and place of practice*

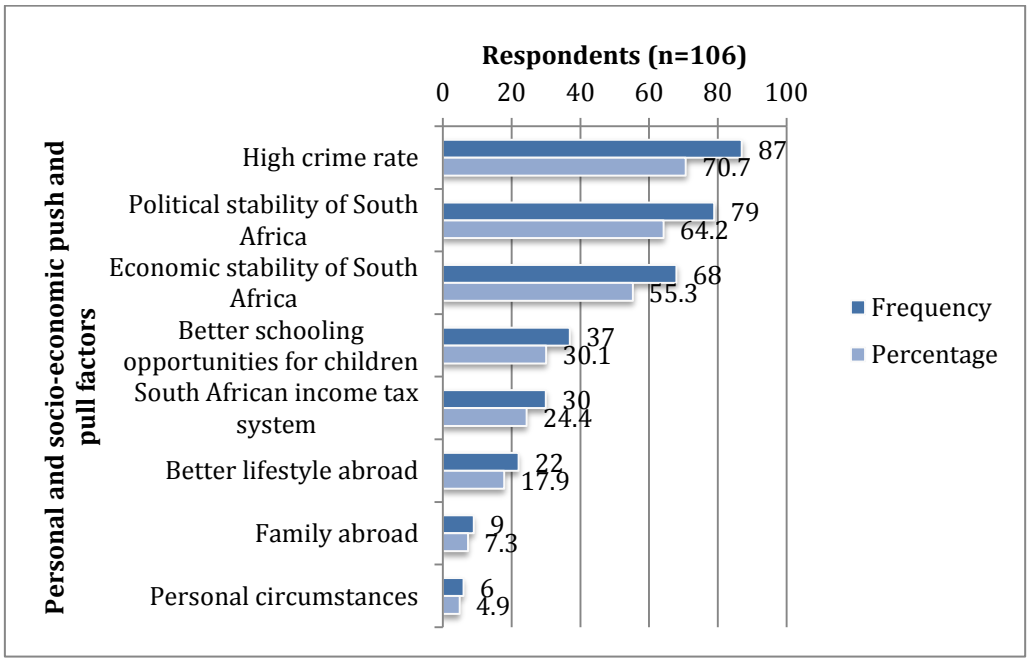


*Note that the number of participants in the private practice sub group was 53, 54 in public practice and 16 respondents in both private and public practice.

3.4.2 Personal, social and economic push and pull factors

Cross tabulation of the responses from participants who expressed various intent to emigrate, [excluding the non – responders (4/123, 3%) and those with no intention to emigrate (13/123)] and non – work related push and pull factors, yielded the following frequencies and percentages for the remaining 106 respondents illustrated in Figure 3.11.

Figure 3.11 Personal, social and economic factors for prospective emigrant radiologists



Note that percentages do not sum to 100% since some respondents selected more than one factor. The dominant factors were crime rate (71%), political (64%) and economic stability (54%).

There was no significant association between any of these factors and age, years of practice or place of practice. There were significant associations between sex and political stability (p=0.031; phi coefficient=0.21). The proportion of respondents who selected this factor was higher for males (72%) than females (51%).

3.5 The role of teleradiology in emigration

3.5.1 Teleradiology as a means for postgraduate study or work opportunities

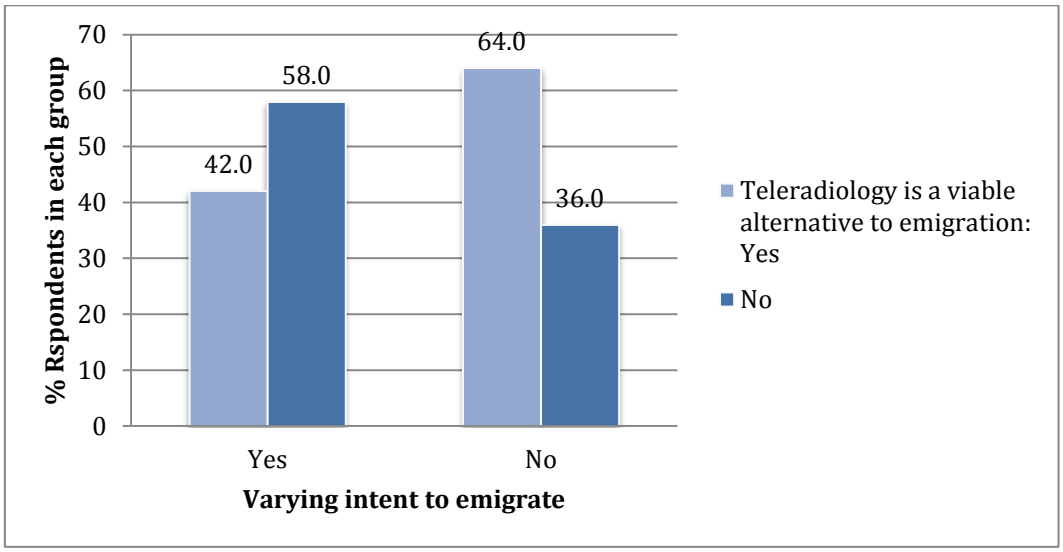
Seventy five percent of the respondents (142/190) had considered this option (2% did not answer the question). There was no significant association between the responses to this question and the consideration of emigration (p=0.084).

3.5.2 Teleradiology as a viable alternative to emigration

Forty seven percent of the respondents (90/190) felt that teleradiology is a viable alternative to emigration whereas 3% did not answer the question.

There was a significant, weak, association between the responses to this question and the consideration of emigration (p=0.011; phi coefficient=0.20). Figure 3.12 shows the correlation between intention to emigrate and teleradiology being considered as a viable alternative to emigration. It illustrates that a greater proportion of those with no intention to emigrate considered teleradiology a viable alternative, (64%, 35/51) compared to those with some consideration of emigration (42%, 50/123).

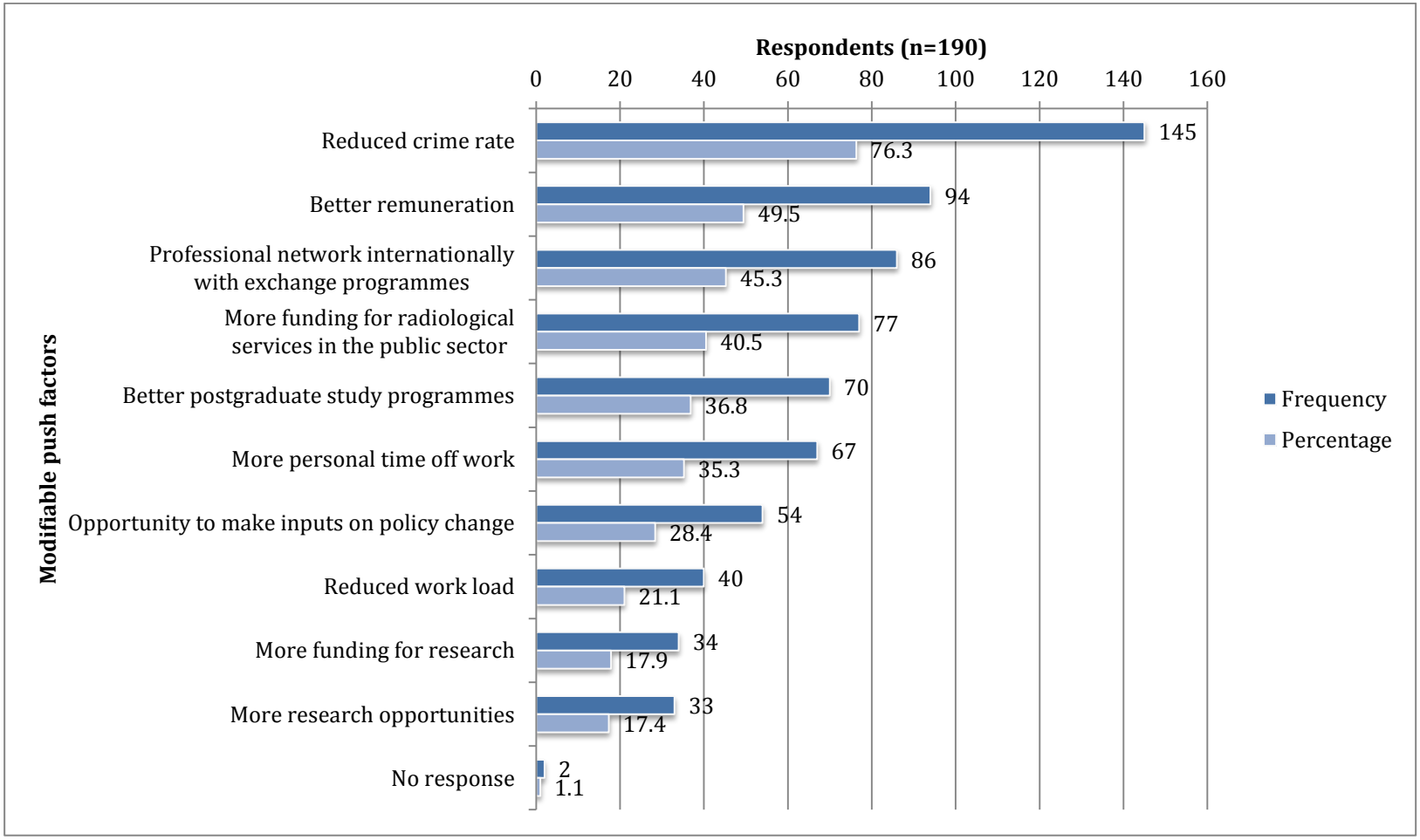
Figure 3.12 Views on teleradiology as a viable alternative to emigration



1.6 Modifiable push factors for South African radiologists

The push factors, which if adequately addressed, would ensure radiologists and registrars remain in practice in South Africa are illustrated in Figure 3.13. Note that percentages do not sum to 100% since some respondents indicated more than one factor. The non-response rate was 1%.

Figure 3.13 Correctable factors which would motivate radiologists to continue their practice in South Africa



The most common factor was a reduced crime rate, indicated by 76% of the respondents. Better remuneration (50%) and international networking with exchange programmes (45%) also had considerable support.

There were significant between-group differences:

1. Reduced crime rate ($p<0.0001$): A higher proportion (85%) of those considering emigration indicated this to be a factor, compared to those not considering emigration (51%).
2. Better remuneration ($p=0.0080$): A lower proportion (42%) of those considering emigration indicated this to be a factor, compared to those not considering emigration (65%).

A thematic analysis of the modifiable factors listed under the "other" category for question thirteen (21 responses, detailed in Appendix E) revealed two major themes:

The main theme identified was political stability and legislature regarding radiologists. Most respondents felt concerned about the current or future political stability of South Africa. Recurring sub themes centred on "corruption" and "service delivery". This is best encapsulated in one of the respondent's answers:
"A government in power that genuinely had the needs of the country and its people at heart, as opposed to enriching itself at the expense of its country and people."

Sub themes regarding legislature were mostly about concerns around NHI. One respondent was "very concerned about litigation in private practice and the inability and

unwillingness of HPCSA to protect radiologists from private legal firms". Another respondent commented on legislation about the subsidisation of most other specialities whereas radiologists were subject to "punitive, non – market related rentals."

The second major theme related to the economic stability of South Africa. The recurrent theme of taxation with a call to "lower tax and hidden taxes" was noted.

One respondent was compelled to share his/her reasons for leaving the country as cited below.

1. "Future financial insecurity"
2. "Lack of moral leadership in the country"
3. "Increasing tax burden"
4. "Insecurity over NHI and its implementation"
5. "Increasing crime rate"

The respondent concluded: "all of the above need to be addressed in order to secure my stay".

4. Discussion

4.1. Results in context

4.1.1 Quality measures of the survey

There are various metrics to determine the quality of a survey. The response rate and non – response rate were employed for this study. The number of respondents participating in the survey, known as the response rate, indicates how many respondents from the sample completed the questionnaire. The response rate of 35% was low. Previous studies that surveyed a native population had better response rates, varying from 69% to 100% (27,13). These studies employed random sampling which ensured generalization of the findings to a bigger population (45). A previous survey of Kenyan doctors however generated a lower response rate of 18% despite a countrywide survey of a large sample size using a random sampling model (35). The primary mode of questionnaire administration was intended to be electronic, based on the literature advocating a greater response rate with electronic surveys compared to paper and pen versions (46). As radiologists and registrars widely had access to Internet facilities, this was designed to facilitate sampling. Only small differences in respondent answers may be observed when comparing self - administered online and paper surveys, thus limiting bias in terms of the mode of administration (46). There is some evidence that self – administered, impersonal questionnaires encourage participants to divulge sensitive information (46), and thus this was an anticipated benefit. Multiple sampling drives, reminders to participate in the survey and both paper and web based questionnaires were used to maximise response rate in our study.

Possible reasons for the low response rate include the sensitive nature of the questionnaire inducing participant anxiety about disclosing their views and the non - random sampling technique. This technique may have introduced non - response error or bias, where data is not obtained from every member in the sample (47). Hence only a small proportion with an interest in the topic may have been compelled to participate. A low response rate with a non – random sampling method implies that the survey results cannot be generalized to the target population with confidence, as the results can be misrepresentative (45,47).

A non – response is defined as failure of participants to answer a question to which they are supposed to respond (48). If the average number of non - responses is minor, then the survey data is deemed to be of good quality (48). Ideally, all questions should have a low non - response rate (there is no agreed minimum acceptable response rate, therefore a value less than 5% is used as a rule of thumb). Overall the questionnaire had a good non – response rate of below 5% for all but two questions.

4.1.2 Demographic profile of the sample

The majority of respondents were male aged 30 – 49 years. More registrars responded than consultants, however further cross tabulation did not reveal any difference in attitudes between registrars and consultants, indicating that there was no bias towards registrars.

It is difficult to ascertain whether the sample was representative of the population because the RSSA 2011 database had no record of the radiologists' demographics for

comparison. Most radiologists were general radiologists with only a quarter with sub speciality qualifications, training or expertise. Over 15% indicated that interventional -, musculoskeletal radiology or mammography were their areas of expertise. In the context of emigration it is important to note the proportion of interventional radiologists, since alternatives to emigration such as teleradiology, are less likely to be satisfactory because of the requirement for interventional radiologists to be on site. Respondents from public and private practice were fairly evenly represented.

4.1.3 Emigration profile

4.1.3.1 Intent to emigrate

More than two thirds of South African radiologists and registrars (67%) had contemplated emigration or were deemed a high risk group for emigration. Two percent were in the process of emigrating. The group with very high emigration potential (22%) consisted of those with definite plans to emigrate (3%) and those who desired working or studying internationally on a temporary basis (19%). Whilst the later group was not asked if they had definite plans to emigrate, it is reasonable to consider them as a very high risk group, as they had the motivation to seek work abroad and once there may obtain qualifications or work experience that may lead to their permanent recruitment. The proportion of those wanting to work or study abroad temporarily is an important group in the context of brain drain. Temporary relocation further compounds the South African doctor shortage besides the significant risk that these doctors may remain abroad permanently. Forty-three percent had considered emigration however had no plans to emigrate,

therefore they have low emigration potential. Only 28% had not considered emigration and therefore have no emigration potential.

The South African Migration Project in 2000 classified emigration potential but found lower percentages for each category, compared to this study (13). None of the other studies had explored emigration potential. Up to 85% of Kenyan doctors surveyed by Yonga et al, had considered emigration (35). This implies that both in South Africa and other African countries significant numbers of doctors have at least contemplated emigration.

Returnees accounted for a small subset of the sample (6%), far less than the percentage with a high emigration potential. This proportion is not large enough to signify a brain drain reversal.

No profile of prospective emigrant radiologists could be defined. Those with the intent to emigrate were a diverse group and without further questioning to ascertain their emigration potential, no emigration profile could be elucidated.

4.1.3.2 Destination country of choice

The prospective destinations of Australia, Canada, the UK, USA, and New Zealand in descending order of preference indicate that the top 5 destination countries remain comparable to prior studies (9,13,30,31). The change in the order of preference from the UK to Australia or Canada may be due to more recent stringent UK immigration laws and saturation of the available radiology posts in most parts of the UK. Lifestyle similarities

between Australia and South Africa, such as the climate, sporting activities, language and better earning potential compared to the UK may also account for the changing preference. No significant associations between destination and demographic parameters were identified.

There are several reasons for these destination countries being chosen by participants. All of the top 5 countries are predominantly English speaking making the ease of transfer to and practice in these areas pull factors for South African radiologists. Most of the countries have large South African expatriate communities, which may assist integration of the prospective emigrants. These destinations, with a few exceptions in Canada and the US, have climates and lifestyles similar to South Africa. The acceptance of South African radiological qualifications in some of these countries may also account for them being popular destinations. The exception is the USA where emigrant doctors are expected to complete their undergraduate medical training again in the form of the USMLE before further specializing as a radiologist. The UK requires a FRCR degree, however, the South African medical undergraduate qualification is accepted. In Australia and New Zealand, South African undergraduate qualifications are considered equivalent whereas specialist qualifications have to be obtained under the auspices of the Royal Australian and New Zealand College of Radiologists. A lower crime rate, better schooling opportunities for children, lifestyle options and political and economic stability in destination countries are other general pull factors.

The Mercer Quality of Living survey and Global Liveability survey assesses the world's best cities to live in annually. Parameters such as infrastructure, education, housing, the

natural environs, healthcare, safety, the political, socio-cultural and economic milieu are taken into account (49,50). Vancouver and Melbourne have ranked first in the Global liveability survey in the last decade (50). The 2014 Mercer survey ranked Vancouver, Ottawa, Toronto and Montreal as the top four cities in the Americas respectively, whilst Auckland and Sydney were rated third and tenth globally (49). These cities are consistently highly ranked for quality of life therefore it is not surprising that these are constant popular choices for potential South African emigrants. South African cities have a much lower global ranking with Cape Town ranked ninetieth for example (49).

4.1.3.3 Likelihood of return to South Africa

The responses to this question were limited by the lack of skip logic in the survey questionnaire. Over 30% of participants selected the 'not applicable' option hence they contradicted their answers for question 6 (intention to emigrate). Excluding this category and non – responses, revealed that the majority of respondents felt it unlikely that they would return (17.1%) and 6% responded that they would never return. Only 10% felt that they would definitely return. This is an indirect measure of assessing emigration potential or assessing the potential brain drain reversal and is far lower than reported by Bezuidenhout et al (9). Once again the number of presumed returnees is not substantial enough to reverse brain drain.

Intuitively, the likelihood of return was shown to decrease with an increasing number of years of practice (significant strong association) and increasing age (significant moderate association). This can be interpreted that older radiologists when settled in the destination country would not be willing to move back to South Africa given their age constraints or to forgo worthwhile retirement options in the destination country.

A significant moderate association between likelihood to return to South Africa and place of practice was demonstrated. Radiologists in public practice were less likely to return to South Africa than those in private practice. This may be explained by the comparatively poorer working conditions and salaries experienced by public service doctors compared to those in private practice. Thus once a South African public service doctor is afforded better working conditions and remuneration internationally, he or she may not want to return in the future to unfavourable conditions in South Africa. Of the 13 returnees, only 4 were from public practice, which supports the idea that public service doctors are less likely to return.

4.1.4 Reasons for emigration

4.1.4.1 Work related push factors

The major work related factors were financial reasons and South African legislation (both 42%). Financial reasons were the top factors in the studies by Astor et al and Bezuidenhout et al (27,9). This is not surprising as 40% of South African specialists indicated that they were not satisfied with their salaries (36). Financial reasons include retirement options that are or may be perceived as superior in host countries.

None of the studies investigated the importance of legislature. This was the second most significant factor in this study and was probably due the concerns surrounding the National Health Insurance Act, anxieties about malpractice claims and the judicial system as highlighted in the open ended responses for question 13 (Appendix E). Whilst further

specific questioning about radiologists' attitudes towards NHI and its possible role in emigration were not pursued, there is evidence that NHI remains a source of anxiety of for South African doctors. The Medical Chronicle's survey demonstrated that over 50% did not support the concept that NHI will be good for healthcare delivery in South Africa (36).

Professional development was the third most popular work related push factor whilst, opportunities for postgraduate education was ranked fourth. The marked cost of attending and travel implications for international congresses for professional development makes this prohibitive for a large number of radiologists, particularly those in exclusive state practice who on average earn less than their counterparts in private practice. Despite the RSSA offering a diverse and dynamic CME programme in the form of national congresses with international faculties and webinars with international lecturers, there is a great need for further professional development, which is easily accessible and affordable for the majority of radiologists. The paucity of national fellowships and the limited types of national fellowships compounds the issue of availability of postgraduate training and subspecialty training. These factors may explain why South African radiologists and registrars are keen to have more professional development and education avenues at their disposal. South African radiologists also felt that professional development is a critical push factor when compared to the doctors surveyed by Bezuidenhout (third versus fourteenth ranked factor respectively) (9). As radiology is a rapidly expanding and technologically demanding field, it is imperative for radiologists to stay abreast of new developments and therefore they may rate this as more important than other doctors. Whilst other South African medical specialities have multiple post

graduate subspecialty training programmes available nationally, radiologists are limited to a handful of national subspecialty training programmes, therefore they may resort to training abroad, increasing their emigration potential. Subspecialty qualifications for radiologists are necessary in order to offer a relevant and up to date service for the clinical subspecialties which these radiologists provide imaging for. Subspecialities are already established in other disciplines e.g. cardiology, endocrinology, paediatric surgery, paediatric pulmonology – and these programs and exams are offered nationally through universities and colleges. Our efforts have been obstructed by the HPCSA and this needs to be highlighted because it is pushing doctors to other countries - we need to be subspecialised to keep up with our colleagues, but there are few national possibilities for achieving this.

This study presents new findings about radiological push and pull factors, which have not been addressed or explored in the literature. Table 4.1 details the overall ranking for each factor.

Table 4.1 Ranking of South African radiological push factors

Radiological Push Factor	**Ranking**
Access to state of the art imaging equipment	5th
Hospital management attitudes	6th
Ability to perform or exposure to interventional radiology	10th
Availability of PACS	12th
Availability of ancillary staff (such as medical physicists)	13th
Availability of consultant posts for newly qualified radiologists	14th

Availability of consumables	15th
Encroachment of other disciplines on radiology	16th

Equipment issues, hospital management attitudes and the ability to perform or exposure to interventional radiology were deemed more important than other work related factors. The disparity in the availability of imaging equipment has been proven by Kabongo et al (38). Radiologists in both the public and private sector have indicated their need for equipment to match the ever-escalating demands of the field and clinical specialities, which radiology supports. Hospital management attitudes have been a concern for doctors in state practice for the last few years for many reasons. The most notable are a failure of progression in staff ranking and reduction of benefits, including the stricter control of RWOPS (remuneration outside public works) by government, where state employed radiologists have been prevented from part time private practice employment. Both these issues have led to a number of doctors resigning from state practice to relocate in private practice. (Hlabangana LT. Chief radiologist CHBAH. Personal communication. 3 November 2014) The desire to perform interventional radiology is important in the context of brain drain, as the participants who favour this subspeciality may be more likely to emigrate for additional income or international experience. Those wishing to perform interventional radiology cannot earn additional income through teleradiology, as they are required to be on-site, whereas diagnostic radiological services can be offered remotely via teleradiology. Whilst these radiological factors are important in a radiologist's everyday practice, participants have indicated that remuneration and restrictive South African legislation are the major push factors. Work related radiological

push factors therefore have a secondary role whilst economic and political push factors are the primary driving forces for emigration.

Workload / duty hours and exposure to HIV/AIDS are general work related push factors for South African doctors. Both factors were also explored by Bezuidenhout et al and were cited as the seventh and eighth most important factors (9). Our findings differ in that these factors were ranked 7th and 11th respectively. Both South African radiologists and other doctors have excessive workloads hence the similar ranking. HIV/AIDS exposure is of less concern to general radiologists who do not perform interventional radiology, as the chance of a needle stick injury or occupational exposure to infected body fluids greatly diminishes in non - interventional radiology. Another difference is that radiologists cited better job opportunities as the 8th most important work related push factor whilst the expatriate doctors in Bezuidenhout's study found this to be the second most important factor (9). This may be due to South African radiologists being more in demand than generalists and some of the other medical specialities. Hence there may be more local job opportunities for radiologists compared to these medical disciplines. The earning potential of radiologists in private practice in South Africa is better than in Australia and the UK and only superseded by Canada. Other specialities tend to earn more working abroad than in South Africa. Hence radiologists in South African private practice, almost equal in number to public practice radiologists in the sample, may not feel that better job opportunities are an important pull factor compared to other medical specialities.

Registrars and radiologists with less than 5 years of experience were more interested in better job opportunities and access to interventional radiology compared to the rest of

the respondents (weak and moderate associations respectively). Registrars have to transition to the job market post qualification thus it is natural for them to focus on future work prospects. Diagnostic radiology is a speciality where practitioners may remain in practice for many decades and retiring later than other disciplines, therefore saturating existing posts. Since the proportion of older radiologists retiring or leaving practice is low, fewer posts are vacant and available for newly qualified radiologists. To compound matters, private practices are moving towards employing those with subspecialty qualifications, further limiting the posts available for junior radiologists without these qualifications. The field of interventional radiology is expanding in public practice whilst few centres perform a dedicated interventional radiology service in private practice currently. In public practice, surgical and to a lesser extent medical specialities rely heavily on interventional radiology for the less invasive management of patients for various conditions instead of referring these patients for surgery. In private practice, the clinicians manage the same subset of patients that would be referred for interventional radiological procedures in public practice more often. Billing for procedures in private practice is more competitive than in public practice as clinicians are paid per consultation/procedure in private practice compared to a fixed salary in public practice irrespective of the patient caseload. Hence private practitioners tend to perform more procedures for reimbursement instead of referring to another discipline such as interventional radiology. This may account for registrars' and junior radiologists' interest in interventional radiology given that they have the most exposure to and highest demand for the subspecialty in their public practice.

Some differences in attitude were found in the private and public sector cohorts. The study revealed a weak association between private practice and better job opportunities. This may indicate that private practitioners are not satisfied with some aspect of their working conditions hence they may desire new job opportunities that meet their requirements. Radiologists in the private sector highlighted the need for opportunities for postgraduate study, professional development and availability of ancillary staff (all weak associations). As the public sector is affiliated with universities, academia is part and parcel of public practice in larger centres. This is generally not the case in private practice therefore these radiologists may motivate for more opportunities for postgraduate study. Ancillary staff, such as medical physicists, are scarce in private practice hence the respondents from private practice highlighting this need. Professional development may be more important to the private sector as these radiologists have to keep abreast of imaging trends to parallel the burgeoning needs of other specialists in private practice who may have more requirements than those in state practice with limited scope.

4.1.4.2 Personal, social and economic push and pull factors

The high crime rate was voted as the most important social push factor and correlates with the findings of 3 previous studies in 2000, 2004 and 2009 (13,31,9). In the 2000 South African Migration Project survey, more than two thirds of South African professionals reported that family (68%) and personal safety (65%) were important push factors (13). South African's anxiety about the rule of law and safety is supported by independent markers such as the 2014 Ibrahim Index of African governance (51). South Africa has a decreased rating in the rule of law over a five year period (2009 – 2013) (ranked eighth in Africa) compared to Botswana (ranked first), Mauritius (ranked second), Ghana (ranked fourth) and (Namibia ranked fifth) (51). South Africa's national security

rating has dropped significantly in the last five years, ranking it twenty fifth in Africa (51). South Africa ranked forty second in Africa for personal safety compared to it's neighbour Botswana which ranked third in Africa in 2013. Furthermore, South Africa's personal safety rating has declined from 2009 – 2013 (51). Thus the high crime rate has remained a persistent critical push factor for South Africans, over the last decade. As long as host countries such as Australia and Canada have a higher safety level than South Africa, the high South African crime rate will remain a substantial push factor.

The political stability of the country is the next most important factor followed by economic stability. The concerns about economic stability were echoed in prior studies (27,35). South Africa ranked fourth in Africa in 2014 for political accountability with a decreased rating over 5 years compared to Botswana which was ranked first in Africa for political accountability (51). Furthermore, the 2014 Ibrahim index indicates a decreased rating in South African public management (classified under sustainable economic opportunity) for this period despite it being ranked first in Africa for this factor (51). Both of these factors also remain persistent push factors for South African radiologists to become emigrants, as highlighted by the study. Cross tabulation revealed that male radiologists were more concerned about political stability than their female counterparts. Astor et al demonstrated in 2005 that 52 % of a total of 644 physicians in Columbia, Nigeria, India, Pakistan and the Philippines wanted to live in a country with higher general safety level when questioned about potential pull factors (27). Therefore internationally and within Africa this remains a concern. Better schooling opportunities for children and the tax system were recurrent pull factors (13,27).

4.1.5 The role of teleradiology in emigration

This study contributes new findings about the possible role of teleradiology in curbing brain drain. Three quarters of respondents had considered teleradiology as a means of postgraduate study or work (for additional or primary remuneration). Whilst there is no strongly significant association between this and the intent to emigrate, it points at new avenues to be explored when addressing postgraduate education, professional development and work opportunities for radiologists.

There was a weak association between the consideration of emigration and teleradiology as an alternative to emigration. Over two thirds (64%) of radiologists with no intent to emigrate had considered teleradiology as a viable alternative to emigration. Whereas further study to establish the external validity of this factor is required, it is promising in that it represents an innovative way to offer native radiologists education and work opportunities which are currently push factors for emigration. Ultimately this may have a role in averting brain drain but needs to be examined in the context of legislation regarding RWOPS for public sector employees.

Another encouraging prospect is that up to 42% of radiologists, who had considered emigration, also thought that teleradiology is a viable alternative. There may be potential to swing this group's intent to emigrate by providing teleradiology networks. The exception to all of these findings is for interventional radiology where radiologists cannot currently perform procedures remotely. Diagnostic teleradiology, by and large, may offer an alternative to emigration.

4.1.6 Modifiable push factors

South African radiologists and registrars felt that reducing the crime rate (76%), better remuneration options (50%) and international networking with exchange programmes (45%) would motivate their continued practice in South Africa. As the chief work related, social, political and economic push factors identified related to the high crime rate, financial reasons and professional development, it stands to reason that the improvement of these factors would discourage emigration. Similar findings were reported in previous studies (13,27,30,31,35). Two significant between-group differences were identified. Firstly 85% of those considering emigration chose “reduced crime rate” compared to those not considering emigration (51%) ($p<0.0001$). Thus the reduction of crime was unanimously voted by those with varying emigration intent. Secondly better remuneration was considered as a modifiable factor by 65% of radiologists with no emigration intent, compared to 42% with intention to emigrate. Addressing remuneration would therefore also address another critical push factor.

The thematic analysis yielded 2 major themes: political stability, and legislature regarding radiology and the economic stability of South Africa. Thus, the thematic analysis further supports these factors as both compelling push factors which are correctable and which government and other stake holders should address. The open ended responses to question 13 which were used for the thematic analysis are provided in Appendix E.

4.1.7 Comparative summary of our study findings and the literature

Table 4.2 summarises a comparison of this study's methodology and major findings and those of related national and international studies.

Table 4.2 Comparison of our study and previous publications (2,27,31,30,35,13,9)

Study	**Oberoi et al 2006**	**Astor et al 2005**	**Awases et al 2004**	**Benamer et al 2009**	**Yonga et al 2013**	**The South African Migration Project 2000**	**Bezuidenhout et al 2009**	**Moodley 2015 (this study)**
Nationality surveyed	Australia	Columbia, Nigeria, Pakistan, India, Philippines	Cameroon, Ghana, Senegal, South Africa, Uganda, Zimbabwe	Libya	Kenya	South Africa	South Africa	South Africa
Sample size	10 Expatriates	925 Residents	559 (84 doctors) Residents	225 Expatriates	1571 Residents	725 (36 doctors) Residents	43 Expatriates	550 Residents (Doctors – Radiologists)
Method	Non - random sampling (opportunistic and snow balling) Semi structured interviews	Random sampling Personally administered questionnaires	Random sampling Questionnaire delivery not specified	Non - random sampling from databases Email questionnaires	Random sampling Semi structured self-administered survey	Random sampling telephonic interviews	Non - random sampling (snow-ball sampling) Email and postal surveys	Non – random sampling, paper and email self administered questionnaires

Response rate	100%	69%	Not addressed	32%	18% *	100%	67%	35%
Emigration potential	Not applicable	Not addressed	58.3% had considered emigrating	Not applicable	85.4% had considered emigrating	2% very high 10% high 25% moderate 28% low 16% very low 20% none (possibility of emigrating)	Not addressed	Emigrating 1.6% Definite plans 2.6% Considered but no definite plans 43% Temporarily work& study abroad 19% Never considered 28% Returnees 7%
Destination country	Not applicable	Not addressed	Australia 10% Canada 7% N. Zealand 5% UK 52%	Europe 66% N. America 20% Arab Gulf 14%	Not addressed	Australia 22% Canada 11% N. Zealand 12% UK 15%	Australia Canada N. Zealand UK	Australia 29% Canada 26% N. Zealand 5% UK 19%

			USA 9 %			USA 24%	UAE Bahrain Yemen	USA 9% Other 6%
Likelihood of return	Not addressed	Not addressed	Not addressed	Definitely or probably 54% Possible or unlikely 46%	Not addressed	Monthly 4% Once every few months 7% Yearly 20% Once every few years 20% Never 12% Don't know 2%	Return permanently 53.6% Not returning 42.9% Uncertain 3.5%	Definitely 11% Probably 11% Possibly 15% Unlikely 17% Never 7%
Push and pull factors	Poor income Lack of job satisfaction/ postgrad training Poor working conditions HIV/AIDS	Higher income 90.8% Better prospects for children 78% Access to enhanced technology, equipment and	Violence and crime 38% General decline in healthcare 38% Gain international experience 43%	Further education and research 88%	Poor economic returns 43.7% Dissatisfied with work support or environment 73.3%	Family safety 68% Personal safety 66% Upkeep of public amenities 70%	Crime 75.9% Financial 86% Job opportunities 79.3%	High crime rate 71% Political stability 64% Economic stability 55%

		medical facilities 74%				Taxes 74% Cost of living 71%		Financial reasons 42%
Modifiable push factors	Capacity building Incentives and motivational systems	Improved work conditions 87% Increased income 83.5%	Healthy working environment 67.8% Better fringe benefits 66.4% Better salaries 77.5%	Reform of health services 43% Social reasons 17%	More involvement in policy making 38% More funding for health services 71.8% Better salaries 77.5%	Improvement in safety & security 25% Family roots 15% Nothing 12%	Not addressed	Reduced crime rate 76% Professional network (international) with exchange programmes 45% Better remuneration 50%

* Calculated value as not stipulated in publication

This study was the first investigating the factors involved in South African medical specialists (radiologists) emigration, therefore a direct comparison with other studies is not possible. Our study adds a new dimension by demonstrating varying emigration intent whereas only one previous study addressed this (13). Our study concurs with the findings of previous studies with regards to destination countries - Australia, Canada, New Zealand, the UK and USA remain popular destination countries for emigrants. Our study demonstrates that Australia remains the top destination with Canada becoming more popular and the UK and notably the USA less popular than before, compared to findings from the South African Migration Project of 2000 (13). The potential for diagnostic teleradiology to obviate emigration is a new finding contributed by this study.

4.2. Current applications

In view of some interest being expressed in teleradiology as a viable alternative to emigration by both those with no intent to emigrate and to a lesser extent by those who have considered it, our findings may inform current national health policies. The provision of RWOPS for public practice radiologists in the form of teleradiology may discourage emigration by supplementing income. This research may also encourage continued professional development exercises such as those conducted by the RSSA and the launch of other innovative CME programmes. The South African College of Radiologists and universities may also explore instituting more national fellowships and initiate exchange programmes, given the interest indicated in the survey. Additionally, the need for more comprehensive and high fidelity databases can be motivated for. For example, the RSSA's database should also include the demographic data of radiologists and if they are practicing internationally.

4.3. Limitations of the current study

The study was limited by the following design flaws. The low response rate could have been augmented by more reminders and sampling attempts over a longer period. The non – random sampling technique may have introduced bias by self-selection of participants. Ideally a random sampling technique should have been employed to obviate this and ensure findings that could be generalised to the study population. The questionnaire was neither validated nor piloted therefore the lack of skip logic, use of exact ages before regrouping into categories and the lack of use of established scales such as the Likert scale to establish the external validity of factors were not anticipated. The use of skip logic would have improved the readability and flow of the questionnaire and avoided contradictory answers. Piloting the questionnaire with a focus group beforehand may have helped anticipate and timeously correct these questionnaire design errors.

4.4. Future applications

A longitudinal study to assess the trend in attitudes of South African radiologists and registrars with regards to emigration is warranted. This will provide a better understanding of the mutable nature of medical brain drain. With an improved questionnaire and sampling method, generalizable results can be obtained, which in turn can inform healthcare planning policies. Further studies on the role of teleradiology as a mitigating factor in brain drain would be beneficial.

5. Conclusion

Medical brain drain is a worldwide documented phenomenon, which ironically is least studied in donor countries that are the most affected. No surveys of South African medical specialists, including radiologists, with regards to emigration have been published. Whilst South African radiologist's intention to emigrate, destination countries and push and pull factors are comparable to the few available studies, this study presents the following new findings: economic, social and political factors are the chief push factors for South African radiologists with radiological push factors playing a secondary role. The reluctance of the older and most experienced South African radiologists to return post emigration was a statistically significant finding, indicating the potential loss of the country's most experienced and skilled doctors. This does not bode well for the future of the discipline, as the transfer of these precious skills will be negated should these radiologists emigrate. We also identified that diagnostic teleradiology services may provide a viable alternative to emigration.

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Appendix A: Ethics Clearance Certificate

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG
Division of the Deputy Registrar (Research)

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
R14/49 Dr Halvani Moodley

CLEARANCE CERTIFICATE	M110967
PROJECT	A Survey of the Factors Involved in the Emigration of South African Radiologist
INVESTIGATORS	Dr Halvani Moodley .
DEPARTMENT	Department of Radiology
DATE CONSIDERED	30/09/2011
M110967+DECISION OF THE COMMITTEE*	Approved unconditionally

Unless otherwise specified this ethical clearance is valid for 5 years and may be renewed upon application.

DATE 30/09/2011 **CHAIRPERSON** .....
(Professor PE Cleaton-Jones)

*Guidelines for written 'informed consent' attached where applicable
cc: Supervisor : Prof S Andronikou

DECLARATION OF INVESTIGATOR(S)

To be completed in duplicate and **ONE COPY** returned to the Secretary at Room 10004, 10th Floor, Senate House, University.
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee. **I agree to a completion of a yearly progress report.**
PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES...

Appendix B: Questionnaire

Question 1:

Indicate your gender.

- Female
- Male

Question 2:

Indicate your age category.

- 20 – 29 years
- 30 – 39 years
- 40 – 49 years
- 50 – 59 years
- 60 – 69 years
- 70 or more years

Question 3:

How many years have you practised as a radiologist?

- I am a registrar
- Less than 1 year
- 1 – 5 years
- 6 – 10 years
- 11 – 15 years
- 16 – 20 years
- More than 20 years

Question 4:

Do you have a sub speciality, sub specialities/ fellowship(s) or perform a niche practice. If yes, please specify the type of sub speciality or niche practice below.

- No
- Yes,_____

Question 5:

Where do you currently work?

- Private practice
- Public practice
- Both

Question 6:

Do you have any intention to emigrate and work abroad?

- Yes, I am in the process of emigrating
- Yes, I have definite plans to emigrate
- Yes, I have considered emigration but do not have any plans to do so
- No, I have not considered emigrating before
- I have previously emigrated and have returned to South Africa
- I intend to work or study abroad on temporary basis

Question 7:

If you do intend to emigrate, which one of the following countries would be the destination of your choice?

- United Kingdom
- United States of America
- Canada
- Australia
- New Zealand
- Other, please specify _____
- Not applicable, as I do not want to emigrate

Question 8:

If you are intending to emigrate, how likely is it that you will return to practice in South Africa in future?

- Definitely
- Probably
- Possibly
- Unlikely
- Never
- Not applicable, as I do not want to emigrate

Question 9:

If you are intending to emigrate or have considered it, which of the following work related factors would motivate you to emigrate? You may choose as many options as applicable.

- Financial reasons including remuneration, retirement and pension
- Better job opportunities
- Opportunities for post graduate study
- Opportunities for research
- Professional development
- Access to state of the art imaging equipment
- Availability of PACS systems
- Availability of ancillary staff such as radiographers, nursing personnel and medical physicists
- Availability of consumables such as contrast agents, catheters and stents for interventional procedures, etc.
- South African legislature regarding radiologists including NHI
- Exposure to HIV/AIDS
- Excessive work load or working hours
- Exposure to or ability to study or perform interventional procedures
- Encroachment of other specialities on radiology for e.g. cardiologists performing cardiac CT
- Availability of consultant posts in public practice
- Hospital management attitudes
- Not applicable, as I do not want to emigrate

Question 10:

If you are intending to emigrate or have considered it, which of the following personal, social and economic factors would motivate you to emigrate? You may choose as many options as applicable.

- High crime rate
- Better lifestyle abroad
- Better schooling opportunities for children
- South African income tax system
- Personal circumstances
- Family abroad
- Political stability of South Africa
- Economic stability of South Africa
- Not applicable, as I do not want to emigrate

Question 11:

Have you considered teleradiology as a means for postgraduate education or work opportunities?

- Yes
- No

Question 12:

Do you think that teleradiology is a viable alternative to emigration?

- Yes
- No

Question 13:

Which of the following factors, if adequately addressed would motivate you to continue practising radiology in South Africa? You may choose as many options as applicable.

- Better remuneration
- Better post graduate study programmes
- More funding for research

- Professional network internationally with exchange programmes
- Reduced work load
- More personal time off work
- Reduced crime rate
- Opportunity to make inputs on policy change
- More funding for radiological services in the public sector
- More research opportunities
- Other, please specify_____

Appendix C: Study Invitation and Consent form (paper based survey)

Project: A survey of the factors involved in the emigration of South African radiologists

Dear Colleague

You are invited to take part in a research study. The following study is being undertaken for a Masters of Medicine dissertation in Diagnostic Radiology by Dr Halvani Moodley at the University of Witwatersrand. It aims to survey the factors involved in the emigration of South African radiologists, by means of a questionnaire.

Aims of the study

This study will assess the potential brain drain of the South African radiologists in order to gauge the scope of the problem and the driving factors behind it, especially those peculiar to the radiological fraternity. In identifying these factors, effective policy change may be made to encourage resident doctors to continue practice in their country of origin.

Participation in the study

Participation in this study is **voluntary** and should you choose to answer the questionnaire, you may terminate it at any point. Termination of the questionnaire or non – participation in this study will not adversely affect you in any way.

The study is conducted by Surveymonkey, a secure online survey company. You may access the questionnaire via the provided link. No identifying data is attached to the questionnaire, therefore **your responses are anonymous**. Neither Surveymonkey nor the researcher will have access to your e-mail address. Your input will be blinded to the researcher and will be treated with the strictest of confidentiality.

There are 13 questions and the questionnaire will take approximately 10 - 15 minutes to complete. The questions consist of **multiple choice answers**. Kindly tick the appropriate option(s). Please note that for specified questions, more than one answer is acceptable. You may answer any or all questions.

The results of the study may be published, and/or presented at a congress, and/or submitted to the Department of Health. All information presented will be anonymous. Thus the benefit of participating in the study is the ability to voice any possible concerns about factors that may be dissuading you from continuing practice in South Africa, with a view to bringing this to the attention of the relevant policy makers. Informed consent is assumed if you complete the questionnaire.
Kindly complete the following questionnaire if:

- you are a **practising South African radiologist or registrar (**registered with the Health Professions Council of South Africa as a radiologist or a registrar in the field of radiology)
- You have not completed this questionnaire by either e-mail or in person previously.

Thank you for taking the time to read this information leaflet.

Chief Researcher:	Dr Halvani Moodley Department of Radiology University of Witwatersrand halvani.moodley@gmail.com 011 025 6188
Supervisor:	Professor Savvas Andronikou
Co – supervisor:	Professor Victor Mngomezulu
REC administrator and chair:	Anisa Keshav anisa.keshav@wits.ac.za 011 717 1234

Appendix D: Study Invitation and Consent Form (e-mail based survey)

Project: A survey of the factors involved in the emigration of South African radiologists

Dear Colleague

You are invited to take part in a research study. The following study is being undertaken for a Masters of Medicine dissertation in Diagnostic Radiology by Dr Halvani Moodley at the University of Witwatersrand. It aims to survey the factors involved in the emigration of South African radiologists, by means of a questionnaire.

Aims of the study

This study will assess the potential brain drain of the South African radiologists in order to gauge the scope of the problem and the driving factors behind it, especially those peculiar to the radiological fraternity. In identifying these factors, effective policy change may be made to encourage resident doctors to continue practice in their country of origin.

Participation in the study

Participation in this study is **voluntary** and should you choose to answer the questionnaire, you may terminate it at any point. Termination of the questionnaire or non – participation in this study will not adversely affect you in any way.

The study is conducted by Surveymonkey, a secure online survey company. You may access the questionnaire via the provided link. No identifying data is attached to the questionnaire, therefore **your responses are anonymous**. Neither Surveymonkey nor the researcher will have access to your e-mail address. Your input will be blinded to the researcher and will be treated with the strictest of confidentiality.

There are 13 questions and the questionnaire will take approximately 10 - 15 minutes to complete. The questions consist of **multiple choice answers**. Kindly tick the appropriate option(s). Please note that for specified questions, more than one answer is acceptable. You may answer any or all questions.

The results of the study may be published, and/or presented at a congress, and/or submitted to the Department of Health. All information presented will be anonymous. Thus the benefit of participating in the study is the ability to voice any possible concerns about factors that may be dissuading you from continuing practice in South Africa, with a view to bringing this to the attention of the relevant policy makers. Informed consent is assumed if you complete the questionnaire.
Kindly complete the following questionnaire if:

- you are a **practising South African radiologist or registrar (**registered with the Health Professions Council of South Africa as a radiologist or a registrar in the field of radiology)
- You have not completed this questionnaire by either e-mail or in person previously.

You may access the questionnaire via the link
https://www.surveymonkey.com/s/JH9N9D3

The closing date for the survey is 17 February 2012 (24h00).

Thank you for taking the time to read this information leaflet.

Chief Researcher:
Dr Halvani Moodley
Department of Radiology
University of Witwatersrand
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011 025 6188

Supervisor:	Professor Savvas Andronikou
Co – supervisor:	Professor Victor Mngomezulu
REC administrator and chair:	Anisa Keshav anisa.keshav@wits.ac.za 011 717 1234

Appendix E Detailed answers for modifiable push factors (question 13) from 21 individual respondents

Modifiable factors from open ended question (13, 'other' option)
• Appoint dedicated, experienced, qualified hospital managers
• Better structures and less corruption eg. tax, NHI and contracts
• Change of political incentives
• Current and future political climate and government attitude against white people will have to change (which unfortunately won't) • Corruption and service delivery would have to be addressed(which unfortunately won't) • Absurd legislation would have to be revised(which unfortunately won't)
• Discrimination against whites, males and Afrikaans. • Quotas for new students on grounds of race and gender often excludes whites and sometimes male, even if they have better marks in school. • Also many traditional Afrikaans schools and universities are forced into English even though only 5 universities were Afrikaans and at least 18 English. • Many jobs are reserved for non-whites, even if a qualified person is not available. Government would rather leave a position vacant than fill it with a white person. • I can go on and on but I think you would understand that most of us don't mind uplifting previously disadvantaged people, but it is again discrimination. • Together with a corrupt and incompetent government there is no future for my children.

• They have difficulty getting an education and a job. • They have to live in a fortress and cannot move around freely as would be normal in a civilised society. • I respect your effort but think it is naive as we all know the reason why people are emigrating.
• Legislation (and implementation thereof) preventing private hospital groups charging punitive, non-market related rentals to Radiologists, whilst subsidising the rentals of most other specialists.
• Long term political stability
• Lower tax and hidden taxes, eg. NHI, security, private schools, road tolls, etc.
• More interventional radiology in the private sector
• No government corruption • Seeing our tax money working to improve infrastructure and living conditions • Better governance - local and central • Less government interference and bureaucracy ie re BEE etc.
• Political certainty, which probably will remain a pipedream in Africa for longer than I have years to live.
• Political stability Stable medical environment Stable economy
• Political stability and less corruption
• Reasons for wanting to leave: • Future financial insecurity Lack of moral leadership in the country Increasing tax burden • Insecurity over NHI and its implementation Increasing crime All of the above need

to be addressed in order to secure my stay
• Stop the threat of National Health
• Teleradiology work from home service
• The answer options on several questions do not cover my responses - information below added to clarify: • Question 8: I do not currently intend to emigrate. However if I decide to do so in the future, I will not return. • Question 9: Another work related factor which would strongly motivate me to emigrate would be: if the level of competence and work ethic amongst medical colleagues, technical and support staff decreases to a level where I can no longer function professionally. • Question 10: The social factors most likely to cause me to emigrate would be: (1): Tertiary education opportunities for my children. Private schooling in SA will be adequate for the foreseeable future, but if university education standards slide there is no other local option. (2): If my (mixed race) children, who will be finishing school more than 30 years after 1994, are in any way disadvantaged by racially based university or job market entry criteria, I will emigrate to allow them to compete on merit alone. (3): Increasing electricity and water failures. These worry me because I see them as an indicator of ability to maintain the basics of civil society.
• Very concerned about litigation in private practice and HPCSA inability and unwillingness to protect radiologists from private legal firms. • Litigation has doubled in the past year - consult the MPS for details.

• I know of so many radiologists who have legal disputes pending and have been harassed by the HPCSA. • Overseas, especially in Australia and New Zealand radiologists are protected from the public by the governing bodies. • Mark my words: This is going to become a big topic in the next few years for radiology in private practice as we are seen as easy money by legal firms.
• If better potential future for family ie less govt corruption. • Less threat to few existing tax payers. Improved basic services (water, electricity). • Formation of larger middle class,far more support of unemployed / poor.
• Opportunities given to judges in the country
• Public sector appointments must be made on merit and not affirmative action only