PERCEPT
HEALTH · SOLVE

The supply of and need for medical specialists in South Africa

Jodi Wishnia, Dave Strugnell, Anja Smith and Shivani Ranchod

02
10
19

Suggested Citation:

WISHNIA, J., STRUGNELL, D., SMITH, A. M. & RANCHOD, S. 2019. The supply of and need for medical specialists in South Africa. Cape Town: Percept.

Note that this report is accompanied by a spreadsheet model, which should be cited separately.

Contents

List of figures

List of Tables

Acknowledgements

The Percept team gratefully acknowledges the contributions of all the stakeholders who helped ensure the findings of this project are valuable and relevant for the South African health sector.

In particular, we would like to thank:

For the funding of the project:

- The Discovery Foundation

For their contribution to the content of the project

- The reference group, chaired by Professor Marian Jacobs with representation from:
  - The Colleges of Medicine: South Africa (CMSA)
  - The South African Committee of Medical Deans (SACOMD)
  - The Health Professions Council of South Africa (HPCSA)
  - The Discovery Foundation
- Dr Nicholas Crisp
- Prof. Alex Van den Heever
- SpesNet and their various specialist associations that contributed
- Healthman and their various specialist associations that contributed
- Surgicom
- The South African Society of Anaesthesiologists (SASA)
- The Hospital Association of South Africa (HASA)

For their contribution to the dataset

- The National Treasury
- HPCSA
- The CMSA
- The Board of Healthcare Funders (BHF)

- Discovery Health
- The Universities of Cape Town, Free State, Witwatersrand, Stellenbosch and KwaZulu-Natal
- The Western Cape Department of Health Provincial Data Centre
- National Health Laboratory Service (NHLS)
- Radiological Society of South Africa (RSSA)

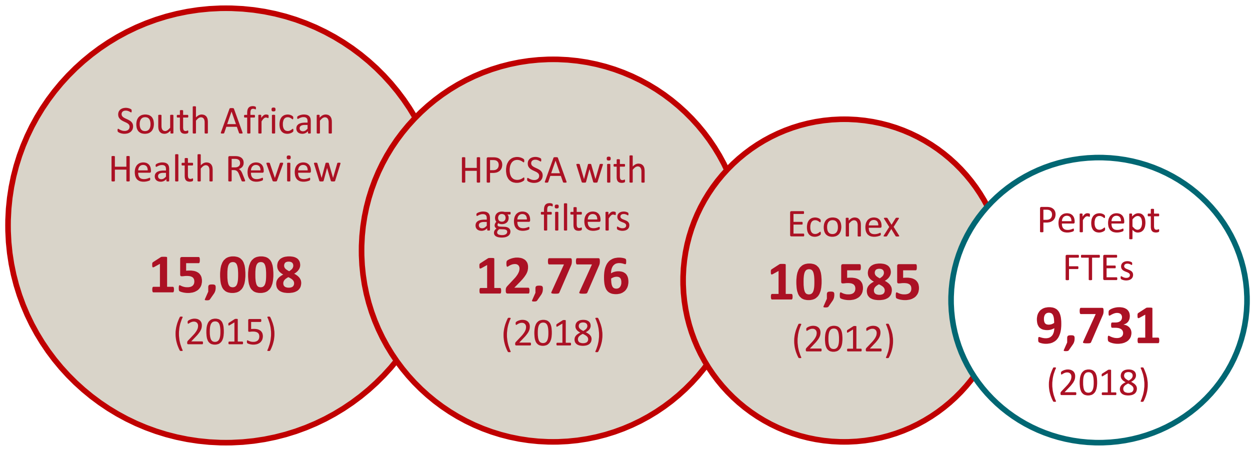
1. Executive summary

This aim of this research was to produce a projection of the supply of and need for medical specialist resources in South Africa, as a tool to facilitate Human Resources for Health (HRH) planning in the country. This report presents the results of the modelling work, after consultation with the reference group that oversaw the work, its constituent bodies and the Ministerial Task Team on HRH planning.

This project focuses on 26 specialties (dental specialties are excluded) and 44 sub-specialties.

The work is located in a context where there is a dire shortage of some specialties, a maldistribution of doctors geographically and between the public and private sectors, and a disjoint between the training platform and the service delivery platform. The figure below illustrates the number of full-time equivalent specialists per 100,000 population across the public (7) and private (69) sectors, and relative to international benchmarks.

This model was built off the foundation of previous work and knowledge within the sector. However, it does differ in some fundamental ways. The novel linking of several datasets allowed for a more accurate estimate of the number of full-time equivalent specialists currently active in South Africa – this in turn provides a more accurate base for future projections. The resultant estimates are considerably lower than previous estimates.



The model explicitly takes into account which sector(s) the specialist is working within – allowing, for the first time, a unified view of the system. This highlights the extent to which doctors work across both sectors (under the so-called RWOPS system). We estimate that at least 35% of public-sector employed specialists also work in the private sector: a previously unknown statistic because of weak monitoring of RWOPS. In projecting the future supply, we allow for movement between the two sectors, ensuring a dynamic view of the system.

The model uses base data for the 2018/19 financial year that reflects the age, sex, sector of employment and full- or part-time status for each specialty. The model then projects from 2020 to 2040 using actuarial population modelling techniques to rigorously allow for entry to, exit from and transitions between sub-groups within the model. The exits include emigration, retirement and death. The model uses in-migration (although this has initially been set at zero) and the specialist training pipeline (registrars) to estimate the supply of specialists going forward, based on current university and fellowship examination dynamics.

The transitional probabilities can be altered to test out policy interventions – for example, an increased retirement age or improved absorption of the training pipeline into the public sector.

The projected supply is linked to need via a set of target ratios for each specialty. Changes in the population need for specialist care in South Africa is driven by epidemiology and how this may change over time. This link to need is crucially important in the face of shifting burden of disease. This project focuses on 26 specialties (excluding dental specialties) and 44 sub-specialties. Each specialty is linked to a sub-population, and that sub-population is projected forward, for the most part using the Thembisa model, supplemented by available research and evidence relating to the burden of disease.

In the model, we compare specialist ratios per 100K population to targets. We allow for the comparison against the following 'targets' in the accompanying Excel spreadsheet:

- National Department of Health HRH Strategy plan 2012/13-2016/17
- 2018/19 current public sector ratio
- 2018/19 current private sector ratio
- A 'recommended' target that was derived by Percept, based on available literature, comparator countries and the current private sector ratios in South Africa

The development of SA specific targets is difficult because of a dearth of data in the sector that would allow us to follow other countries' methods. This is a key area for further work, as without targets, it is difficult to plan effectively.

The user can define their own target ratios. This allows for scenarios to be tested. Vertical substitution, horizontal substitution, technological change and infrastructure all link to target ratios. The target ratios can also be levered up or down to allow for changes in need over time – or to allow for priority setting (i.e. preferencing some needs over others).

The findings from this model lead us to the following key findings with regards to the specialist population in South Africa:

- In 2019, the country has only managed to meet the targets set out in its HRH strategy plan for five of the specialisations: family medicine, ophthalmology, psychiatry, radiation oncology and urology. However, this includes the subspecialist population and all private sector specialists. We also know that these targets were conservative at the time and therefore these may not be a useful benchmark. By 2040, all except cardiothoracic surgery, neurosurgery, otorhinolaryngology, public health, radiology, forensic pathology and surgery meet the HRH strategy targets, albeit way past the deadline set in the strategy document.
- Overall, the number of specialists is expected to more than double by 2040. Crucially, this assumes that the size of the current training pipeline is maintained, and that emigration rates do not increase.
- We notice clearly the feminisation of the health sector in the specialist projections. It is notable that the specialties remaining at a deficit against the HRH strategy targets are historically more male-dominated, and this creates the case for stimulating interest in the surgical disciplines

amongst young women doctors. There are clear differentials in male/female specialty preferences. These choices have the potential to skew the available specialties in future, although this will be constrained by the availability of registrar posts.

- The inequity between the public and private sectors is projected to persist and this requires policy intervention to either make the public sector an attractive option for specialists, or to contract with private specialists. Much of the movement from public to private depends on medical students' and registrars' experiences during their training period – a key area for intervention.
- The shortage of anaesthetists and surgical specialties in the public sector has far-reaching consequences and a short- to medium-term solution needs to be determined to increase access to these skills.
- The impact of shifts in the burden of disease linked to an increasing non-communicable burden and population ageing has far-reaching implications for HRH planning.

This work has several limitations, which we briefly reference here:

- The dynamics of each specialty, in terms of the link to the burden of disease, target-setting and future scenarios should be workshopped with expert input to allow for more meaningful assumptions and scenario building per specialty type.
- The model does not include geographical information due to data limitations. This masks the considerable discrepancies in the availability and mix of specialists at a sub-national level.
- The projections are based on a snapshot of first-year registrar dynamics and therefore any anomalies are carried forward given that we only have one year's data on this. In future, a trend over 5-10 years would be more valuable for the forecasting.

We have learnt many lessons on the fragmentation and difficulties of pulling together the various datasets that allow for robust planning. We hope that this piece of work will highlight some of the issues and pave the way for more efficient data housing and sharing to allow this type of planning work to be much quicker and more regular than what is currently possible. Ideally HRH projections should be done on an ongoing basis – requiring that the processes are institutionalised.

We have succeeded in creating a user-friendly and easily-updateable work-force planning model for medical specialists. The opportunity exists to extend this to other cadres of health workers, to build a more integrated view of the health system. We have also provided comprehensive, public-domain documentation of the model and our assumptions to ensure continuity.

2. Project Background

This medical specialist forecasting exercise was commissioned by the Discovery Foundation and kicked off in late 2017. The brief was to develop a medical specialist projection model, resting on available data and a review of the relevant literature, projecting both the supply of, and need for, medical specialists in South Africa over the next twenty years.

> There is an absence of rigorous public-domain health workforce planning in South Africa currently, the impact of which is reflected in critical shortages and the maldistribution of resources; this also explains the dearth of literature on HRH planning in South Africa.

The last publicly available health workforce projections for South Africa's public sector needs were generated in 2011. The commencement of this project pre-dated the 2019 Ministerial Task Team (MTT) on HRH. The final report from the MTT process was not published at the time of publication of this report. Work estimating the need for and cost of adequate HRH is of paramount importance; in South Africa, HRH makes up almost two-thirds of total public health expenditure.

The outcomes of the project as foreseen at its start were:

- To develop a set of projections of medical specialists in South Africa by specialty (and in some cases sub-specialty);
- to develop a model of need that, together with supply-side projections, will enable workforce planning; and
- To inform ongoing national workforce planning for medical specialists.

The project drew on the following data sources and methodologies:

- Qualitative input through interviews with key stakeholders (including medical school deans, medical schemes, the Department of Health and professional societies) (Section 3);
- Local and international experience: this involved engaging with previous work that has been done in South Africa to ensure that existing expertise and data were leveraged (Section 4);
- International experience: an extensive literature review looking at best practices for HRH modelling and target setting internationally (Section 4);
- The initial 2018 population of medical specialists by sector, working status (full- or part-time), sex and age, with expected movements within and out of this population over time,

supplemented by new entrants into the registrar population from MMed training programmes (Section 6); and

- Targets for specialist to population ratios based on South Africa's burden of disease (Section 7).

A note on terminology:

In the South African context, expressed demand is a poor indicator of underlying need. This is exacerbated by the two-tier nature of the system where expressed demand in the private sector is more than double that in the public sector. The notion of need is therefore more meaningful in the context of HRH planning for the future. It is, of course, crucial to consider how much of that need can be met over time – that it to marry theoretical estimates of HRH requirements with meaningful planning processes.

The "burden of disease", as the term is most commonly used, is typically measured in relation to the causes of death. For our purposes, we have thought of the burden of disease as the disease profile driving the need for health service delivery. For HRH planning it is important to consider not only what it is that people die from, but also what it is that creates the "burden of care" in the system.

3. A multi-stakeholder process

Engagement with key stakeholders has been an important part of the process. We endeavoured to understand the existing work done for South Africa in this area and to learn from these exercises. The Discovery Foundation established a 'reference group'[1] for the project, whose role was to provide oversight and guidance. We relied on this reference group for input and introductions to stakeholders. We also engaged with specialist groups and networks, to ensure that our projections were grounded in reality as far as possible.

We received ethics clearance from the University of Witwatersrand (Ref 180506), which gave stakeholders peace of mind that the data would only be used for this project and that the information would be protected. Ethics clearance was granted in June 2018; the research protocol and clearance confirmation are attached as appendices.

[1] The reference group included members from Discovery Foundation, Discovery Health, HPCSA, CMSA and CoMD. The intended representative from the National Department of Health was unfortunately not available.

The table below lists the major stakeholders consulted and the reason for engaging each of them on this project:

Table 1: Stakeholder list (non-exhaustive)

Stakeholder	Reason for engagement
Prof Alex van den Heever and Dr Nicholas Crisp	Engagement on previous specialist modelling work
Econex	Engagement on previous specialist modelling work
National Treasury	Engagement on data (PERSAL)
Health Professions Council of South Africa (HPCSA)	Engagement on data (number of specialists) and provisional results
South African Medical Association (SAMA)	Engagement on data (number of specialists)
SPESNET	Engagement on data (number of specialists)
Board of Healthcare Funders (BHF)	Engagement on data (private sector specialists), work that their research unit has done and provisional results
Discovery Health	Engagement on data (claims) and provisional results
Colleges of Medicine South Africa (CMSA)	Engagement on data (fellowship examinations) and provisional results
South African Committee of Medical Deans (SACOMD)	Engagement on data (undergraduate medical students and registrars) and provisional results
Universities with medical schools	Engagement on data (undergraduate medical students and registrars)
Western Cape Department of Health Provincial Data Centre	Engagement on data de-identification protocol and management
Healthman	Providers of secretariat function for specialist groups. Engaged to help obtain expert views of specialist to population ratio (letter attached as an annexure to this report)
Surgicom (Dr Philip Matley)	Engagement on demand side modelling (representing private-sector surgeons)
SASA (Natalie Zimmelman)	Engagement on demand side modelling (Chief executive of South African Society of Anaesthesiologists)
National Health Laboratory Service (NHLS)	Engagement on supply-side data
Radiological Society South Africa (RSSA)	Engagement on supply-side data
Hospital Association of South Africa (HASA)	Engagement on provisional results
Workstream 1 of the Ministerial Task Team on HRH (MTT)	Engagement on provisional results

It should be noted that the scope and budget of the project did not allow for in-depth expert engagement for each specialty/sub-specialty. Ideally the epidemiological assumptions, target ratio and policy levers for each specialty/sub-specialty should be interrogated.

The insights from these discussions are not presented as separate qualitative data, but rather inform the thinking, quantitative analysis and literature review presented in this document.

The Percept team also brought in a variety of skills, drawing from economics, public health and actuarial disciplines. This has ensured that the modelling is robust, grounded in sound research, local context and mathematical rigour.

4. Literature review: implications for HRH planning and our model

The team submitted a review of the literature to the South African Health Review (SAHR), for publication in December 2018. The paper served as the literature review for the project. The text of the chapter forms the majority of the content in this section but has been slightly amended for the purposes of this report; the full chapter can be found at this link. Superscripts in this chapter relate to references set out in section 14.

In this review, we consider the implications of NHI for HRH planning in South Africa, including structures and processes, the different model typologies, model designs and data requirements. Within this framework, a brief reflection is offered on the different public-domain health workforce planning models and approaches used in South Africa over the last 15 years.

4.1 Methodology of literature review

This literature overview is based on a review of literature on workforce projection models and planning processes internationally, a review of previous work in South Africa that is located in the public domain and a review of available data sources.

In 2013, Ono et al.[6] reviewed 26 health workforce projection models across 18 Organisation for Economic Co-operation and Development (OECD) member countries. Three countries, namely the Netherlands[7,8], Australia[9,10], and the United Kingdom[11,12], repeatedly emerged as being exceptional for the way they approached the process of planning and data collection, and the models they used.

The experiences of these countries, as well as Japanese[6,12,13] and Thai[14] experience, are relied on given the dearth of literature from other African or other middle-income countries.[2]

While the overview focuses on health workforce planning in general, specific points are illustrated by referring to the issues and complexities associated with physician planning.

The review of previous work done in South Africa included the 2008/09 project by the Colleges of Medicine of South Africa (CMSA)[15], work done by Econex in 2009[16] and 2010[17], the 2011 health workforce planning model by the NDoH as part of a larger process to develop a National Human Resources Strategy for South Africa[17] and work done to cost South Africa's public PHC system based on the World Health Organization model (Workload Indicators of Staffing Need (WISN)) for determining the correct mix and number of staff, as per the demand for services.

4.2 HRH planning and NHI

National Health Insurance (NHI) amplifies the need for coordinated, comprehensive health workforce planning in South Africa, given the intention to move South Africa toward a more integrated health system and to improve equity, quality of care and access to services.[4] Increased health-seeking behaviour anticipated under NHI implies the need for expanded availability of all health workforce personnel, including specialists and general practitioners (referred to collectively as physicians), who are currently drastically underrepresented in the public sector.[3] The implementation of NHI both accentuates the urgent need and creates the opportunity for a more centralised, coordinated approach to health workforce planning in South Africa.

The urgent need

The absence of effective planning in the current system can be illustrated in a number of ways, including the dire shortages in the public sector, a maldistribution of resources geographically and challenges in the interface between the training platform and the public service. We briefly provide examples of each of these.

---

[2] Literature from African countries generally emphasizes the extreme need for more human resources, and programmes that have been implemented to expand human resources, rather than giving detailed descriptions of planning processes. The available English literature on workforce projection models from other middle-income or upper-middle-income countries is limited, as much of the experience in Latin America is described in Spanish or Portuguese only.

[3] The term 'physician' is used in this chapter in this broad sense, reflecting the international literature, rather than the narrower meaning of internal medicine specialist that is common in South Africa.

The collapse of oncology services in KwaZulu-Natal[18] and North-West[19] in 2017 and 2018 respectively are examples of severe shortages that have threatened the public sector's service delivery capacity. These shortages have also severely compromised the training platform, affecting not just current but also future supply. The collapses point both to systemic challenges and to the long-term effects of an absence of effective planning.

The geographic maldistribution of resources can be clearly seen using the example of anaesthetist services, which are required for the provision of an adequate surgery service. Three provinces have single digit numbers of public-sector anaesthetists: Mpumalanga, Limpopo[4] and the Free State[5]. This creates an inequity in access to surgical care, and pressure on surrounding provinces.

In 2018, a large number of junior doctors were not placed in the public sector to complete their internships and community service because these posts were not funded by the provinces.[20,21] While aggravated by severe cuts in provincial health budgets, this disconnect between the training platform and the available budget for HRH illustrates the current lack of co-ordination and planning.

NHI accentuates all these issues. The imperative of access to quality care brings into focus current (and future) shortages. The goal of improved equity will require interventions to remedy the current geographic maldistribution. The planned restructuring of the health sector requires planning tools which can be used to assess the impact of alternative policy options on the country's HRH requirements, including interventions that relate to the training platform.

There are still many unknowns regarding how NHI will be implemented. Areas of uncertainty include the nature and scope of the minimum benefit package, the extent to which existing private financing mechanisms will be permitted to continue, and the extent to which the NHI Fund will purchase services from private providers. All of these decision points require effective HRH planning tools to assess the achievability and sustainability of policy.

---

[4] http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742016000200007

[5] Personal communication with Natalie Zimmerman of South African Specialist Association

The opportunity

The creation of the NHI Fund introduces a purchaser-provider split into the South African health system, with the fund acting as a single purchaser. The role of a purchaser in a health system is to match the supply of and demand for healthcare in a manner that is equitable, deciding what care to purchase, from whom and on what basis.

The implementation of NHI also creates the opportunity to reconsider the structural mechanism for doing HRH planning work, particularly because this work is a central requirement for a strategic purchaser of health services.

Rigorous planning for Human Resources for Health (HRH) is necessary to achieve optimal balance in the functional and geographical distribution of health staff[5], and to ensure that strategies can be put in place to deal with shortages. Mechanisms to do so may include training, importing and reorganising staff, efficiency improvements and/or purchasing of services from the private sector. Any intervention should be evidence-based, emphasising the need for meaningful planning tools. The proposed structural changes to the health system, and the demands these changes will pose, make it imperative to learn from previous work and to build nuanced and rigorous tools and processes for system-wide HRH planning.

In addition, the move towards a more integrated health system under NHI will require consideration of HRH resources in both the public and private sectors. This is relevant because the South African private sector shows dramatically higher physician-to-population ratios[16] than the public sector, given the highly-resourced nature of the private-sector market together with non-financial factors that often drive doctors away from the public sector.[22] Integrated planning tools will help to illustrate ways in which the resources across the two sectors can be leveraged to the benefit of all South Africans.

There has not been a comprehensive health workforce planning initiative that considers supply, demand and unmet need in both the public and private sectors, i.e. that considers the system as a whole.

Previous private sector work did not fully take into account the complexities of public sector delivery[17], while public sector-driven planning models focused mainly on planning for public sector need and context (e.g. the 2011 HRH model[2]). Separate consideration of the two systems ignores overlaps (public sector doctors can apply to work in the private sector while being employed full-time in the public sector, under Remunerative Work Outside Public Service or RWOPS), movements between the two sectors, and the policy imperative to consider re-organisation of the system as a whole.

Any restructuring of the health system has HRH implications. HRH models and projections can be used to assess the impact of restructuring on the future gaps between the need for and supply of resources. An example of health system restructuring is the launch of the District Clinical Specialist Team (DCST) model, which aims to get teams of specialists to provide mentoring in primary health care (PHC) and lower level hospitals (district and regional), while also providing clinical services for highly complicated cases.[23] This approach changes the planning needs for specialists, as it focuses more on a task-shifting and mentorship approach that should reduce reliance on specialists across the country.

The proposed NHI is a large-scale redesign of the South African health system. The opportunity to consider HRH planning as part of that redesign is clear and considers ways to institutionalise and regularise planning, the possible approaches to HRH modelling and approaches to improve the availability of timeous and accurate data. Each of these aspects is considered in turn.

4.3 Institutionalising HRH planning

HRH planning in South Africa has historically been an *ad hoc* process. It is also not clear from recent policy and market processes that there is a clear view on how to approach HRH planning in South Africa in future. The Health Market Inquiry (HMI) has recommended the establishment of a supply-side regulator[24], where the function of HRH planning would be well-placed (although this is not mentioned). The draft Medical Schemes Amendment Bill makes provision for the Council for Medical Schemes to house the data needed for HRH planning, although it is not clear that they, as a regulator of private healthcare funders, are best placed in the health system to do so. The draft NHI Bill is largely silent on HRH planning.

This section considers the need for ongoing processes, the need for the creation of structures to undertake HRH planning and whether separate processes are required for different cadres of the workforce.

The need for ongoing processes

A review of international best practice indicates that ongoing processes are ubiquitous, although there are variations in the entities tasked to do the planning. This was recognised in the NDoH HRH strategy which pertained to the period 2012/13-2016/17, but with the intention to take a 2030 view, as per the National Development Plan, with five-yearly updates to the

> Health workforce planning needs to be actively and continuously managed in order to prevent supply-demand gaps from emerging[1], as has occurred in South Africa.

HRH strategy planned. The next update to the strategy is the expected output from the 2019 MTT process (i.e. two years post the expiration of the last strategy). The absence of an ongoing process in South Africa is reflected in the recent call from the South African Committee of Medical Deans (SACOMD) for the establishment of a joint workforce planning process to ensure integration between the training platform and the availability of posts for graduate doctors and registrars.[1]

Who does the planning?

Planning can be conducted by a series of expert panels set up by government (Japan), by a multi-stakeholder government-industry committee (Netherlands), by a more permanent, dedicated national planning agency or by the government itself. Both the United Kingdom and Australia have transitioned from having dedicated agencies to locating the planning function within government. This shift is reflection of the maturation of the process – it is usually at the beginning that HRH planning processes require careful incubation.

The Japanese government has set up various commissions and expert panels to conduct health workforce planning for different categories of healthcare workers. The panels have generally been housed in the Department of Health.[6] Estimates produced by the Japanese government commission were also tested by academics using their own estimation models.[12,13] This is an advantage of work being placed in the public domain and should ultimately lead to more robust models and results. In the United Kingdom, the Centre for Workforce Intelligence (CfWI), a dedicated HRH planning institution, was responsible for all health workforce planning and analysis from 2010 to 2015. The centre was closed in March 2016, with staff transferred to the Department of Health and Health Education England (located in the NHS).[25] The move appears to be a political decision, and there is little information yet on the effectiveness of this in-sourced approach.

Australia had a dedicated national health workforce planning agency, Health Workforce Australia, from 2008 to 2014.[26,10] It was established as a statutory body. In 2014, the functions of this body were transferred to the Department of Health.

> It appears that the establishment of a separate body is a useful first step to ensure focussed effort on establishing process, data collection and model building. Once established, it may make sense to move this functionality back to the Department of Health.

Of the approaches, the approach taken in the Netherlands seems most suitable to South Africa. Their Advisory Committee is composed of three groups of stakeholders: medical professionals, medical training institutes, and health funders. The outputs are then discussed by relevant specialised platforms (sub-committees) of the

Advisory Committee.[8] The Committee is set up to advise the Dutch Government on how to plan and budget for HRH. This approach aligns with the recommendation in the South African NDoH Human Resources Strategy for the Health Sector 2012/13-2016/17 that a separate agency be established to take responsibility for South Africa's health workforce planning and strategy.[2] This recommendation has not yet been implemented. This approach also aligns with the recent call from SACOMD.

Which health professionals are covered?

Another dimension to consider is which healthcare professionals are covered, and whether there are separate processes for different disciplines or an integrated approach. The United Kingdom and Australia have favoured an integrated approach, planning for a wide range of health (and social care) professions under a single entity, while the Japanese have separate processes for the different cadres.

> We favour an integrated approach given the need for multidisciplinary teams in the health system and changes in scope of practice through task shifting/sharing or the emergence of new cadres.[27]

There is a complex interplay between fluctuation in the number of different categories in the health workforce, and the question of whether the overall supply meets the health needs of the population being served. Generally, separate planning processes do not allow for an accurate interplay between cadres.

In the South African context, the Econex work considered nurse[28], general practitioner and specialist numbers separately[17,29], while the CMSA work considered only specialists.[15] The national health workforce planning model was more comprehensive, covering 100 medical professions, including physicians, nurses, dental practitioners, allied health professions (such as occupational therapists and physiotherapists) and community health workers.[2] This was an appropriate approach given the multi-disciplinary team-based approach foreseen in the NHI Green[27] and White Papers.[4] These policy papers make it clear that the public PHC sector will remain a nurse-driven service, with doctors and specialists using hospitals as their base, and providing outreach services.

4.4 Designing an HRH projection model

Effective HRH planning requires modelling work to project the supply of health professionals, and to consider its adequacy. In this section we consider model typologies, the components of supply-side modelling, the components of either demand or need modelling, the use of scenarios in HRH modelling and the creation of staffing norms from HRH models.

Health workforce projection model typologies

It is useful to compare the HRH modelling that has previously been done in South Africa to the types of models that can be identified in international literature. At least four health workforce planning model types can be identified, of increasing complexity.[6,30,31]

- *Supply-side focused* models, with simple demographic assumptions to control for demand-side factors (population size, and in certain cases, simple utilisation assumptions);
- Supply-side and *demand-side* (estimated gap) models, with demand-side assumptions moving beyond simple demographics, and more detailed utilisation assumptions;
- Supply-side and *need-based* (estimated gap that considers need) models that move from utilisation-based demand to more nuanced considerations of demographic and morbidity trends;
- An extension of the third model type (supply-side and demand-side, sensitive to need) that also includes *specific service targets or specific health outcome targets*. This approach allows for a more integrated consideration of "numbers, mix, distribution, productivity and outcome".[31]

All of the previous work done in South Africa falls into the first category of models. The aim of the 2008/09 project by the CMSA was to research the number of specialists and subspecialists within South Africa and to calculate whether these numbers are sufficient[27] by comparing South Africa's supply of specialists per 1 000 population with international benchmarks[15] (not taking cognisance of factors driving need or demand in South Africa).

Work done by Econex in 2009[16] and 2010[17] was similarly supply-side focused. By the authors' own admission, it was not "a complicated needs or demand-based model".[17] The aim of the model and overall analysis was to contribute data on nurse, doctor and specialist numbers to the NHI discussion.

The 2011 health workforce planning model by the NDoH was part of a larger process to develop a National Human Resources Strategy for South Africa.[17] As with the other two models, it stopped short of considering changes in healthcare service needs over time.

Given the shortages of HRH resources in the South African context, it is likely that demand is not a good reflection of the underlying health needs of the population. There is therefore the risk that if planning is based on gaps between supply and demand, existing inequities in the system will be perpetuated. An estimated gap approach that considers needs is therefore better suited to the South African context.

Supply-side components

The main components on the supply side of a model should include data on the current workforce stock; full-time equivalent(s) per category of health worker; controls for international migration; exits through death and retirement; and data on the number of health workers in training. These pillars are common features in the planning of most countries surveyed.[6] Doing the modelling by age and sex of the workforce is key to allow for feminisation and ageing.

Although South Africa has a young population, similar to that of many other middle-income countries, its health workforce population mimics the dynamics of high-income countries and is likely to be affected by the same factors present in those countries. This includes increased feminisation of the workforce[12,32] (and the implications of this on specialty choice and working hours), and the declining number of health workers available as a consequence of both an ageing workforce and changing retirement patterns.[33] At the same time, the South African market for health workers is subject to some of the influences observed in other low- and middle-income countries, for example, pull factors that make physicians leave for high-income countries with better working conditions[6] and a large private health sector.

Demand and need components

Demographic developments are typically taken into account by using data on population projections and patient registration (e.g. Netherlands).[8] Sociocultural developments based on expert estimations and empirical data (if available) are also frequently used.

The Australian approach projects population size and links current and future utilisation to demographics (age and sex cohorts). Service utilisation (or changes in utilisation) are derived from changes in population composition.[10] In addition, current unmet need for care in the baseline period is also considered.[10]

In the United Kingdom, changes in need are based on consensus expert estimations.[34] All three countries used a panel of experts to provide inputs on epidemiological and other factors driving need.[8,10]

Interestingly, the Thai approach to physician modelling (1972-2004) was typically informed by demand-side projections targeting specific service targets, rather than being supply-led. Regardless, however, of initial emphasis, ultimately both supply and demand have to be considered.

4.5 Planning for change through scenarios

Apart from the baseline projection, best practice international models typically include three to four scenarios.[8,10,34] Scenarios can be used to illustrate the impact of future uncertainty and are well suited to areas such as epidemiological developments, sociocultural developments, innovation and technological developments, changes in demand and changes in productivity.[1,2,3] They can also be used to illustrate the impact of policy interventions such as health reforms, changes in the use of foreign doctors, task shifting, and changes in work hours. Complex scenarios allow the interactions between different forces to be illustrated. In this way, planning tools can be used to aid decision-making by enabling comparison between interventions.

Most of the models reviewed included scenarios dealing with specific factors impacting on physician productivity, including technological changes. In recent years, some models have also started to account for task-shifting in the form of horizontal and/or vertical substitution; for example, substitution between doctors and other mid-level or lower-level health staff such as nurses or trained assistants (clinical associates in the South African context).[1] Given South Africa's shortage of medical professionals, these substitutions become relevant when planning for NHI. This may mean that some cadres will need their scope of work expanded so that they can be suitably accredited, and so that the NHI Fund is able to purchase services from these providers individually or from within multidisciplinary practices or groups.

4.6 The link between HRH projection models and staffing norms

HRH model projections linking supply and either demand or need should be translated into and checked against staffing norms in order to link planning and implementation. Clear staffing norms could help to ensure equity in HR distribution.[4] They may also be useful to plan for incremental coverage, moving from expressed demand (minimum level) to need (more comprehensive coverage). However, norms may oversimplify the complexities of health delivery, and retention of some flexibility in the system is desirable.

One of the activities suggested in the NDoH's HRH strategy was to develop detailed staffing norms for tertiary, regional and district hospitals "to ensure a balanced health system".[5] Although there was a large project to develop these norms following release of the draft HRH strategy, it is not clear that the norms were ever implemented.

Another example of staffing norms is the World Health Organization model: WISN. Work has been done to cost South Africa's public PHC system using WISN to determine the mix and number of staff. Levels of compliance with WISN are very low (7% of clinics in March 2016).[6] A study done by the Medical Research Council (MRC) in North West province found the WISN model to be significantly more expensive than norms suggested by the MRC.[4] This example illustrates the importance of linking staffing norms to broader HRH planning processes and modelling.

4.7 Sources of data

The lack of a single, integrated source of HRH data is an impediment to HRH planning in South Africa. We contrast data availability in South Africa with international practice.

Potential data sources for South African HRH planning

Currently, South Africa's public and private health sectors do not regularly provide publicly available data on their HRH counts and demographics.

There is no single repository of health workforce data that includes all the necessary fields of interest, neither within each sector nor for the country as a whole.

Rather, data are housed in a variety of institutions, from regulatory bodies such as the Health Professions Council of South Africa (HPCSA), tasked with registration to permit clinical practice, to bodies such as the Board of Health Care Funders (BHF), tasked with issuing practice numbers to enable healthcare providers to claim from health funders. Given the siloed nature of the public and private health systems in South Africa, any proper health workforce planning model will require data from several different organisations, government datasets and regulatory bodies. This makes the process cumbersome and difficult to replicate regularly.

Regulatory bodies such as the HPCSA and the Nursing Council should have the full list of registered health professionals, by type. These datasets, however, do not provide an up-to-date view of whether the professional is located in the public or private sector (or both). There are also concerns about the accuracy of these datasets in terms of emigration, death and retirement.[7] Professional registration data should act as the foundation for the total HRH count; however, further data are required to improve accuracy and separate out the public sector from the private sector, those who are registered but not practising, and those who are out of the country either temporarily or permanently.

Payroll information from public provincial departments of health, via the PERSAL (government payroll information) system, can be used to identify registered health workers employed in the public health system. On their own, the PERSAL data do not contain sufficient information on health worker type (for example, the data do not differentiate between medical specialties).

In the private sector, the main data source could be the BHF database. Importantly, the BHF database also distinguishes between group and individual practices, allowing for a more granular understanding of the number of health professionals in the private sector. This database could be triangulated with medical scheme claims data from the largest medical schemes to ascertain which of the professionals in the BHF database are still practising and at what intensity.

To create a South African baseline dataset for the system as a whole, these individual datasets will have to be collated and linked (in a manner cognisant of data sensitivities). While the *South African Health Review* does report on some HRH data year on year, the data sources are likely the same as described above and therefore come with the same cumbersome data collection and collation issues and quality concerns.

The recent draft Medical Schemes Amendment Bill (2018) proposed that a central repository be introduced of all health-related data for the country.[38] This would significantly improve the ability to do robust planning.

Data sources used internationally

Two main data sources are typically required:

- Supply data: Best practice models tend to draw heavily on healthcare professional surveys or censuses of specific categories of healthcare workers. These censuses provide nuanced information on work hours, movements in and out of the workforce, and how societal gender norms interact with the aforementioned. Inputs from expert panels, particularly on demand-side and epidemiological drivers, are also frequently used,[1,3] as are data from training institutions, such as data on medical school intake, medical school graduates and fellows in medical schools (for specialisation).[1,3] In countries like Australia, where a high proportion of physicians are immigrants, data from the government department tasked with managing immigration may also be required.

- Demand and need data: The data required to model demand and need can be obtained from national population projections and data on current utilisation (e.g. hospital episode statistics).[2,3,9] Expert estimates on need and demand can supplement these administrative and other data.

5. Data

5.1 Availability

As discussed in Section 4, South Africa does not have a single authoritative dataset for medical specialists which shows the numbers of registrars, specialists and subspecialists, which sector they work in, to what extent they work (i.e. part-time or full-time), by age, sex and specialty. Therefore, it was necessary to triangulate from several sources for an informed estimate of the 2018 population, which forms the foundation for the supply-side projections in the model.

Decisions had to be made on which datasets to use, given availability and quality. The available datasets on the current supply of specialists included the following:

1) **Public and private sector specialists:** The Health Professions Council of South Africa (HPCSA) professional registration data should ideally be the foundational data source for the current supply as they are a regulatory body meant to register all health professionals irrespective of sector. The HPCSA provided the team with a de-identified dataset. This included age, sex, specialty and date of first registration in that specialty. While it does have a marker for sector, analysis of the data quality clearly indicated the inaccuracy of this variable. There are other data fields which we did not have access to (such as population group) – these could be used to enrich further research. The total number of registrations (around 14,000) also far exceeds all other estimates of specialist numbers in South Africa, suggesting that triangulation with other data sources to isolate those currently in practice was critical.

   The South African Medical Association (SAMA) also has data across both public and private. However, not all doctors belong to SAMA, making their data a subset of the HPCSA data.

2) **Public sector specialists:** The PERSAL database is the foundational dataset for public sector specialists. A drawback of this dataset is that there is no information on the type of specialist employed. While the category exists in the system for capturing these data, it has not been consistently inputted or vetted. We also only received the salary data for the provincial departments of health and not entities like the national health laboratory services (NHLS),

which employ most of the pathology specialists. We received the NHLS data separately. PERSAL has name, surname, age, sex and ID number.

3) **Private sector specialists:** The BHF has been delegated responsibility by the Council for Medical Schemes (CMS) for issuing practice numbers to all private sector health professionals, without which these professionals are unable to bill medical schemes. The BHF dataset therefore acts as the most complete list of private-sector specialists, except in the case of some group practices where data on the underlying individuals is incomplete. It includes name and surnames, age, sex, specialty, professional registration number, practice number and ID number. The dataset further includes an indicator of whether the specialist is also employed by the public sector and engaged in remunerated work outside of public service (RWOPS). These are public sector health professionals who are (legally) working in the private sector, outside of their public-sector work hours. The matching of PERSAL and BHF data is important to account for RWOPS and hence not over-count the supply of specialists for South Africa.

4) **Ensuring quality of public and private sector specialist data:** Discovery Health's claim dataset helped to ensure that all specialists on the BHF dataset are in fact still practising, and the extent to which they are practising on a full-time or part-time basis. Specialists' who claimed more than R20K per annum were deemed to be 'active' in the private sector. This decision was driven by analysing the claims data. We then used the available range of claims per annum to determine a full-time/part-time split for those deemed active. Ideally claims data from multiple schemes should be used. Despite the Discovery Health representing a large proportion of the market, it is possible that some specialists were not represented in the dataset.

5) **Registrar data:** Medical specialists have to first study medicine at an undergraduate degree level (typically 5-6 years), and then complete two years of internship at a public hospital and one year of community service also at a public hospital, before they can consider enrolling in a specialist training programme. During the specialist training, they are referred to as registrars. Data on current registrars (MMed registrations), used to inform the projected future specialist supply, were requested from all universities with medical schools. It was requested that the de-identified (mostly aggregated) university data show registrars by year of study, discipline and sex. Only five universities provided data, after repeated requests, and therefore total registrar numbers were triangulated using Colleges of Medicine: South

Africa (CMSA) data to be representative of the whole country. The registrar dataset required significant analysis. We have written up the process in a separate report, available on request, and provide a summary in Appendix 5.

5.2 Data security

Several prospective data suppliers raised a concern about our linking of datasets on personally identifiable data such as ID numbers in terms of the "Protection of Personal Information (PoPI) Act". However, this linkage was critical as a way to ensure the triangulation did not result in over-estimation of the supply. To address the concern, the Western Cape Department of Health Provincial Data Centre acted as the trusted third party for this project, for the purpose of linking and anonymising the data. We only received the full, anonymised dataset and will never have access to the identifiable dataset from each stakeholder - these went straight to the data centre.

5.3 Data points

The specialist and registrar data cover 26 specialist categories, namely:

1. Anaesthetists;
2. Cardiothoracic surgeons;
3. Clinical pharmacologists;
4. Dermatologists;
5. Emergency medicine;
6. Family physicians;
7. Forensic pathologists;
8. Medical geneticists;
9. Neurologists;
10. Neurosurgeons;
11. Nuclear physicians;
12. Obstetricians/gynaecologists;
13. Ophthalmologists;
14. Orthopaedic surgeons;
15. Otorhinolaryngologists;
16. Paediatric surgeons;
17. Paediatricians;
18. Pathologists;

19. Physicians;
20. Plastic surgeons;
21. Psychiatrists;
22. Public health medicine practitioners;
23. Radiation oncologists;
24. Radiologists;
25. Surgeons; and
26. Urologists.

There are also 44 sub-specialist categories, shown below. The groups are per the HPCSA policy documentation on specialisation:

1. **Anaesthetists** (critical care);
2. **Emergency medicine** (critical care);
3. **Obstetricians/gynaecologists** (critical care, gynaecology oncology, maternal and foetal medicine and reproductive medicine);
4. **Paediatricians** (allergology, cardiology, clinical haematology, critical care, development paediatrics, endocrinology, gastroenterology, infectious diseases, medical genetics, medical oncology, neonatology, nephrology, neurology, pulmonology and rheumatology);
5. **Physicians** (allergology, cardiology, clinical haematology, critical care, endocrinology, gastroenterology, geriatric medicine, infectious diseases, medical genetics, medical oncology, nephrology, pulmonology and rheumatology);
6. **Public health medicine** (occupational health);
7. **Psychiatrists** (child psychiatry, forensic psychiatry, geriatric psychiatry and neuro psychiatry); and
8. **Surgeons** (critical care, gastroenterology, paediatric surgery, trauma surgery and vascular surgery).

The subspecialist pipeline is driven by the current specialist to subspecialist ratio within the practising specialist group. We did not have any other data to make this assumption more nuanced. Therefore, specialty numbers grow in the projections and the associated subspecialty numbers grow at the same rate as their parent specialty.

For each registrar, specialist or subspecialist, we required the following information:

- Age and sex;
- Specialty;
- Full-time or part-time;
- Which sector/s they are working in (public and/or private);
- Year of study for registrars (first year or 2nd-6th year).

Note that population group and geography were not included as variables.

5.4 Datasets and linking

The tables below explain what data were available to identify public, private and RWOPS specialists. An 'x' denotes that data is available. The arrows denote which elements we had planned to use to match across data sources, and the combined row shows what the final dataset for that group will consist of.

Table 2: Data linking for public sector non-RWOPS

	HPCSA #	Name & Surname	ID # (age and sex)	Province	Specialty
HPCSA	x	x		x	x
PERSAL		x	x	x	
Combined	x	x	x	x	x

Table 3: Data linking for private sector only

	HPCSA #	Name & Surname	ID # (age and sex)	Practice #	Province	Specialty
HPCSA	x	x			x	x
BHF	x	x	x	x	x	X
Discovery			x	x	x	x
Combined	x	x	x		x	x

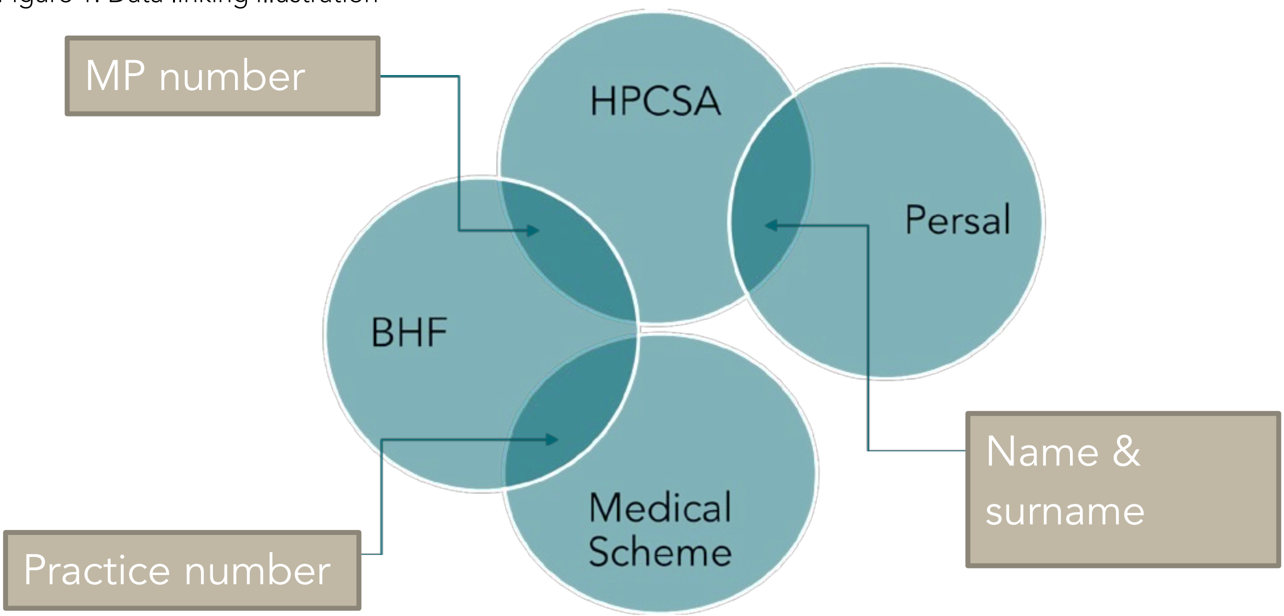
Table 4: Data linking for RWOPS

	HPCSA #	Name & Surname	ID # (age and sex)	Province	Specialty
HPCSA	x	x		x	x
BHF RWOPS	x	x	x	x	x
Combined	x	x	x	x	x

Note that the linking of HPCSA and PERSAL data using name and surname was done using fuzzy matching techniques.

This is illustrated differently below:

Figure 1: Data linking illustration



Datasets we received directly included:

a. De-identified HPCSA data showing **specialists, subspecialists and registrars;**

b. De-identified and mostly aggregated university data showing **registrars** by year of study, discipline and sex. We received this data from Universities of KwaZulu-Natal, Cape Town, Free State, Stellenbosch, Witwatersrand- to various levels of completion. Sefako

Makgatho Health Sciences University, Walter Sisulu, University of Limpopo and Pretoria never provided data despite being contacted several times; and

c. De-identified College of Medicine: South Africa (CMSA) data which shows **registrars** who have written and passed their final examinations which would allow them to qualify as a specialist once their practical training and research degree has been completed.

d. De-identified NHLS data, which showed pathology type and sex but not age of the pathologist.

In the end, datasets that were sent directly to the WCDoH data centre included:

a. Government employee data from the PERSAL system, showing **specialists, subspecialists** and **registrars** only;

b. Board of Healthcare Funders (BHF) data, showing **specialists and subspecialists** only;

c. HPCSA data obtained from their website, which had identifiers such as name, surname and practitioner registration number for **specialists, subspecialists and registrars** – this was necessary as the data received from the HPCSA contained no personal identifiers making data linking impossible.; and

d. Discovery Health Medical Scheme claims data which included the practice number and the volume of claims for **specialists and subspecialists**.

For group practices, we were not always able to see all the individual specialists that fall under the practice (although in theory the BHF should be able to discern between the group and the underlying individuals). This unfortunately results in an underestimation of the number of private specialists. For the following specialties (7 out of the total 26) we needed to use a different approach:

- Clinical pharmacology;
- Emergency medicine;
- Family medicine;
- Nuclear physicians;
- Ophthalmology;
- Radiation oncology;
- Radiology; and
- Pathology.

There are 10,572 HPCSA records for the 18 medical specialists for which this issue does not exist, of which 7,628 are matched in our dataset through the methods described in this report. This gives us an overall match rate of 72.15%. We use this as a target match ratio for the seven specialties listed above.

We use radiology to illustrate the method used:

There were 901 HPCSA records for radiologists, however only 303 were matched in our dataset. Given our target matching rate of 72.15%, we want our starting population to be 650 (901*71.25%). We therefore use the 303 matched, plus need to add the equivalent of another 347 radiologists to the starting population in the model, to get to the desired 650 total. We expect the public sector data to be complete and therefore all of the missing radiologists to be in the private sector, as that is where the group practice problem lies. We allow for each of the remaining 598 data points (901-303) to carry a weight of 0.5803 in the starting population (347/598). We further need to split these by age, sex and full-time/part-time status, and in the absence of actual data do so as follows:

- Use the average age at first HPCSA registration for all matched specialists (36 years of age), and assume this was the age at first HPCSA registration for these additional 347 specialists;
- Assume in the absence of further data that all additional specialists are employed full-time; and
- Split by sex in the same proportions as the 303 matched private sector radiologist population (43.23% female).

The net effect of the above approach is that we add 598 female radiologist data points to our starting population with a weight of 0.25087 (0.5803 x 0.4323) and another 598 male radiologist data points with a weight of 0.32939 (0.5803 x (1-0.4323)) each. The sum of these weights is 347, the required addition to the radiologist starting population derived above.

6. Supply side assumptions

We needed to make several assumptions around the supply of registrars, specialists and subspecialists, to adequately model the supply of these cadres within the system. These are detailed in the section below. We provide a summary of all assumptions in the table below, for ease of reference.

Table 5: Summary of supply-side assumptions

Area	Assumption
Age range of registrars	28-50
Age range of specialists	31-75
Geography	South Africa
Remunerated work outside of public sector	70% of time spent in the public sector and 30% of time spent in the private sector (for each medical specialist in this category)
Transition probabilities	
Retirement age range - public sector	55-75
Retirement age range - private sector	65-75
Death - Female	25% of SA85-90 Light
Death - Male	45% of SA85-90 Light
Move from public sector to private sector	A range of probabilities between end of registrar-ship and retirement
Move from private sector to public sector	A range of probabilities between 45 and 65
Move from full-time to part-time: women	A range of options between 32 and 39
Move from full-time to part-time: men	A range of options between 50 and 65
Move from part-time to full-time: women	A range of possibilities between 40 and 55
Move from part-time to full-time: men	0 as the move to part-time takes place at the end of career
Probability of emigrating	A range of possibilities between 31 and 45
Full-time equivalent calculations for registrars	First-year registrar is 60% of a specialist full-time equivalent (FTE). We then weighted the 2^{nd}-6^{th} year registrars to get to a weighted average of 80% of specialist FTE
Full-time equivalent calculations for part-time cadre	Guided by public sector 5/8ths posts (62.5%)

6.1 Age Ranges

Age ranges are important as they impact on the assumptions regarding emigration, death, retirement and work choices. Therefore, we needed to ascertain reasonable age ranges for specialists and registrars. The subspecialists follow the same rules as the specialists.

It takes a minimum of 13 years to **specialise** in South Africa. This includes a six-year medicine undergraduate programme, two years of internship in a public hospital, one year of community service in a public hospital and then at least four years of registrar training in a particular field of specialisation, also within the public sector. It seems reasonable to assume that many specialists will choose to work for as long as possible, given the training time. Therefore, we have assumed that specialists could work up until a maximum of 75 years of age. This is with the caveat that most public sector specialists would leave service at 65, when their pension pays out, but may choose to continue in sessional work in the private or public sector until 75.

The data we received from five universities (Cape Town, Stellenbosch, Witwatersrand, Free State and KwaZulu-Natal) reinforced our assumption of a 28-50 age range. Only 2% of the total registrars we received data for fell outside of the 28-50 age range. It is possible that the other training institutions (Sefako Makgatho, Walter Sisulu, Limpopo and Pretoria) show a slightly different picture; however, in the absence of evidence to the contrary we have assumed that the distribution by age, sex and specialty across the country followed that observed in the five universities in respect of which data was provided.

6.2 Geography

The model has not included the provincial spread of specialists, as this data is difficult to obtain from the private sector and it is extremely difficult to predict (beyond just an assumption that things will remain as they are) how people will move within the country. We also did not receive registrar data from all the universities, further limiting our ability to model at a sub-national level.

6.3 Treatment of Remunerated Work Outside the Public Sector

The model counts those public sector officials who are currently doing remunerated work outside the public sector (RWOPS) as 70% in the public sector and 30% in the private sector. Unfortunately, the RWOPS policy document does not stipulate this split; information from stakeholders guided this assumption.

It is likely that the number of RWOPS on the register may be drastically underestimated, due to some capturing issues and policy weaknesses. One of the benefits of our approach of matching individuals across datasets is that we have been able to more accurately estimate the numbers of those working in both sectors, by pinpointing those on Persal who are also active in the private sector, as reflected in BHF and Discovery data.

The model allows for the percentage split of time between public and private to be changed to test the impact of RWOPS on the availability of specialists in each sector.

6.4 Transition probabilities

The modelling allows for five transition assumptions/decrements. The rationale for each and the way in which assumptions have been set is described below.

Retirement

In the public sector, people generally retire at 65 because of how public-sector retirement benefits are structured. The earliest age at which public-sector employees can retire without penalty is 55. The private sector does not have the same restrictions, given that specialists either work for themselves or in a group practice and so can define the rules around retirement. We have assumed that earliest retirement in the private sector would be 60. Our assumptions for the public and private sectors respectively are shown in Table 6 below. One paper, which conducted a systematic review of 65 relevant studies, found that physicians tend to stay in practice after the usual retirement age of 65[6]. This has informed our age band going up to 75 for the private sector, and the probabilities in the ages leading up to 65 and 75, respectively. The rates proposed are cumulative over the age band, e.g. the assumption for the 55-60 age band in the public sector should be interpreted as implying that 15% of all 55-year-old public sector specialists will have retired by the time they reach 60, in the absence of competing decrements.

Age bands outside of the ones represented in the table are assumed to have a 0% probability. Ages above 65 are 'N/A' in the public sector as we assumed 100% retirement at 65.

[6] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5109800/pdf/12960_2016_Article_166.pdf

Table 6: Retirement transition probabilities

<table>
<tr><th>Age</th><th>Public Sector</th><th>Private Sector</th></tr>
<tr><td>55-59</td><td>15%</td><td>0%</td></tr>
<tr><td>60-64</td><td>30%</td><td rowspan="2">10% (60-65)</td></tr>
<tr><td>65</td><td>100%</td></tr>
<tr><td>65-70</td><td>N/A</td><td>40%</td></tr>
<tr><td>70-74</td><td>N/A</td><td>90%</td></tr>
<tr><td>75</td><td>N/A</td><td>100%</td></tr>
</table>

Death

It is commonplace for actuaries to use the SA85-90 Light table, based on the mortality experience of insured lives in the late 1980s, as a base for mortality projections for populations with little anticipated exposure to HIV. Although this underlying experience seems out-of-date, it is the last survey of mortality experience in South Africa not significantly affected by AIDS deaths. Allowances for mortality improvements since, and for the mortality profiles of specific sub-populations, are typically made by proportional adjustments to these mortality rates. Based on our experience and on informal consultations with life insurers, we have allowed for male medical specialist mortality at 45% and female at 25% of SA85/90 light. Given how low mortality rates are relative to other 'exit' assumptions such as emigration and retirement, however, this is unlikely to be a material assumption in the model.

Move from public sector to private sector

One paper published about South African medical specialists found that 56% of the specialists in the country work in the private sector[7]. Econex found evidence of significant maldistribution of resources, with 86.5 specialists per 100K in the private sector and only 11.4 per 100K in the public sector in 2013[8] (the denominator in each case representing the population served by each sector). It is well known that the supply of medical skills is unbalanced across the sectors; however, it is often difficult to quantify this (particularly per specialty) given the lack of publicly-available data for both sectors.

[7] https://human-resources-health.biomedcentral.com/articles/10.1186/1478-4491-11-1

[8] https://econex.co.za/wp-content/uploads/2015/08/ECONEX_Doctor-shortages-and-training_FINAL1.pdf

We needed to build some assumptions on how specialists move between the two sectors over the span of their career. We assume these patterns to be no different for women and men[9]. It is important to note that all registrar training takes place in a public hospital. Again, the rates proposed are cumulative over the age band.

At the end of finishing registrar training, a specialist has worked in public hospitals for at least seven years. The South African public sector is well known to be a difficult environment, given funding and resource shortages. Therefore, we assume that a fair number of newly qualified specialists will immediately transition into the private sector[10]. We assume the flow from public to private remains fairly steady from the ages of 32-40 years, as specialists feel more confident in their ability to open their own private practices. We then assume a lower rate between 40 and 50 years, as people build their career in either sector. These assumptions imply that, in the absence of competing decrements, approximately 60% of those completing registrar-ships at 31 would have moved to the private sector by age 40. From 50-60 years we assume the rate increases again to 25%, given that specialists may now prefer to work in the less-structured private environment, where they can choose their own hours. We assume the rate increases to 35% between 60 and 65 years (as mandatory retirement looms). This drops to a zero rate of movement into the private sector after 65 years because there are no doctors left in the public sector post-retirement age. However, those conducting RWOPS will remain as part-time counts in the private sector population, as discussed in RWOPS section.

[9] Note that recent reports about the safety of women health workers in the public sector may mean that these transition rates do differ between men and women.

[10] This was supported in stakeholder interviews

Table 7: Probability of moving from public to private sector

Age band	Probability of moving
31-35 years	25%
35-40 years	25%
40-50 years	15%
50-55 years	25%
55-60 years	25%
60-65 years	35%
65-75 years	0%

Move from private sector to public sector

Similarly, we needed to make assumptions about how people move from the private sector into the public sector. We assume that people would only move across to the public sector at a late age, maybe in an effort to give back or if they have a particular super specialty and they can get more experience in the public system. Some may move over in a part-time role (sessional doctors and consultants) so the rates have been suitably decreased so as to not double count with the full-time/part-time assumptions. Assumptions end at 65 as we assume that the public sector would not hire people over the age of 65 in a full-time role. As above, the rates proposed are cumulative over the age band.

Table 8: Probability of moving from private to public sector

Age	Probability of moving
40-50 years	10%
50-60 years	5%
60-65 years	2%

Move from full-time to part-time

We believe that these rates would differ between the public and private sectors, especially due to the supply-side constraints in the public sector. Most public hospitals do not offer part-time posts for clinical staff and it is not as easy to move between full- and part-time as it would be in private practice. However, our view is that the additional model complexity which flows from allowing for a differential between sectors is not justified by the additional accuracy it might theoretically offer, especially given the highly subjective nature of the assumptions. Therefore, a decision has been taken to have one flat rate for the public and private sectors for movement from full- to part-time and vice versa, that is linked to sex and age- two key drivers for this move.

We assume the movement from full-time to part-time to be different for men and women. Women tend to move to part-time during reproductive ages and men tend to do so towards the end of their careers. One article cites a survey that was carried out amongst a subset of specialists which showed that 10% of physicians stated that they intended to move to part-time during their career[11]. However, the rates may vary substantially between specialties. So, given that and the fact that this is one rate across public and private, the probabilities have been raised to a maximum of 25% of the population. The rates proposed are cumulative over the age band, i.e. the rate per age must sum to the total rate proposed for the age band.

Table 9: Probability of moving from full-time to part-time for women

Full-time/part-time: Female	Probability of moving
32-35 years	10%
35-37 years	25%
37-39 years	15%

Table 10: Probability of moving from full-time to part-time for men

Full-time/part-time: Male	Probability of moving
50-55 years	15%
55-60 years	20%
60-65 years	25%

[11] http://www.journalacs.org/article/S1072-7515(11)00375-9/pdf

Move from part-time to full-time

We assume the move from part-time to full-time to be the same across sectors for the same model complexity reasons as above. However, the supply-side constraints are less in the public sector for full-time posts, so this assumption of it being the same across sectors is less important when thinking of part-time to full-time movement. We have assumed there is no move from part-time to full-time for men, as they tend to move to part-time only at the tail-end of their careers. Therefore, this only applies to women specialists.

For women, the assumed move to full-time comes between ages 40-55, as their responsibilities for child-rearing are lessened as children enter schooling. As above, the rates proposed are cumulative over the age band.

Table 11: Probability of moving from part-time to full-time for women

PT-FT: Female	Probability of moving
40-45 years	50%
45-50 years	35%
50-55 years	25%

Emigration

We found only one paper that specifically references South African doctors' desire to emigrate. In that paper, which focussed on the career plans of medical students after graduating, 7% of those who participated in the survey indicated that they planned to emigrate[12]. Another paper showed a slightly lower rate, although this relates to all professionals and not just doctors. This article found that of the skilled professionals in South Africa, 2% would definitely emigrate and a further 10% have a high likelihood of emigrating[13]. Medical doctors were included in the survey, amongst other professionals. We expect that specialists may find it somewhat easier to emigrate, given the scarcity of their skills. Given these two data points, we have assumed the rate to be in line with the medical students' rate. Therefore, we assume that specialists are even more likely than the average professional to emigrate.

[12] https://open.uct.ac.za/bitstream/item/19022/de%vries_Article_2010.pdf?sequence=1
[13] http://samponline.org/wp-content/uploads/2016/10/Acrobat18.pdf

We assume that people are more willing to move early on in their career and have weighted the probability to the mid-range age band. The rates proposed are cumulative over the age band, i.e. the rate per age must sum to the total rate proposed for the age band. The cumulative effect of these assumptions is that approximately 12% of specialists qualifying at age 31 will have emigrated by the time they turn 45.

Lastly, we suggest that the emigration rate be an assumption that the user can change easily, to test assumptions and the impact of, for example, policy uncertainty on emigration patterns.

Table 12: Probability of emigration, by age band

Age	Probability of moving
31-35	4%
35-40	6%
40-45	3%

Full-time equivalents (FTEs)

Registrars are employed as salaried employees in the public sector and provide semi-specialist services while being trained. The model also includes registrars for each of the specialties, so that the training pipeline is explicitly included and so that these skills within the system do not go unaccounted for.

The model can be run with or without registrars contributing to the FTE estimates. If registrars are included, an assumption has been made that a first-year registrar is 60% of a specialist full-time equivalent (FTE). We then weighted the 2^{nd}-6^{th} year registrars to get to a weighted average of 80% of a specialist FTE. These assumptions help to account for all medical specialist capacity currently in the public sector. **We will show in the results section the public sector specialists without the registrar FTEs as this represents the forecast of qualified specialists, which is comparable to the private sector numbers.**

We further assume that part-time specialists contribute 62.5% of an FTE specialist. This is driven by the public-sector norm which places part-time staff on a '5/8ths' post.

All of these assumptions are changeable in the model and have been tested for reasonability. Given the dearth of data to guide the assumptions, the model will allow for updates to the assumptions and for the user to test different options to see their impact on the results.

7. Need and target ratios

7.1 Shifting needs

The model requires assumptions on how the population in South Africa may change epidemiologically, and how these changes relate to the various specialties. This was done by linking each specialty to a sub-population, and then projecting that sub-population forward. We linked the population to specialists as shown in the table below. These population definitions can be refined over time with expert input.

Table 13: Linking specialists to population groups

Specialty	Population
Anaesthetists	Surgical population
Cardiothoracic Surgeons	Population over 50
Clinical Pharmacologist	Total population
Dermatologists	Total population
Emergency Medicine	Population requiring emergency medical services
Family Physician	Total population
Medical Geneticist	Total population
Neurologists	Population over 50
Neurosurgeons	Surgical population
Nuclear Physicians	Total population
Obstetricians and gynaecologists	Women over 15 years
Ophthalmologists	Total population
Orthopaedic Surgeons	Surgical and emergency population
Otorhinolaryngologist	Population under 15s and 50+
Paediatric Surgeons	Population under 15
Paediatricians	Population under 15
Physicians	Total population
Plastic Surgeons	Surgical population
Psychiatrists	Population living with NCDs
Public Health Med	Total population
Radiation Oncologists	Population with Cancer
Radiologists	Total population
Surgeons	Surgical and emergency population
Urologist	Men over 15

The data sources used to inform the size of the various sub-populations are listed in the table below:

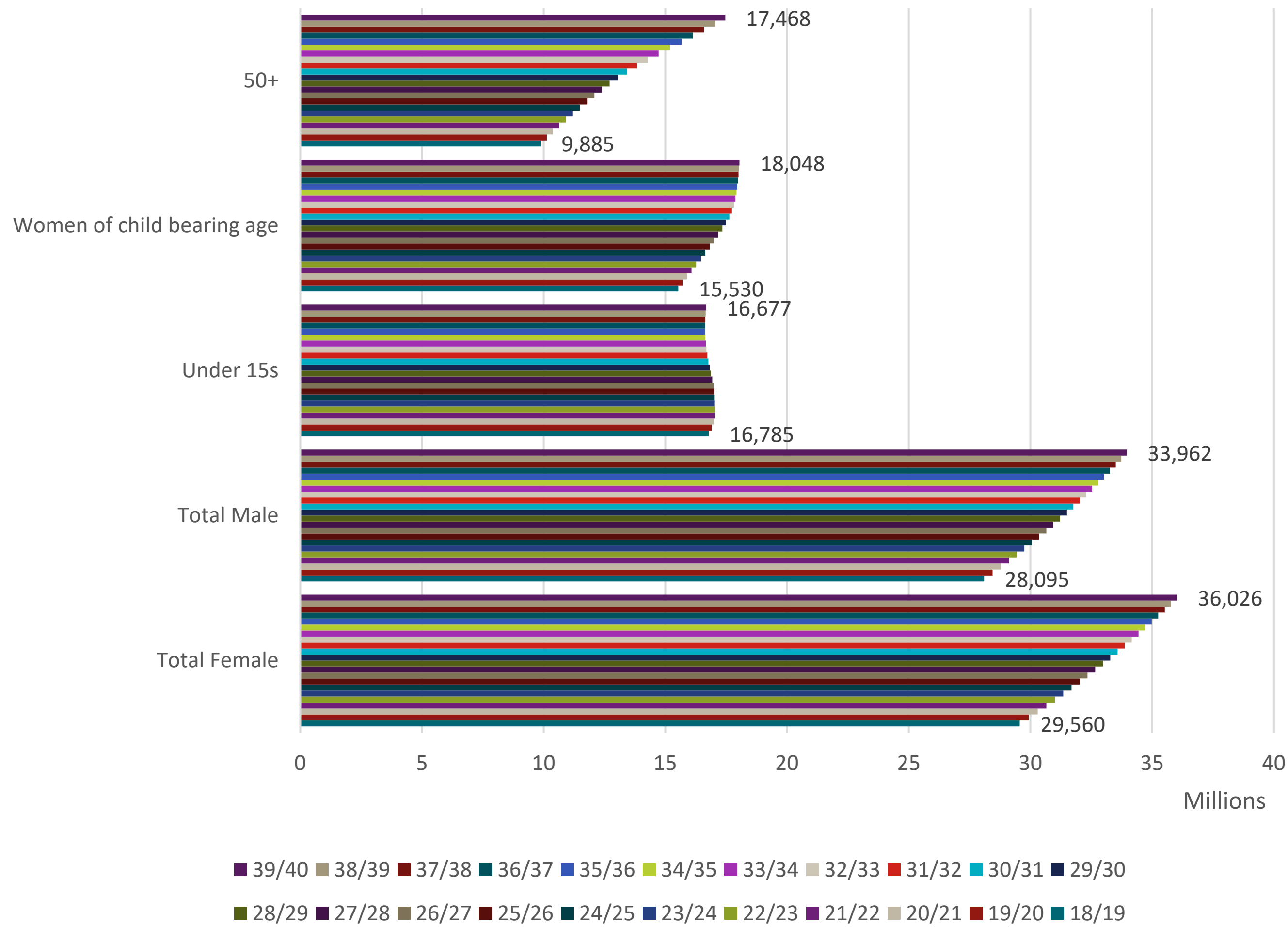
Table 14: Epidemiological and demographic groups for the model

Population group	Data source	Age band	Sex
Total population	Thembisa (total population) CMS (medical scheme population, assumed to not grow)	Under 5 5-14 15-49 50+	Female Male
Birth rate	Thembisa CMS	N/A	N/A
HIV prevalence	Thembisa	Under 5 5-14 15-49 50+	Female Male
Non-Communicable Diseases (excluding cancers)	CMS (and then applied to public sector)	Under 5 5-14 15-49 50+	Female Male
Cancers	Discovery Health Medical Scheme (DHMS) data, adjusted downwards for the public sector projections from year 1 with an annual growth rate of 2%. DHMS data for the private sector, with the average incidence growth rate from 2011-2017, by age and sex, guiding the annual	Children under 15 Adults over 15	Female adults Male adults Children are not separated by sex

Population group	Data source	Age band	Sex
	growth rate assumption in the model		
Tuberculosis	National Department of Health	Not available	Not available
Emergency patients	Available South African literature	Not available	Not available
Surgical patients	Available South African literature	Not available	Not available

The South African overall population, as well as particular combinations of age and sex (e.g. men over 15) and the number of people living with HIV, are projected using the Thembisa model. The figure below shows the projected population from 2018/19 to 2039/40 by sex and key age groups. As expected, there are more women than men (51%-49% in 2039/40). The population 50 years and older is expected to almost double by 39/40, placing a significant health burden on the country as older age is strongly correlated with a more complex burden of disease. The population under-15 shows no significant increases, which has implications for the economically active population group going forward.

Figure 2: Projected age and sex profile of South African population



We have separated cancers out from NCDs because of the growing burden and cost of cancer treatment in South Africa. Cancer also links very directly to at least one specific specialist type (radiation oncologists).

We believe the **cancer data** is hugely underestimated in the National Cancer Registry (NCR) - which would form the only publicly available South Africa specific cancer dataset for the public sector. However, the NCR only includes those we know of, and therefore misses out on the many people we suspect are not diagnosed due to supply-side limitations in the public sector (limited screening and late diagnosis).

Therefore, we decided to use the incidence in the SA population (187/100K) referenced in the Discovery Health Medical Scheme (DHMS) oncology data instead of the NCR data. We then grew the incidence to match the DHMS members' rate (237/100K) by 2028/29. The growth is assumed to be stable year on year, at 2% each year. We then estimate that incidence grows at the same rate (an increase of 2% per annum) until 2039/40. By 2039/40, we estimate the incidence of cancer within the public sector population is 289/100K.

For the private sector, we also used the DHMS data for the population registered on DHMS (237/100K). Although the incidence is higher than what the Council for Medical Schemes (CMS) estimates, we believe the data quality from DHMS is of a higher standard since it is not prone to variation in reporting quality across medical schemes as the Council data are. From the DHMS data, we can see the trends in incidence from 2011 to 2017 for children, female adults and male adults. We took the average of these seven years and grew the incidence by this amount for each year, until 2039/30. This was calculated as 3.5% for children, 0.9% for female adults and 2.2% for male adults.

We justify using a different rate for the public and private sectors given the access issues in the public sector, which have dramatically reduced the number of identified cases. If we were to assume the same rate as DHMS data shows for the population covered by this scheme, the model would indicate an enormous increase in the need for radiation oncologists, which would not be accurate given the actual cases seen. However, we grow the public sector incidence, accounting for improvements in access as we move towards National Health Insurance, and we suggest that the rates are adjusted as more data becomes available for the public sector.

We use CMS data for **chronic diseases** to estimate the trend for the other (non-cancer) NCDs. The other NCDs are difficult to link to any one type of specialist and therefore this group is used for several of the specialists, when projecting need. In future iterations, more of the distinct NCDs could be separated out with assistance from experts on how best to map these to individual specialist types for forecasting.

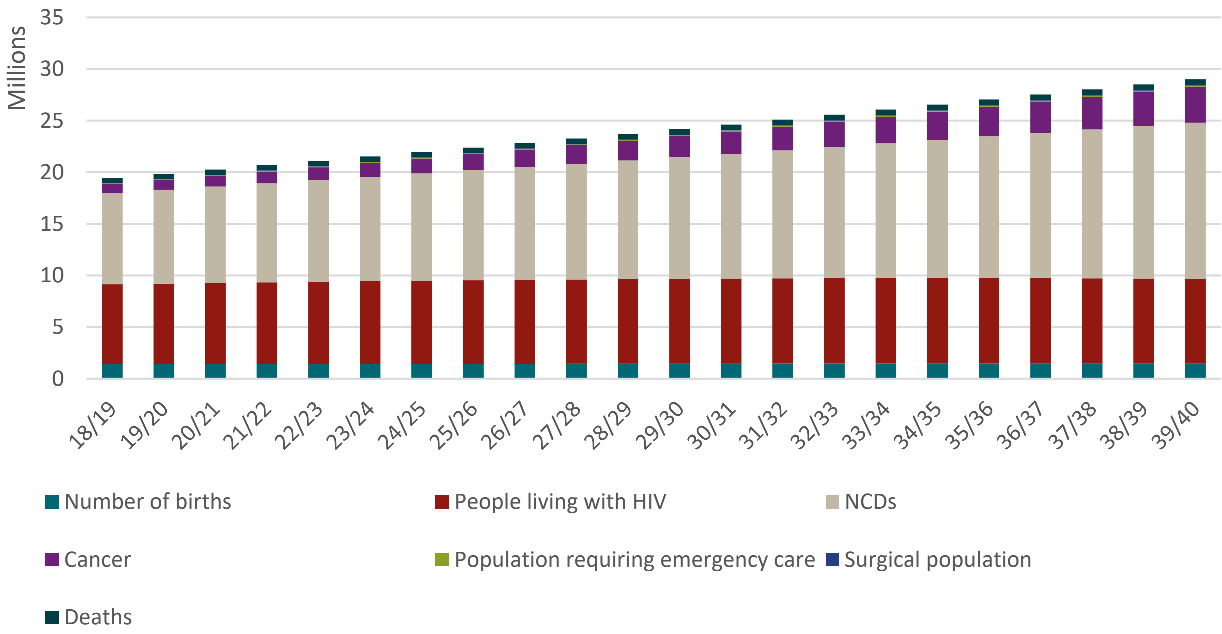
The **emergency sub-population** was difficult to estimate, given a dearth of data. We therefore had to rely on existing South African academic literature. There was a study published in 2007[14] by leading researchers, that projected the burden of injuries in South Africa, using available South Africa statistical data on cause of death, for the year 2000. This data is outdated; however it was the most reliable estimate we could find. This research estimated a trauma rate of 1.35 per 1,000 population, which we used to forecast the emergency population. We do believe this is an underestimate.

[14]https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2636399/

The **surgical sub-population** was also difficult to ascertain, and we relied on available South African literature to guide our assumptions. A study, published in 2017, aimed to quantify the geographical maldistribution of surgical services in South Africa[15]. In doing so, it provided data on the number of surgical beds in the country (public and private sectors). We used this number of beds to estimate the need for surgical services[16]. We realise that the number of beds is a limited proxy for the need, however, this sort of data is not collected in South Africa- although there is growing interest following the Lancet commission on Global Surgery[17].

The separate estimates from each component of the burden of disease are combined to form the picture below. The NCD population (excluding cancers) is shown to almost double between 18/19 and 39/40- also placing a large burden on the health system and the need for medical specialists and HRH in general. The population living with HIV is projected in the Thembisa model to level out – reflective of the investments in treatment and prevention.

Figure 3: Estimated burden of disease in South Africa



The model projects the shifts in each of the sub-population groups between 2018 and 2040. The table below shows the sub-population estimates at three points in time.

---

[15] http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S0256-95742017001200022

[16] The calculation is as follows: number of surgical beds * 80% bed occupancy rate *365 days in a year divided by the average length of stay

[17] https://www.lancetglobalsurgery.org/

Table 15: Population changes over time: absolute numbers

Financial Year	18/19	29/30	39/40
Total SA population	57,655,714	64,775,931	69,988,237
Total Female	29,560,338	33,280,989	36,026,358
Total Male	28,095,376	31,494,941	33,961,879
Under 15s	16,784,684	16,818,931	16,677,487
Women of child-bearing age (15-49)	15,530,370	17,497,240	18,047,682
Number of births	1,406,799	1,457,458	1,490,749
Men over 15	19,652,890	23,034,283	25,570,888
50+	9,884,992	13,056,295	17,467,903
Under 15s and 50+	26,669,676	29,875,226	34,145,389
PLWHIV	7,731,068	8,216,890	8,179,451
Non-communicable Diseases	8,866,896	11,786,717	15,134,310
Population with cancer	895,396	1,848,100	3,042,691
Population in need of emergency care	77,908	87,529	94,572
Surgical population	23,070	24,883	26,210
Deaths	492,426	553,238	597,755

The next table shows the percentage change from 2018/19 to 2039/40, by subpopulation group. The population with cancer immediately jumps out (an increase of 340%), along with the over-50 age group with a 177% increase. Both have significant implications for the need for medical specialists and the financing of health care services in South Africa.

Table 16: Subpopulation group changes over time: growth

Financial Year	18/19	39/40	Growth:18/19-39/40
Total SA population	57,655,714	69,988,237	121%
Total Female	29,560,338	36,026,358	122%
Total Male	28,095,376	33,961,879	121%
Under 15s	16,784,684	16,677,487	99%
Women of childbearing age (15-49)	15,530,370	18,047,682	116%
Number of births	1,406,799	1,490,749	106%
Men over 15	19,652,890	25,570,888	130%
50+	9,884,992	17,467,903	177%
Under 15s and 50+	26,669,676	34,145,389	128%
PLWHIV	7,731,068	8,179,451	106%
Non-communicable Diseases	8,866,896	15,134,310	171%
Population with cancer	895,396	3,042,691	340%
Population in need of emergency care	77,908	94,572	121%
Surgical population	23,070	26,210	114%
Deaths	492,426	597,755	121%

7.2 Target ratios

The model produces estimates of the gap between the projected supply of and estimated need for medical specialists. The need for specialists is expressed in terms of target ratios. Target ratios for each specialist type are difficult to come by, especially for countries similar to South Africa as these countries typically do not undertake HRH planning at such a detailed level. An extensive literature review was conducted to initially try and find ratios within lower- or middle-income countries which are comparable to South Africa. When that proved unsuccessful, we widened the search to any country, and found some data for OECD countries, but not for all the specialist types and especially not for subspecialties. Many of these ratios were also far higher than South Africa could reasonably aspire to in the medium term, and so are not very helpful in informing a feasible target ratio.

We know that South Africa's medical specialists tend to work in the private sector and as a result the spread is skewed toward the private sector. Therefore, the current ratios in each of the two sectors could act as lower and upper bounds.

Within the HRH Strategy developed by the NDoH, work was done to estimate target ratios for each of the medical specialists. It is important to note that these were developed with the overarching philosophy of trying to decrease the need for medical specialist through task shifting and other mechanisms. These target ratios are for South Africa as a whole and are therefore conservative and at the lower end, given the context in which they were created. The supporting analyses are also not available, making the methods difficult to interrogate. Nevertheless, we have used these targets for the initial target in the model as they have also now formed part of the NDoH's HRH Strategy and are the only published and NDoH-accepted South African targets available. It is also a useful benchmark against which to measure progress since the HRH strategy was published.

We developed a 'recommended' set of target ratios for the model. The data points that were used to arrive at a 'recommended' target ratio include the following:

- The NDoH's HRH Strategy (2011) target ratios;
- Target ratios as identified from a literature review/scan and inputs received from South African specialist associations;[18]

[18] We specifically also looked for target ratios that could be used from two African countries that recently experienced quite extensive HRH planning processes: Mozambique and Ghana. A literature search revealed that the data on targets or target ratios in the public domain are mostly on GPs, nurses and occupational health positions. We could not find target ratios per medical specialty.

- Actual upper and lower bound specialist ratios from the OECD's database;
- Actual current (2019) private sector ratios (see Section 9.1);
- Actual current (2019) public sector ratios (see Section 9.1).

It is important to note that our 'recommended' ratios should be taken as a starting point and should be further developed through in-depth stakeholder engagement (which fell outside of the scope of this project).

The targets per specialty are presented per 100,000 (100K) total population so as to be internationally comparable.

In order to build a projection model that is sensitive to changes in need over time it is necessary to adjust the targets to allow for changes in the burden of disease over time. We therefore created another target option in the spreadsheet model, called 'recommended with epidemiological impact'. For this, we took the subpopulation attributed to each specialty and applied the following formula:

*[original 'recommended' target for the specialty] * [projection year subpopulation/projection year total population] / [2019 subpopulation/2019 total population]*

This formula essentially adjusts the recommended target we estimated for that specialty by the change in the subpopulation's share of the total population from 2019 to the projection year. For example, the target ratio for radiation oncologists needed in 2040 increases using this method, given that the cancer population makes up a larger share of the total population in 2040, as compared to 2019.

A table setting out our synthesis of the literature and relevant data sources, and our detailed thinking on the various target ratio assumptions, including assumptions around the recommended target ratio, can be found in Appendix 4. The recommended target ratios can be thought of as a resource-rich or aspirational target ratio, i.e. ratios that we suggest pursuing if there were more resources available. The table contains a notes section to explain our thinking in triangulating between the various data sources and how we arrived at an assumption for each specialty. These assumptions are debatable, especially in the absence of clear international benchmarks and examples for many of the specialties. These target ratios do not explicitly take into account interactions between the different specialties. This should form the focus of future work where it is recommended that expert guidance be obtained from a panel of medical specialists to reflect on interactions between different specialties and task sharing between cadres.

To give an indication of the size of the recommended scenario: when all the medical specialties are added together, we arrive at an overall medical specialty target ratio of **42.46 per 100K**. It may initially appear excessive because it is almost five times the size of current (2019) actual public-sector ratios (7.51/100k) and slightly less than double the size of the combined number of specialists in South Africa (23.02/100K). But, to contextualise the number: the overall medical specialist ratio for Turkey is **124 per 100K**, while it is **151 per 100K** for Mexico (OECD Health Statics, 2018, with 2015 being the most recent data year). Our 'recommended' overall target ratio is therefore only about a third of the size of Turkey's and even smaller compared to Mexico.

Lastly, we allow the user to input their own targets, to allow for key stakeholders and content specialists to be able to test more nuanced or updated figures.

Table 17: Actual and target ratios per 100K from various sources and different scenarios for the year 2019

Specialties:	Current actual: public	Current actual: private	NDoH HRH strategy targets	Recommended
Anaesthesiology	0.64	9.69	3.70	5.00
Cardiothoracic Surgery	0.06	0.58	0.30	0.40
Clinical Pharmacology	0.01	0.10	0.03	0.10
Dermatology	0.07	1.33	0.40	1.00
Emergency Medicine	0.13	0.17	0.20	1.00
Family Medicine	0.66	3.78	0.20	2.00
Forensic pathology	0.12	-	0.60	1.20
Medical Genetics	0.01	-	0.21	0.21
Neurology	0.04	0.71	0.20	0.77
Neurosurgery	0.09	1.12	0.50	1.20
Nuclear Physician	0.07	0.28	0.10	0.20
Obstetrics and Gynaecology	0.62	6.57	1.70	2.40
Ophthalmology	0.41	1.91	0.50	1.90
Orthopaedic Surgery	0.36	5.30	1.60	2.40
Otorhinolaryngology	0.13	1.90	1.10	2.06
Paediatric Surgery	0.04	0.08	0.08	0.26
Paediatrics	0.89	4.34	2.10	4.00
Pathology	0.45	3.39	1.00	2.00
Physician	0.95	9.08	2.40	2.80
Plastic and Reconstructive Surgery	0.08	1.26	0.30	0.53
Psychiatry	0.38	4.98	1.00	3.00

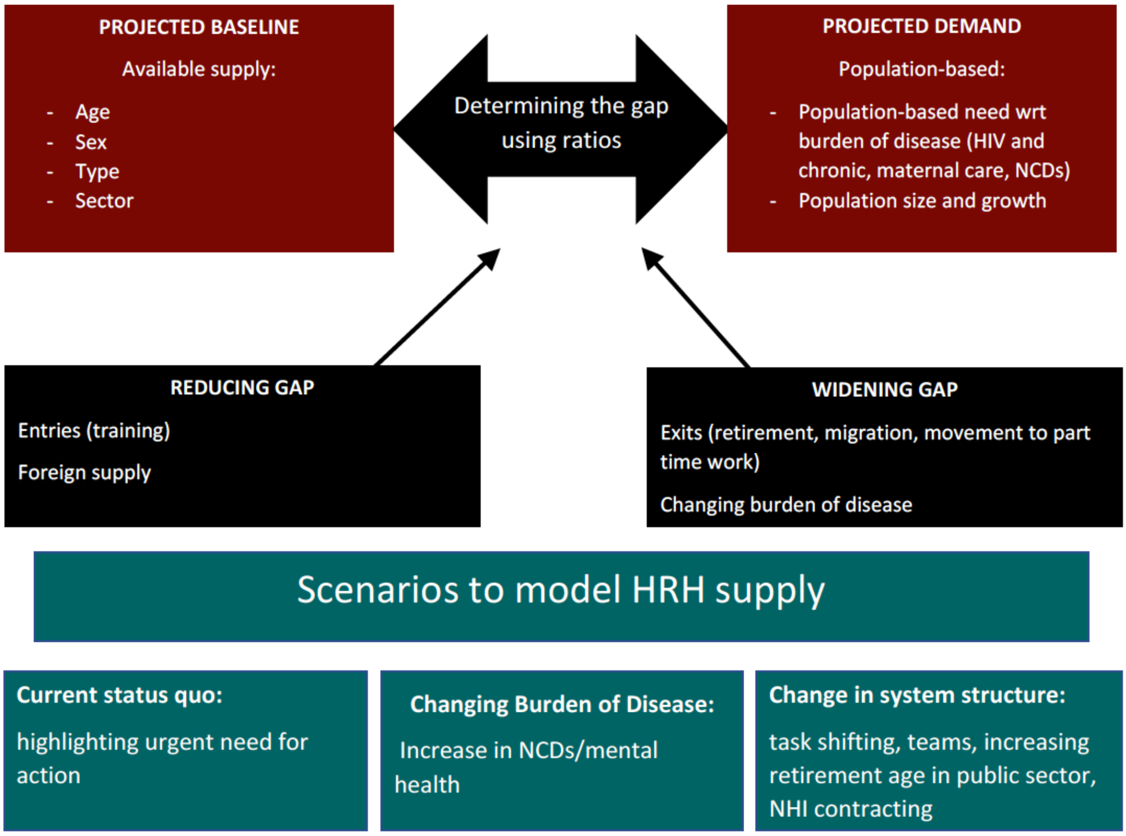
Specialties:	Current actual: public	Current actual: private	NDoH HRH strategy targets	Recommended
Public Health Medicine	0.12	-	0.40	0.25
Radiation Oncology	0.08	1.22	0.20	1.28
Radiology	0.48	4.65	1.50	2.00
Surgery	0.53	4.51	2.40	3.50
Urology	0.10	1.85	0.30	1.00

The high ratios in the private sector are quickly evident and show the need for reasonable country-wide targets for the country, given that South Africa still falls way below other middle-income countries in terms of access to medical specialists.

8. Model Design

Our departure point for design was the model developed by Alex van den Heever and Nicholas Crisp for the NDoH. A simplified outline of our model structure is depicted in Figure 3.

Figure 4: Simplified model outline

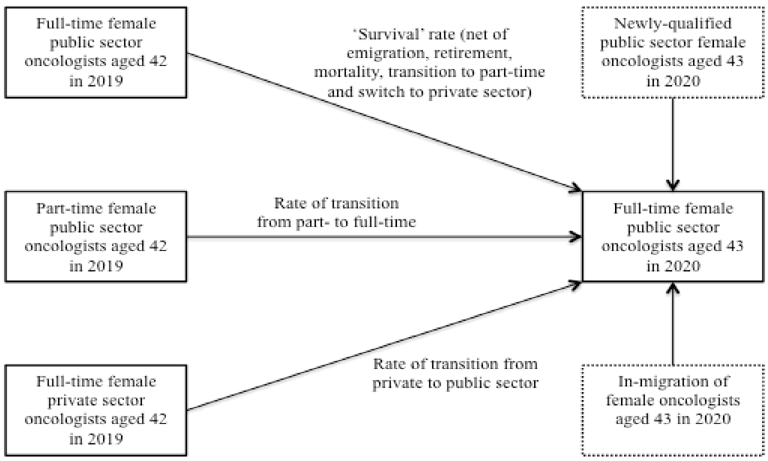


The supply-side model includes as exogenous (external) population inputs the following:

- starting population of specialists and subspecialists in 2018, split by specialty or sub-specialty, sector, working status, age and sex;
- starting population of registrars in 2018, split by specialty, age, sex and study period (first year or 2^{nd}-6^{th} year);
- future projected intake of first year MMed students (registrars) from 2019 onwards, split by specialty, age and sex; and

We then applied a set of transition probabilities onto these inputs, which determine the probability of each of the following for a specialist of a given age, sex, sector and working status:

Figure 5: Illustration of model dynamics (female public-sector oncologists aged 43 in 2020)



The model was coded in the programming language Python, but we have developed a user-friendly Microsoft Excel interface to allow stakeholders to easily navigate the results and experiment with different scenarios. Any of the assumptions can be changed in Python and the model rerun, and the outputs pasted into the Excel model. The results will then auto-update (after you have refreshed the pivot tables) based on these new assumptions. Unfortunately, it was not possible to house such a big dataset (with the transition probabilities applied in a mathematically rigorous manner) in Excel.

Internationally, best practise is to show results based on the total population (per 100K) and not for specific sub-groups, as this makes it difficult to compare. However, we do show in the results section the need by sub-population for some of the key epidemiological areas, to show the need for particular specialists, as per South Africa's burden of disease trajectory.

9. Results

This section presents the projection results of the model. We take the baseline projections, assuming no change in policies or intake, and compare that to the need (represented by target ratios).

The reader can assume we are referring to the full-time equivalent (FTEs) in the analysis unless otherwise stated. The FTEs include *qualified* specialists and subspecialists and take into account all the transition assumptions described in the sections above[19]. Therefore, if the assumptions are changed, these results would also change. For ease of visual representation of the results, we have grouped the specialties into three groups. The three groups and their specialties are shown in the table below:

Table 18: Specialties by group

Group	Specialty
Surgical	Anaesthesiology
	Cardiothoracic Surgery
	Neurosurgery
	Obstetrics and Gynaecology
	Orthopaedic Surgery
	Paediatric Surgery
	Plastic and Reconstructive Surgery
	Surgery
	Ophthalmology
	Otorhinolaryngology
	Urology
Medicine	Dermatology
	Family Medicine
	Neurology
	Paediatrics
	Physician
	Psychiatry
	Radiation Oncology
Other	Emergency Medicine
	Forensic pathology
	Medical Genetics
	Clinical Pharmacology
	Nuclear Physician
	Pathology
	Public Health Medicine
	Radiology

9.1 2018/2019 Status quo

We first detail the results from the model for 2019, the base year. This section acts as a snapshot of current HRH availability and allows the reader to sanity check the baseline assumptions before going into the projections in the sections below. The results below do not include any registrar time, to allow for a fair comparison between the sectors.

[19] Therefore, these results do NOT include any semi-specialist supply from registrars

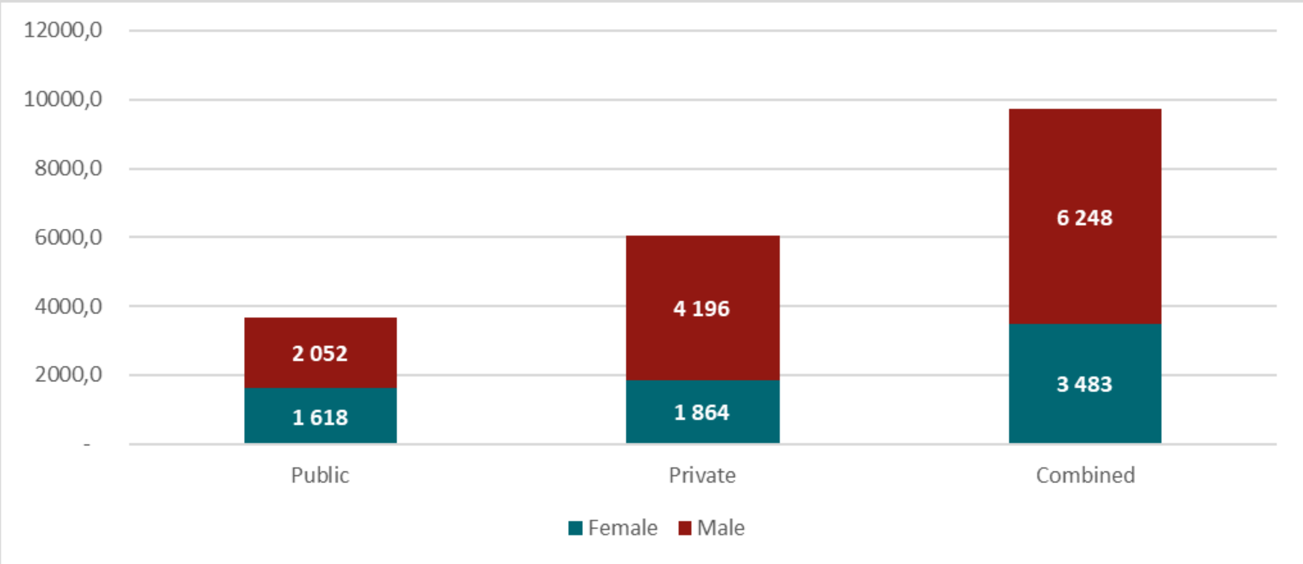
From our data providers, the full time equivalent (FTE) medical specialists for the 26 specialties was **9,731**. This resulted in 3,483 FTEs in the public sector (38% of the total) and 6,061 in the private sector (62% of the total), as shown in the table below.

Table 19: Aggregate statistics by sector and sex

	2018/19 population
Private	**6,061**
Female	1,864
Male	4,196
Public	**3,670**
Female	1,618
Male	2,052
Grand Total	**9,731**

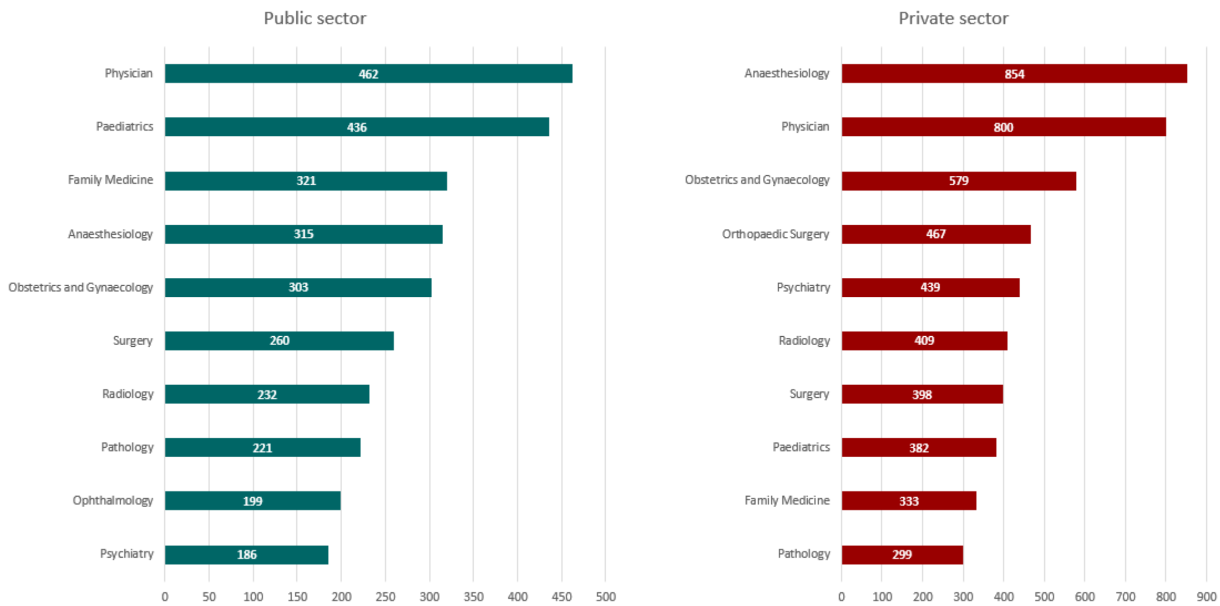
The split of medical specialists by sex is substantially skewed towards men, with women making up only 36% of the total medical specialist population in 2018/19. This picture was reflected in the individual sectors as well as shown below.

Figure 6: Number of specialist statistics by sector and sex (2019)



Below we show the numbers of medical specialists for the specialties which make up ~80% of the total medical specialist population. The figure below shows this graphically, displaying the disparity across specialties but also across the sectors.

Figure 7: Top 80% of specialist population, by sector (2019)



Below we display the 2019 numbers in tabular form, including the share per sector. The shaded cells are the specialties for which the private sector has a larger share. Given that the public sector looks after the vast majority of South Africa's population, one would want human resources to be skewed towards this sector. However, given the realities of the public sector, including: infrastructure and consumable shortages; shortages in other cadres of health workers; and a competitive private sector market, we see an almost even split in most of the specialties. We have seen the ramifications of this in the substantial backlog of surgical cases in the public sector. There is, therefore, a case to be made for contracting private sector resources, while discussions remain on-going with regards to the NHI.

Figure 8: Top 80% of specialists, by sector (2019)

Specialty (incl. sub-specialists)	Public sector	Private	Share public sector	Share private sector
Psychiatry	186	439	30%	70%
Ophthalmology	199	Not in private sector top 10	54%	46%
Pathology	221	299	43%	57%
Radiology	232	409	36%	64%
Surgery	260	398	40%	60%
Obstetrics and Gynaecology	303	579	34%	66%
Anaesthesiology	315	854	27%	73%
Family Medicine	321	333	49%	51%
Paediatrics	436	382	53%	47%
Physician	462	800	37%	63%
Orthopaedic Surgery	Not in public sector top 10	467	28%	72%

In 2010, it was estimated that there were 9,630 medical specialists, with a split of 43.8% in the public sector and 56.2% in the private sector.[20] Therefore, our 2019 base number of 9,731 (62% of which are in the private sector) which includes RWOPS aligns well to the existing estimates which did not take RWOPS into account.

When looking at our raw data set for specialists in each sector (i.e. not FTEs), we get a total of **10,130** specialists in 2019.

The table below shows the number of specialists, per specialty, who were shown to be working in both sectors (RWOPS). Overall, 35% of public sector specialists engage in RWOPS (1,434 of 4,112). Given that the policy is not enforced strictly, it is possible that public sector clients are being short-changed by specialists who are overworked across both sectors. Anaesthetists (221) and physicians (201) have the highest number, closely followed by obstetricians/gynaecologists (190) and surgeons (170). The presence of the surgical specialists within the RWOPS community is unsurprising, given the infrastructure constraints in the public sector.

[20] Cited from Econex Note 7: an update on medical specialist numbers but also referred to in the HRH Strategic Plan for South Africa: 2012-2017

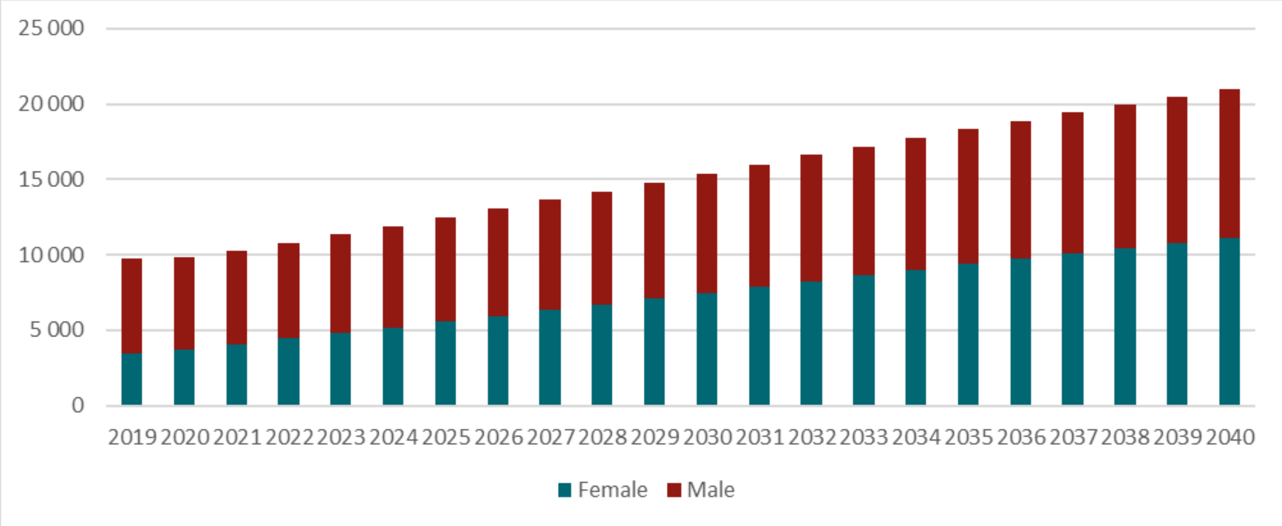
Table 20: Number of specialists who work in both the public and private sector (2019)

Specialty	Number
Anaesthesiology	221
Cardiothoracic Surgery	25
Clinical Pharmacology	0
Dermatology	34
Emergency Medicine	3
Family Medicine	1
Forensic Pathology	0
Medical Genetics	0
Neurology	10
Neurosurgery	29
Nuclear Physician	5
Obstetrics and Gynaecology	190
Ophthalmology	0
Orthopaedic Surgery	142
Otorhinolaryngology	57
Paediatric Surgery	11
Paediatrics	102
Pathology	1
Physician	201
Plastic and Reconstructive Surgery	36
Psychiatry	121
Public Health Medicine	0
Radiation Oncology	6
Radiology	18
Surgery	170
Urology	51
Total	**1,434**

9.2 Projections by demography: 2019 to 2040

Overall the number of specialists is expected to double by 2040. This of course assumes that the training pipeline stays the same size and that emigration rates do not increase. The figure below shows the shift in female and male specialists from 2019 to 2040. This is largely driven by the current sex split in the training pipeline, and by the gradual retirement and death of the older, largely male, cohorts. The share of women specialists increases from 36% in 2019 to 53% in 2040. This change implies dramatic growth in the women specialist workforce and will have implications for the structuring of work and trends observed around work, for example, movements from full time to part time employment and choice of specialty.

Figure 9: Projected specialist FTEs by sex



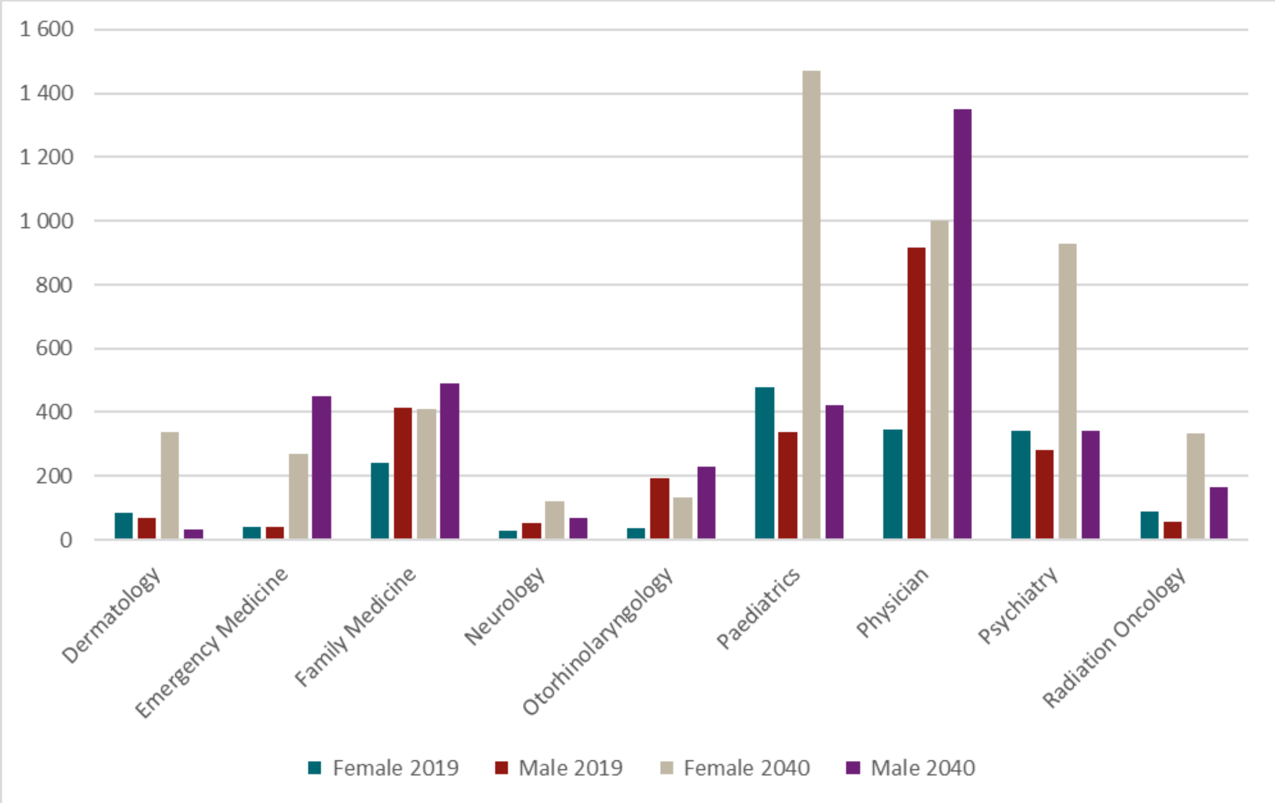
There is an average projected increase of 259% in female doctors within the surgical specialties. However, this is off a low base (the absolute number increase from 1,131to 4,059). By 2040, the projection shows an almost 50-50 split between male and female doctors (47% female). Female doctors appear to prefer anaesthesiology, paediatric surgery and ophthalmology relative to other surgical disciplines. Orthopaedic surgery and neurosurgery are the most strongly male-dominated disciplines.

Table 21: Projected growth in the surgical specialties by sex

Row Labels	Female 2019	Male 2019	Female 2040	Male 2040
Anaesthesiology	481	688	1,784	1,086
Cardiothoracic Surgery	5	78	24	102
Neurosurgery	12	131	21	212
Obstetrics and Gynaecology	337	545	1,056	986
Ophthalmology	125	242	300	221
Orthopaedic Surgery	33	612	181	944
Paediatric Surgery	15	12	169	36
Plastic and Reconstructive Surgery	25	125	107	107
Surgery	98	559	417	867
Grand Total	**1,131**	**2,992**	**4,059**	**4,561**

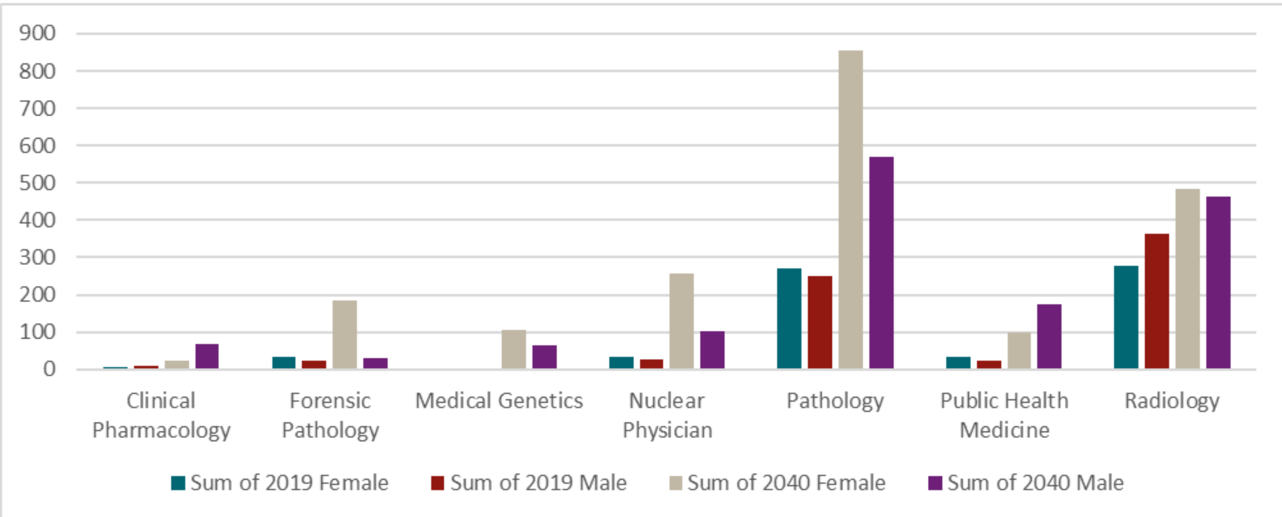
The medicine specialties show female specialists increasing from 42% to 59%. Dermatology, paediatrics, neurology, psychiatry and radiation oncology are all projected to have more female doctors than male.

Figure 10: Projected growth in the medicine specialties by sex



Within the other specialties, women also increased their share from 49% to 58% in 2040.

Figure 11: Projected growth in the other specialties by sex



The trends described above show a workforce that is increasingly dominated by women. The feminisation of the medical profession is a topic of much discussion internationally, mostly due to the risk of transition to part time during child-bearing years and the impact of this on the available resources.

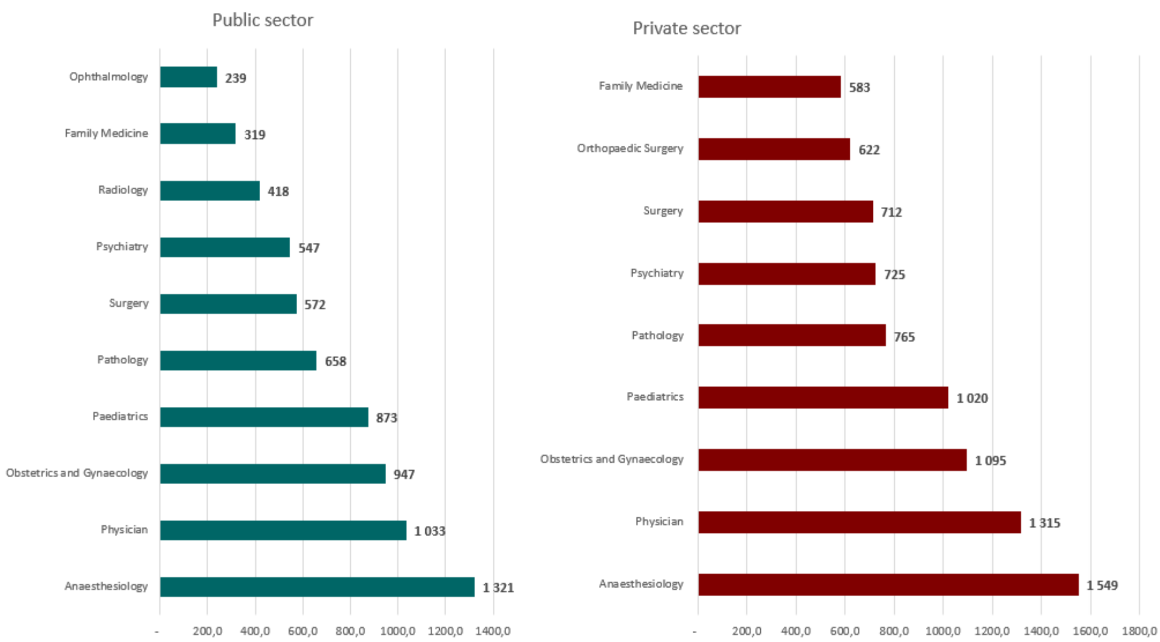
9.3 Projections by sector

It is well documented that South Africa's private sector is much better resourced than the public sector (even if still insufficiently so). Therefore, an analysis by sector is helpful in quantifying this difference (and the nuances of how this varies by specialty) and providing key findings that could help policymakers and stakeholders in planning for specialist services for the country as a whole. The proposed NHI reform contemplate that the NHI fund would be able to contract with both public and private providers for services for the entire South African population.

The proportion of specialists in the private sector is projected to reduce slightly (from 62% to 55%). In reality, this will depend on how the two sectors relate to each other under NHI, and the ability of the public sector to fund additional posts.

We looked at the top 10 specialties (of a maximum number of 26) in terms of actual numbers per sector, for the year 2040. Notably, in the public and private sectors, these 10 specialties make up over 70% of the total number of specialists in each sector. We also see that there is little difference in the share of the top 10 specialties between 2019 and 2040.

Figure 12: Top 10 specialties by number, by sector in 2040



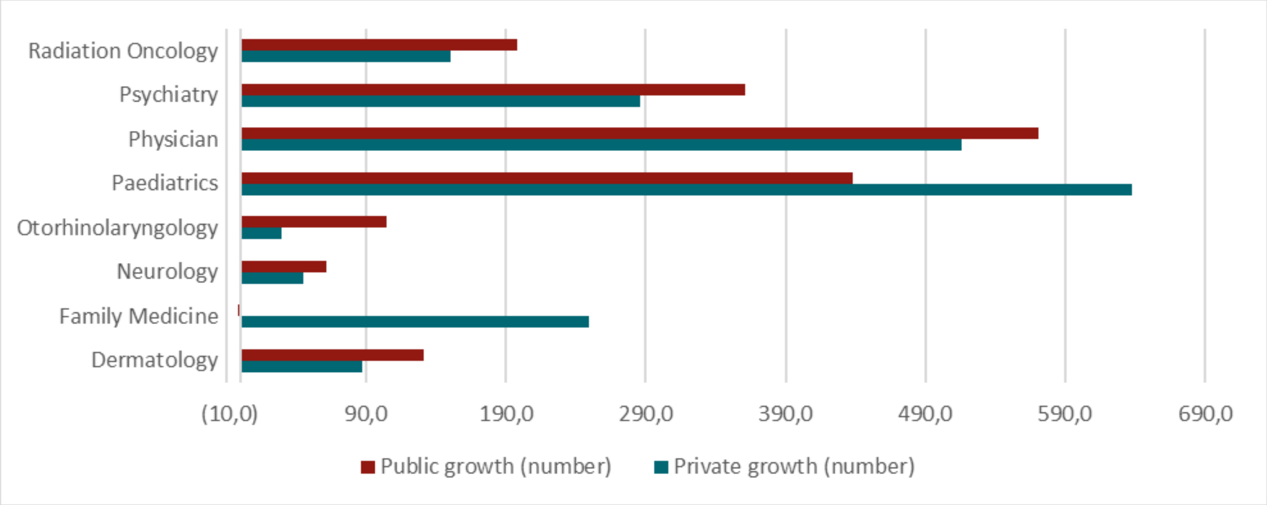
Growth by specialty type differs in each sector. The public sector shows higher growth in all specialties, except ophthalmology, paediatric surgery, family medicine, paediatrics, emergency medicine and nuclear physicians (6/26). Below, we show growth for the surgical specialties, which are the most critically under-resourced in the public sector.

Table 22: Growth from 2019 to 2040 in the public and private sector: surgical specialties

Specialty	Private growth from 2019-2040	Public growth from 2019-2040	Private growth (%)	Public growth (%)	Total entrants to specialist pool (2019-2040)	Total exits from specialist pool (2019-2040
Anaesthesiology	695	1,006	81%	319%	2,675	900
Cardiothoracic Surgery	21	22	42%	71%	115	68
Neurosurgery	35	55	36%	125%	207	110
Obstetrics and Gynaecology	516	644	89%	213%	1,982	769
Ophthalmology	114	40	68%	20%	449	268
Orthopaedic Surgery	155	326	33%	184%	1,015	499
Paediatric Surgery	97	81	1399%	411%	215	27
Plastic and Reconstructive Surgery	15	50	13%	130%	182	114
Surgery	315	312	79%	120%	1,208	547
Urology	8	76	5%	149%	252	160

The figure below shows the growth per specialty, in actual numbers of specialists (FTE) from 2019 to 2040, for the medicine specialties. In the medicine specialties, there is a decline in **family medicine** in the public sector.

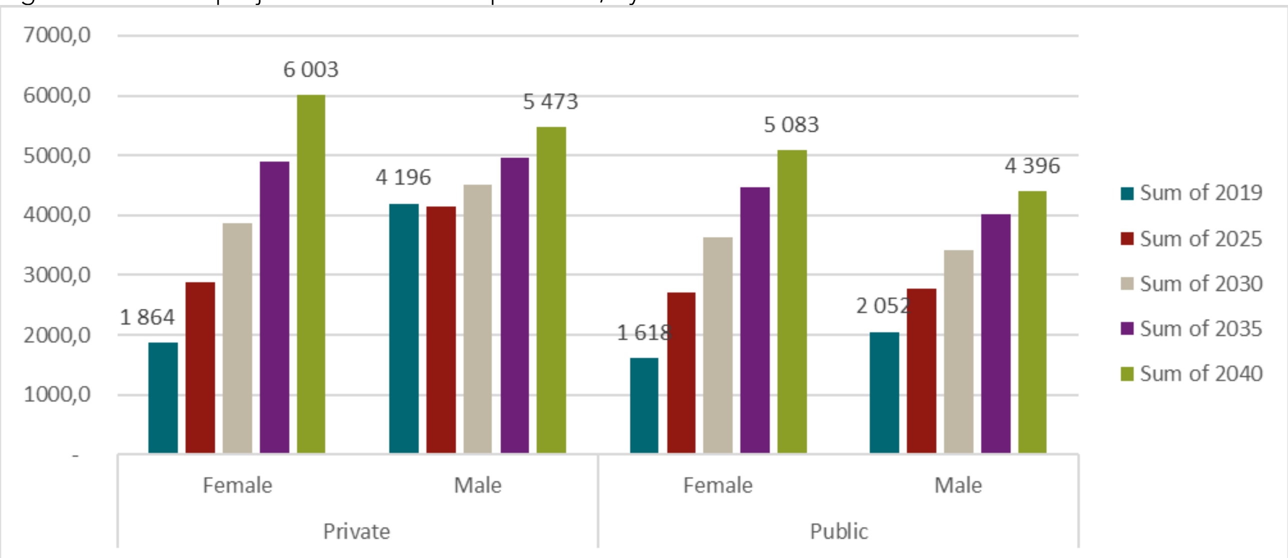
Figure 13: Growth from 2019 to 2040 in the public and private sector: medicine specialties



In the 'other' specialties, there was growth in all specialties. The private sector data showed no medical geneticists, forensic pathologists or public health medicine specialists in its starting population in 2019.

The figure below shows the sex break down for each sector, in years 2019, 2025,2030, 2035 and 2040. In the private sector, female specialists are projected to grow in number from 1,864 in 2019 to 6,003 in 2040 (222% increase). In the public sector, female specialists are projected to grow in number from 1,618 to 5,083 (214%). For men, the growth is much smaller at 30% in the private sector and 114% in the public sector. The feminisation of the workforce is apparent in both sectors.

Figure 14: Overall projected numbers of specialists, by sex and sector



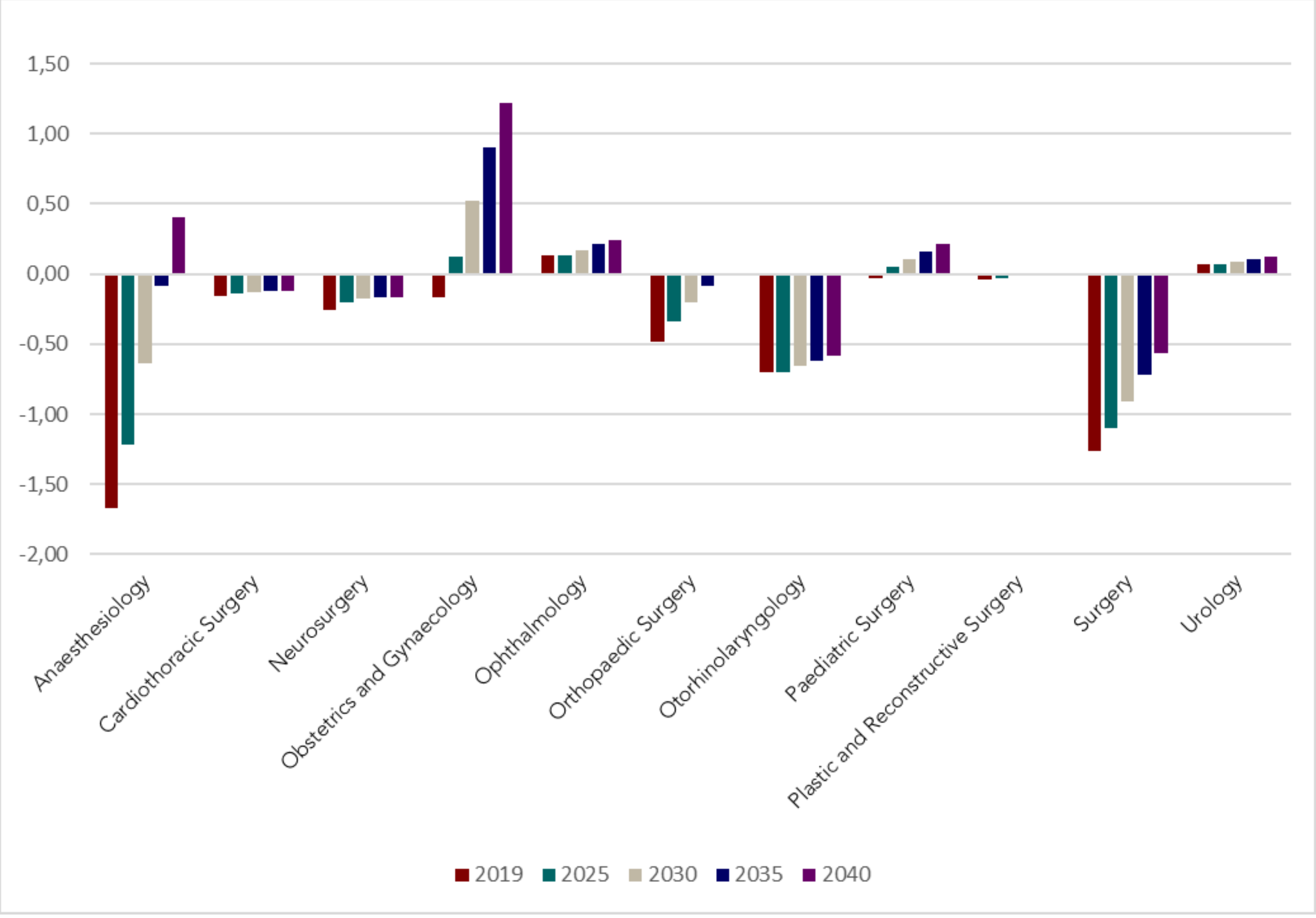
9.4 Analysis by target ratios

This section details the findings against the target ratios (per 100K total population). The excel model allows the user to test all the various target ratios, but for the report, we focus on the NDOH HRH strategy targets from 2012 and our recommended targets adjusted for changes in the epidemiological burden. We also show the gaps in the sector if we were to use the current private sector ratio as a target (which is higher in most cases than the recommended adjusted target ratio).

NDoH 2012 HRH Strategy targets

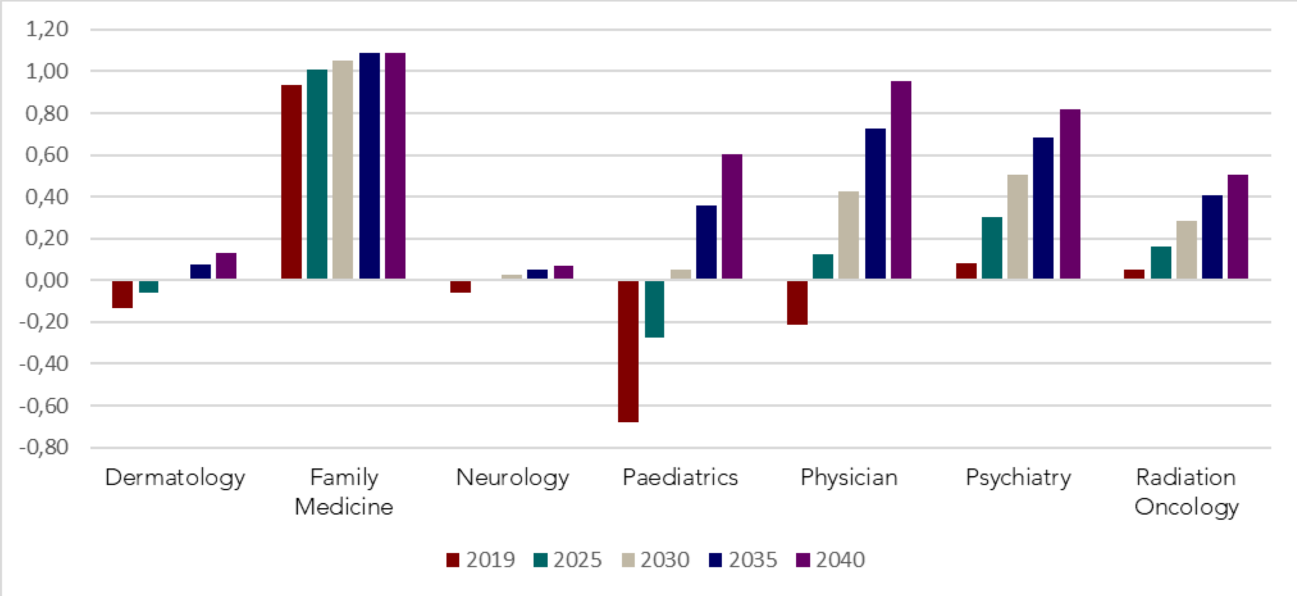
The figure below shows the gap, relative to the NDoH HRH targets, for the surgical specialties. Anaesthesiology sits at a deficit until 2030. Cardiothoracic surgery, neurosurgery, otorhinolaryngology and general surgery remain below the target throughout the years.

Figure 15: Projected gap (per 100K) against NDoH HRH Strategy targets (surgical specialties)



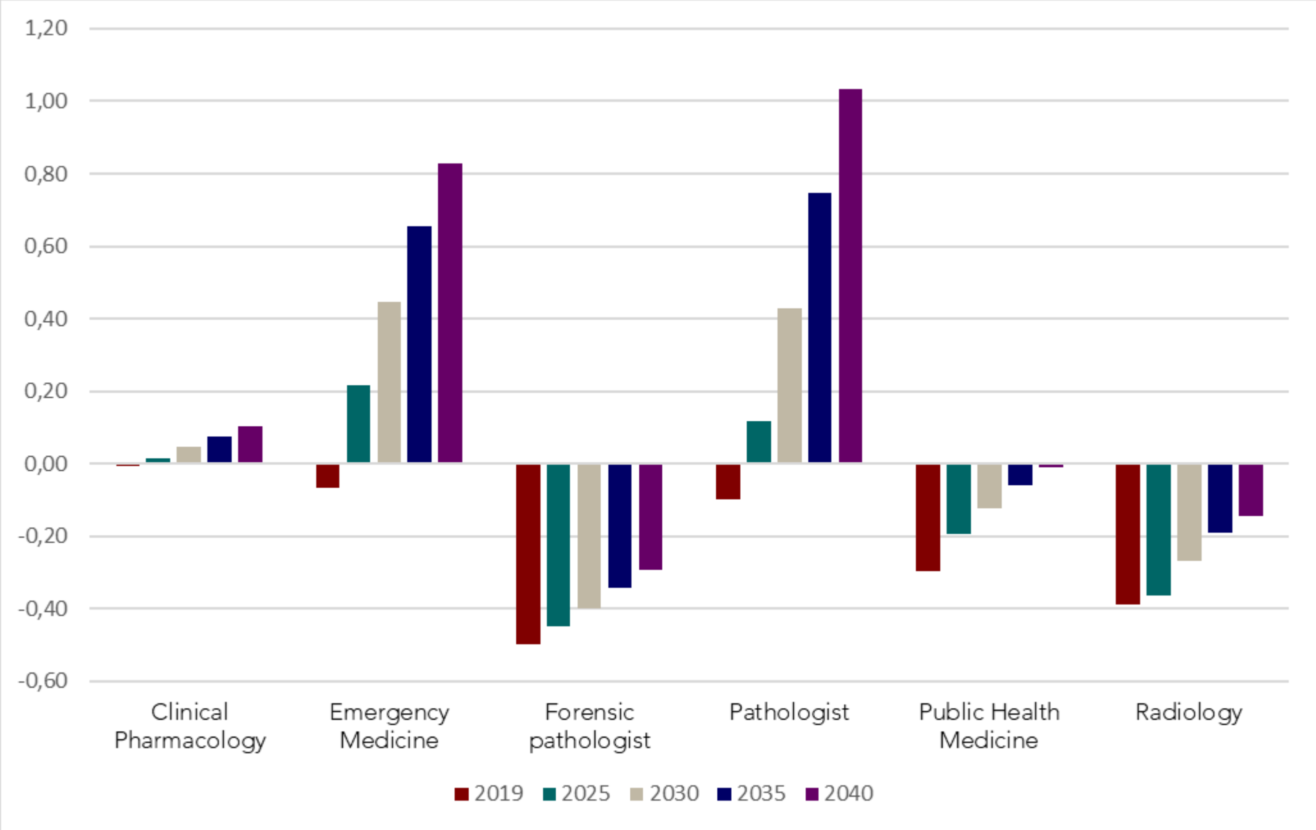
For the medicine specialties, all meet the target well before 2040, with family medicine, psychiatry and radiation oncology meeting the target in 2019 already.

Figure 16: Projected gap (per 100K) against NDoH HRH Strategy targets (medicine specialties)



The other specialties show a concerning deficit in forensic pathology and radiology and this warrants attention in terms of the training pipeline. None meet the target in 2019.

Figure 17: Projected gap (per 100K) against NDoH HRH Strategy targets (other specialties)



The table below shows the gap per 100K population, against the NDoH HRH target ratios. The numbers in red represent a deficit. The numbers in black represent a surplus between 0 and 1. The numbers in green represent a surplus of greater than 1/100K.

Family medicine, obstetrics & gynaecology and pathology how a surplus of greater than 1/100K in 2040.

Table 23: Gap per 100K: Projected ratios against NDoH HRH strategy targets

Specialty	2019	2025	2030	2035	2040
Anaesthesiology	-1.67	-1.22	-0.64	-0.08	0.40
Cardiothoracic Surgery	-0.16	-0.14	-0.13	-0.12	-0.12
Clinical Pharmacology	-0.01	0.02	0.05	0.08	0.10
Dermatology	-0.14	-0.06	0.01	0.07	0.13
Emergency Medicine	-0.06	0.22	0.45	0.65	0.83
Family Medicine	0.93	1.01	1.05	1.09	1.09
Forensic pathology	-0.50	-0.45	-0.40	-0.34	-0.29
Medical Genetics	-0.20	-0.15	-0.09	-0.02	0.04
Neurology	-0.06	0.00	0.02	0.05	0.07
Neurosurgery	-0.25	-0.20	-0.18	-0.17	-0.17
Nuclear Physician	0.00	0.09	0.21	0.32	0.42
Obstetrics and Gynaecology	-0.17	0.13	0.52	0.90	1.22
Ophthalmology	0.14	0.14	0.17	0.22	0.24
Orthopaedic Surgery	-0.48	-0.34	-0.20	-0.08	0.01
Otorhinolaryngology	-0.70	-0.70	-0.66	-0.62	-0.58
Paediatric Surgery	-0.03	0.05	0.11	0.16	0.21
Paediatrics	-0.68	-0.27	0.05	0.36	0.60
Pathology	-0.10	0.12	0.43	0.75	1.03
Physician	-0.21	0.12	0.43	0.73	0.96
Plastic and Reconstructive Surgery	-0.04	-0.03	-0.01	0.00	0.01
Psychiatry	0.08	0.30	0.51	0.68	0.82
Public Health Medicine	-0.30	-0.19	-0.12	-0.06	-0.01
Radiation Oncology	0.05	0.16	0.29	0.40	0.51
Radiology	-0.39	-0.36	-0.27	-0.19	-0.14
Surgery	-1.26	-1.10	-0.91	-0.72	-0.57
Urology	0.07	0.07	0.09	0.11	0.13

Recommend targets adjusted for epidemiology

It is important to show how South Africa's changing burden of disease impacts the need for medical specialists in the country going forward.

The table below shows the subpopulation numbers at 2019 and 2040, and the growth between those two points. Only paediatrics shows a slight decline, and this is due to South Africa's declining fertility rate.

Table 24: Growth in subpopulations: 2019-2040

Specialty	2019	2040	Growth 2019-2040
Anaesthesiology	23,070	26,210	14%
Cardiothoracic Surgery	23,070	26,210	14%
Clinical Pharmacology	57,655,714	69,988,237	21%
Dermatology	57,655,714	69,988,237	21%
Emergency Medicine	77,908	94,572	21%
Family Medicine	57,655,714	69,988,237	21%
Forensic pathology	57,655,714	69,988,237	21%
Medical Genetics	57,655,714	69,988,237	21%
Neurology	9,884,992	17,467,903	77%
Neurosurgery	23,070	26,210	14%
Nuclear Physician	57,655,714	69,988,237	21%
Obstetrics and Gynaecology	21,218,140	27,739,862	31%
Ophthalmology	57,655,714	69,988,237	21%
Orthopaedic Surgery	100,978	120,782	20%
Otorhinolaryngology	26,669,676	34,145,389	28%
Paediatric Surgery	23,070	26,210	14%
Paediatrics	16,784,684	16,677,487	-1%
Pathology	57,655,714	69,988,237	21%
Physician	57,655,714	69,988,237	21%
Plastic and Reconstructive Surgery	23,070	26,210	14%
Psychiatry	8,866,896	15,134,310	71%
Public Health Medicine	57,655,714	69,988,237	21%
Radiation Oncology	837,211	3,478,003	315%
Radiology	57,655,714	69,988,237	21%
Surgery	100,978	120,782	20%
Urology	19,652,890	25,570,888	30%

Unsurprisingly, South Africa shows extreme deficits against the 'recommended-with - epidemiological-impact' targets. In the three figures below, only **public health medicine** surpasses the target (1/26). The gap is especially large for most of the surgical specialties and radiation oncology. The specialties that still show concerningly large deficits (greater than 2/100K) by 2040 against the target include:

- Otorhinolaryngology
- Surgery
- Psychiatry
- Radiation oncology

Figure 18: Gap (per 100K) against the recommended with epidemiological impact targets (surgical specialties)

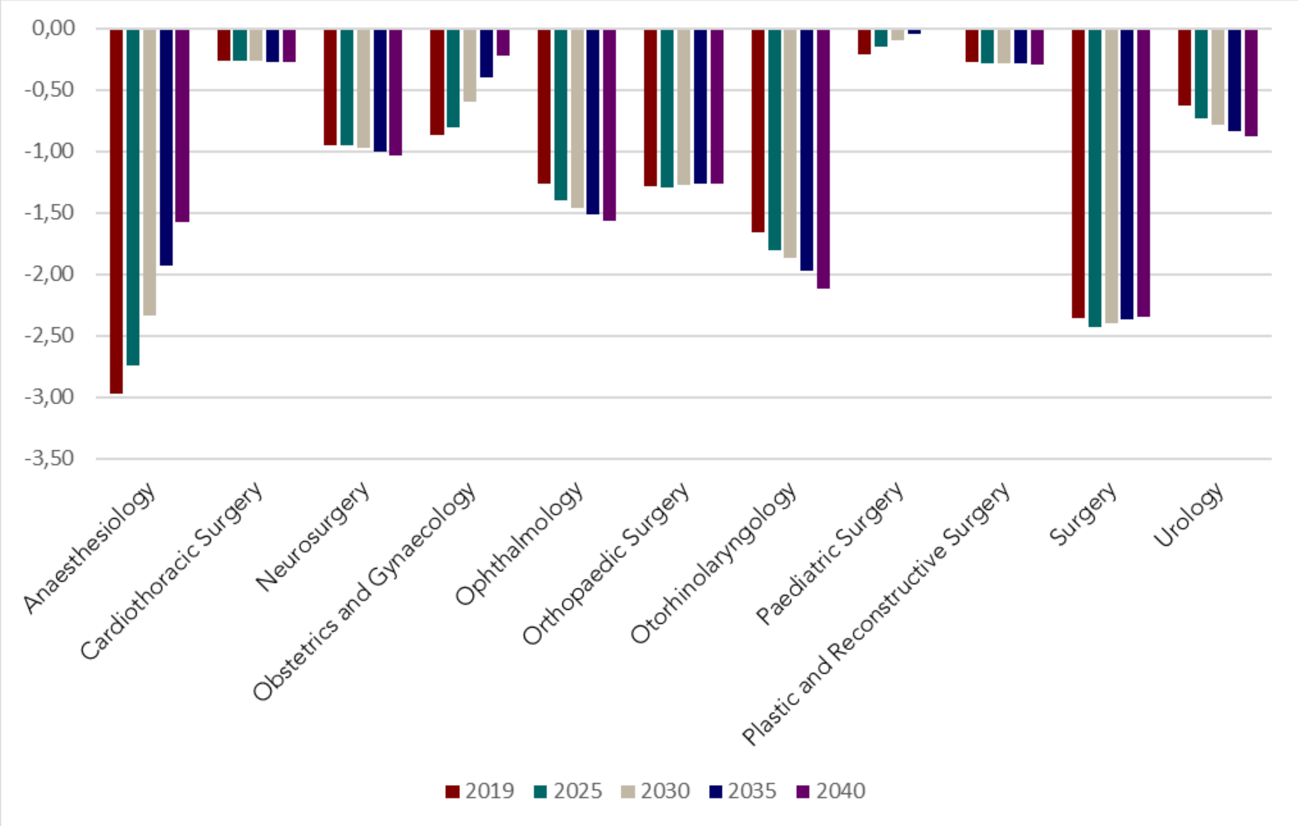


Figure 19: Gap (per 100K) against the recommended with epidemiological impact targets (medicine specialties)

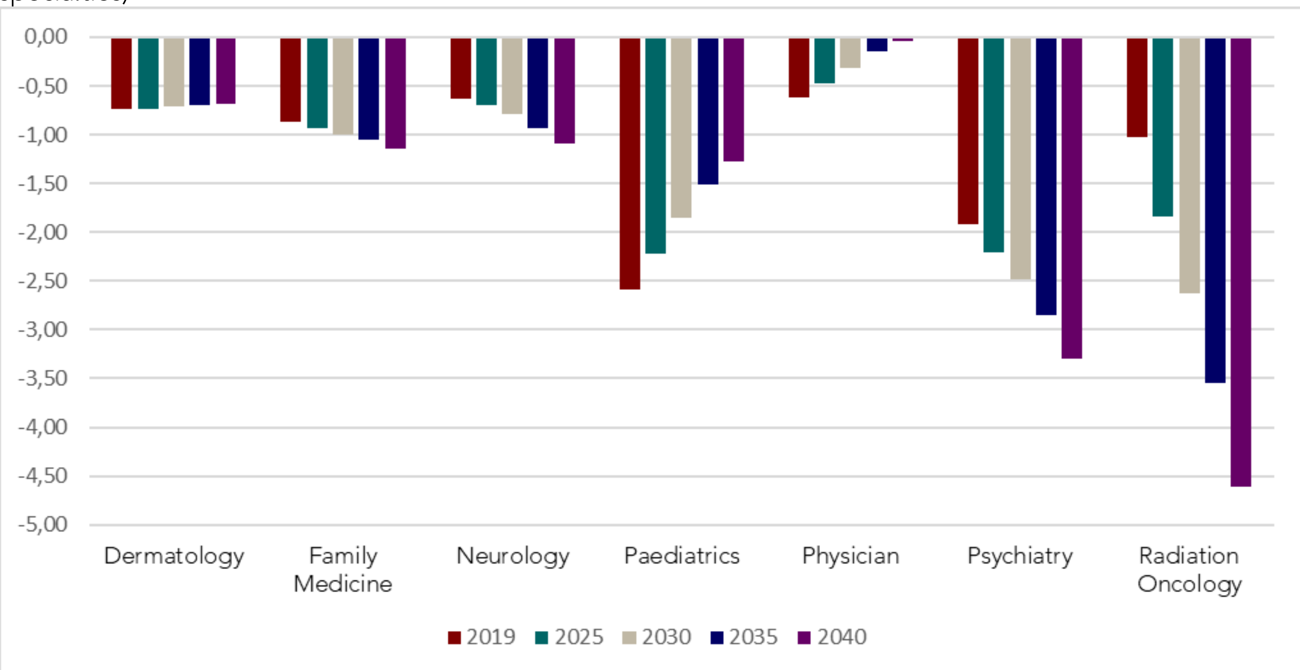
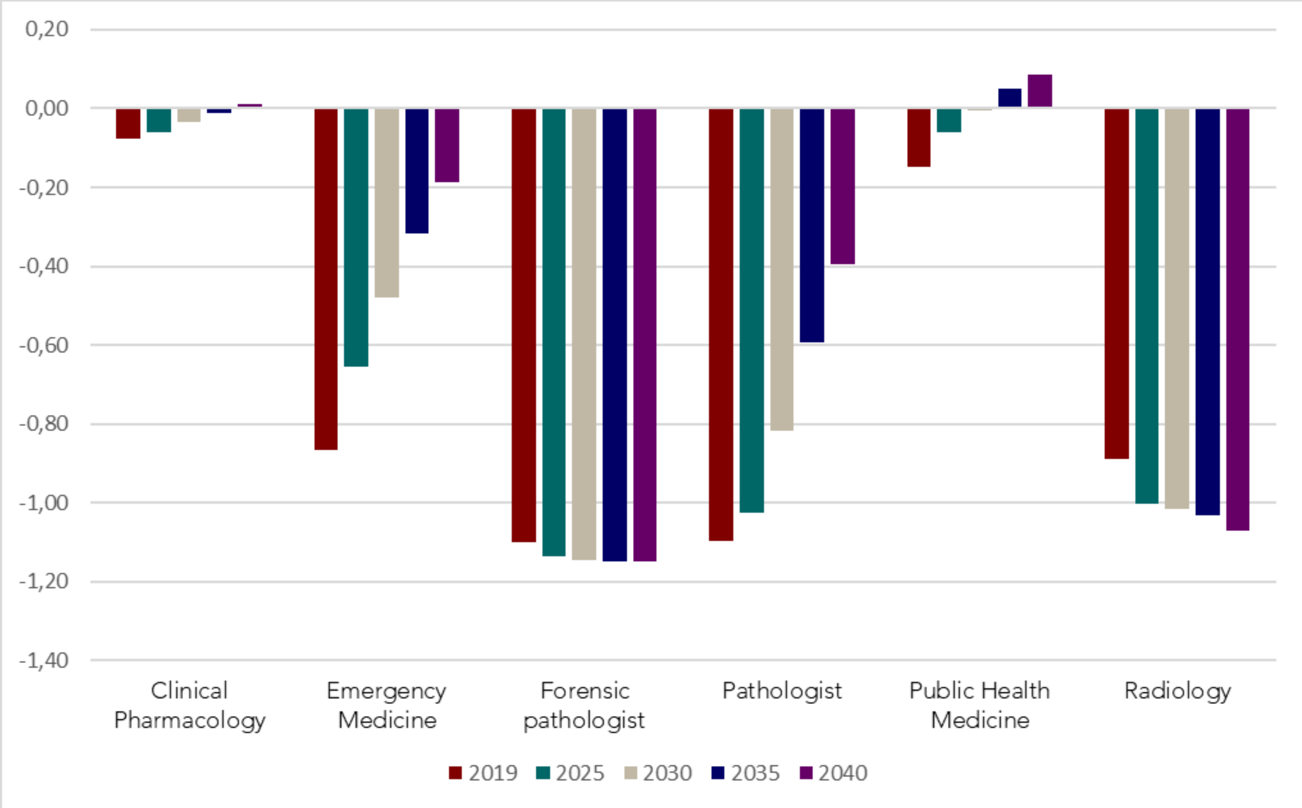


Figure 20: Gap (per 100K) against the recommended with epidemiological impact targets (other specialties)



The table below shows the gap per 100K population, against the 'recommended-with - epidemiological-impact' targets ratios. The numbers in red represent a deficit. The numbers in black represent a surplus between 0 and 1. The numbers in green represent a surplus of greater than 1/100K.

Table 25: Gap per 100K: Projected against current private sector actual

Specialty	2019	2025	2030	2035	2040
Anaesthesiology	-2.97	-2.75	-2.33	-1.93	-1.58
Cardiothoracic Surgery	-0.26	-0.26	-0.26	-0.27	-0.27
Clinical Pharmacology	-0.08	-0.06	-0.04	-0.01	0.01
Dermatology	-0.74	-0.73	-0.71	-0.70	-0.68
Emergency Medicine	-0.86	-0.66	-0.48	-0.32	-0.19
Family Medicine	-0.87	-0.93	-1.00	-1.05	-1.14
Forensic pathology	-1.10	-1.13	-1.15	-1.15	-1.15
Medical Genetics	-0.20	-0.17	-0.11	-0.06	-0.01
Neurology	-0.63	-0.70	-0.79	-0.93	-1.09
Neurosurgery	-0.95	-0.95	-0.97	-1.00	-1.03
Nuclear Physician	-0.10	-0.02	0.08	0.18	0.27
Obstetrics and Gynaecology	-0.87	-0.80	-0.60	-0.39	-0.22
Ophthalmology	-1.26	-1.40	-1.46	-1.51	-1.56
Orthopaedic Surgery	-1.28	-1.29	-1.28	-1.26	-1.26
Otorhinolaryngology	-1.66	-1.80	-1.86	-1.97	-2.12

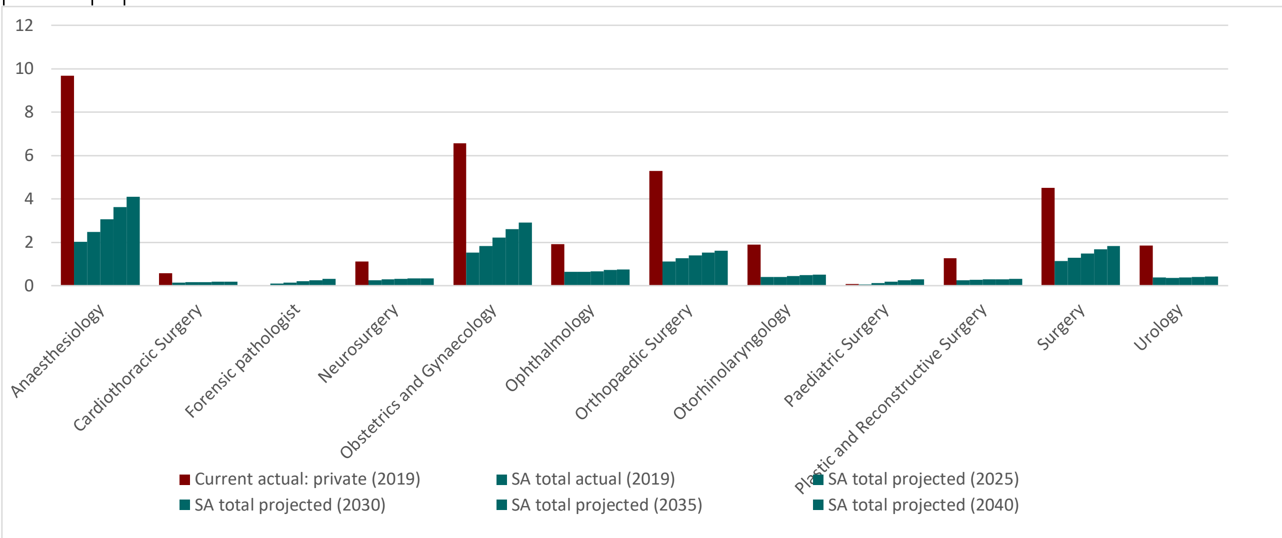
Specialty	2019	2025	2030	2035	2040
Paediatric Surgery	-0.21	-0.14	-0.09	-0.05	0.00
Paediatrics	-2.58	-2.23	-1.86	-1.51	-1.27
Pathology	-1.10	-1.03	-0.82	-0.59	-0.39
Physician	-0.61	-0.47	-0.32	-0.15	-0.04
Plastic and Reconstructive Surgery	-0.27	-0.28	-0.28	-0.28	-0.30
Psychiatry	-1.92	-2.21	-2.48	-2.85	-3.30
Public Health Medicine	-0.15	-0.06	0.00	0.05	0.09
Radiation Oncology	-1.03	-1.84	-2.63	-3.55	-4.61
Radiology	-0.89	-1.00	-1.02	-1.03	-1.07
Surgery	-2.36	-2.43	-2.40	-2.37	-2.35
Urology	-0.63	-0.73	-0.79	-0.83	-0.88

Current private sector ratio of specialists per 100K private population

Using the current ratio of private sector specialists to the private sector population as the target, the picture becomes more dire.

The projected ratio of available surgical specialties within South Africa do not meet the current private sector ratios for any specialties. This highlights the discrepancy in surgical resources between the two sectors.

Figure 21: SA total surgical specialties projected ratio per 100K against current private sector ratio per 100K private population



As with the surgical specialties, the medicine specialties also all fall below the private sector ratio.

Figure 22: SA total medicine specialties projected ratio per 100K against current private sector ratio per 100K private population

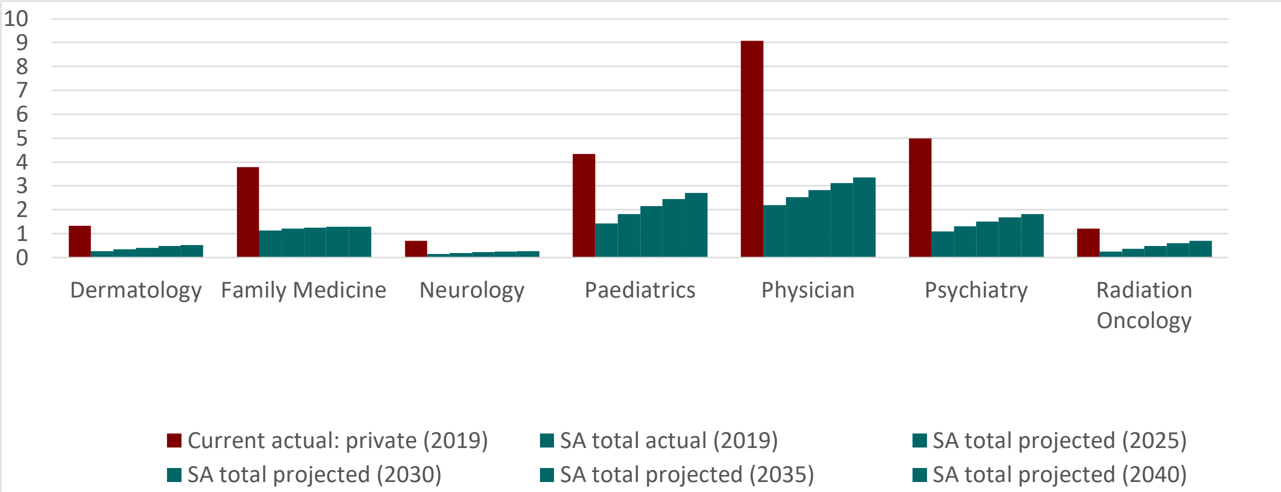
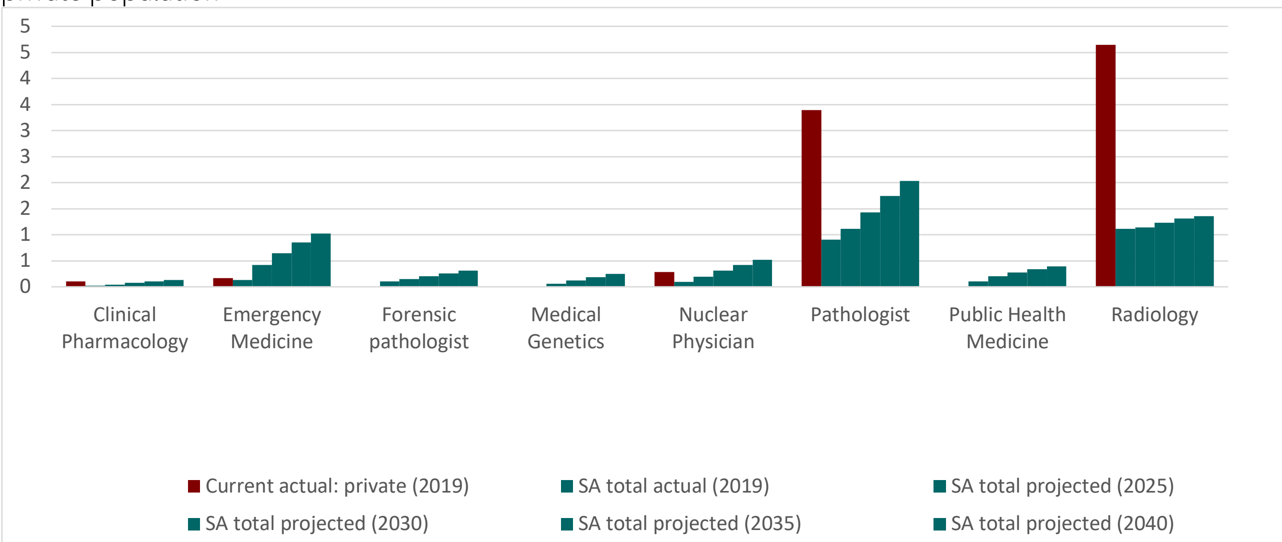


Figure 23: SA total other specialties projected ratio per 100K against current private sector ratio per 100K private population



The table below shows the gap per 100K population, against the current SA actual ratios and the current private sector actual ratios. The numbers in red represent a deficit. The numbers in black represent a surplus between 0 and 1. The numbers in green represent a surplus of greater than 1/100K.

Table 26: Gap per 100K: current SA actual against current private sector actual

Specialty	2019	2025	2030	2035	2040
Anaesthesiology	-7.66	-8.19	-9.57	-11.30	-13.48
Cardiothoracic Surgery	-0.44	-0.49	-0.55	-0.59	-0.64
Clinical Pharmacology	-0.08	-0.12	-0.20	-0.29	-0.39
Dermatology	-1.07	-1.11	-1.30	-1.54	-1.80
Emergency Medicine	-0.03	-0.69	-1.40	-2.18	-3.04
Family Medicine	-2.65	-3.56	-4.34	-4.96	-5.32
Forensic pathology	0.10	-0.15	-0.39	-0.64	-0.91

Specialty	2019	2025	2030	2035	2040
Medical Genetics	0.01	-0.09	-0.24	-0.44	-0.66
Neurology	-0.57	-0.67	-0.74	-0.84	-0.95
Neurosurgery	-0.87	-0.97	-1.05	-1.11	-1.19
Nuclear Physician	-0.18	-0.37	-0.67	-1.03	-1.47
Obstetrics and Gynaecology	-5.04	-5.46	-6.57	-7.93	-9.51
Ophthalmology	-1.27	-1.43	-1.74	-2.09	-2.46
Orthopaedic Surgery	-4.18	-4.21	-4.50	-4.90	-5.45
Otorhinolaryngology	-1.50	-1.33	-1.37	-1.49	-1.71
Paediatric Surgery	-0.03	-0.22	-0.41	-0.63	-0.89
Paediatrics	-2.92	-4.51	-5.78	-7.18	-8.87
Pathology	-2.49	-3.04	-4.15	-5.37	-6.65
Physician	-6.89	-7.72	-8.81	-10.08	-11.57
Plastic and Reconstructive Surgery	-1.00	-0.98	-0.99	-1.06	-1.12
Psychiatry	-3.89	-4.32	-4.99	-5.69	-6.41
Public Health Medicine	0.10	-0.22	-0.51	-0.82	-1.16
Radiation Oncology	-0.96	-1.09	-1.39	-1.77	-2.22
Radiology	-3.53	-3.38	-3.69	-4.14	-4.67
Surgery	-3.37	-3.81	-4.52	-5.36	-6.25
Urology	-1.48	-1.33	-1.36	-1.43	-1.52

Applying the results

This analysis has shown the importance of agreed upon targets and how they influence planning. We have also highlighted some of the inequities across the sectors and showed the shifting transition towards a more female-dominated medical specialists' profession. The excel model allows the user to input and test any other targets and their impact on the gap.

We hope to continue workshopping the results with key stakeholders and see the excel-model as a user-friendly tool to change the parameters and the assumptions as more data and research becomes available.

10. Limitations and lessons learned

Data

This project was the first of its kind in terms of trying to link several different datasets to come to a reliable specialist starting population that can be used for HRH planning. As such, we have learned many lessons on the way, especially in terms of how fragmented the HRH data is in South Africa. There is no one definitive dataset on HRH in South Africa - making planning exceptionally difficult.

In addition, individual bodies are recording HRH data differently and in varying levels of detail, complicating the linking of datasets.

There are several fields in the PERSAL data which are not accurately populated (such as specialty type and RWOPS status). Accurate collection of these data would support HRH planning efforts.

We have assumed a fixed split of public and private time for those doing RWOPS. In reality, there are varying percentages and the full extent of impact on public-sector capacity remains unknown.

The BHF data is impeded by a poor link between group practices and the underlying individuals. Efforts should be made to improve the collection of data on a look-through basis. Locum data is also largely missing from the system.

The model has not included geography at this point as the data were insufficient to do this meaningfully. Given the real differences between rural and urban and historically advantaged areas, this overlay is important as we move to universal health coverage. Modelling by sub-geography is also necessary to identify areas where the supply may collapse due to insufficient capacity in a locality to train future specialists.

We also did not include population group as a variable in our modelling. Inclusion of this variable would allow for tracking of transformation efforts over time.

Assumptions

The modelling rests on a number of assumptions relating to entries, exits and transitions between population sub-groups. There is a dearth of data and research to inform these assumptions and hence all of these assumptions can be refined over time as more research emerges.

The training pipeline (i.e. new entrants to the registrar pool) is based on the assumption that the future first-year student profile, by age and sex and specialty, is the same as the current distribution. Therefore, the current first-year distribution of registrars is a key driver of the future pipeline of specialists in the country, and this model dependency should be clearly understood in interpreting the projections. In future, a trend over 5-10 years would be more valuable for the forecasting.

The subspecialist pipeline is driven by the current specialist to subspecialist ratio within the practising specialist group. We did not have any other data to make this assumption more nuanced. Therefore, specialty numbers grow in the projections and the associated subspecialty numbers grow at the same rate as their parent specialty.

Our estimations of target ratios are largely subjective and should be more strongly informed by expert input and a clearer sense of the envisaged service delivery design (including norms). This in turn would allow for more meaningful guidance of the training pipeline. The difficulty in finding specialist target ratios that are context and burden-of-disease specific is noted.

Estimating the subpopulations was difficult due to the lack of epidemiological data outside of the HIV/TB domain. Therefore, we do suspect that some groups, especially the surgical group, is an under-representation of need. Research into the epidemiological projections for South Africa is an area that requires significant investment.

Modelling

Our modelling did not extend to the consideration of the costs of training and employing medical specialists. This is a necessary extension in order to test the impact of increasing the size of the training platform. Given that the number of specialists is projected to more than double by 2040, it is important to understand the cost of absorption.

11. Conclusions and recommendations for medical specialist planning

The status quo

The total number of medical specialists is lower than any estimate previously produced (approximately 10,000 medical specialists in South Africa) – by linking multiple datasets we have removed all of those on the HPCSA register who are not in active clinical practice.

35% of those in the public sector also do some work in the private sector – this highlights the extent of the overlap between the two sectors which was previously unknown.

In 2019, the country has only managed to meet the targets set out in its HRH strategy plan for five of the specialisations: family medicine, ophthalmology, psychiatry, radiation oncology and urology. However, this includes the subspecialist population and all private sector specialists. We also know that these targets were conservative at the time and therefore these may not be a useful benchmark.

Projected numbers of specialists

By 2040, cardiothoracic surgery, forensic pathology, neurosurgery, otorhinolaryngology, radiology, public health and surgery still show a deficit against the target despite an overall doubling of the number of specialists. It is notable that these specialties are historically more male-dominated and poor achievement of these targets is mostly likely driven by feminisation of the sector and the need to encourage the selection of surgical specialties amongst women. Based on our analysis, these specialties require the most urgent attention. There is much work to be done to make the surgical specialties more female-friendly and also to change the perceptions amongst women about the nature of these specialties. Efforts are also required to improve the physical infrastructure to support surgery in the public sector.

The shortage of surgical specialties in the public sector has far-reaching consequences and a short to medium term solution needs to be determined to increase access to these skills.

The inequity between the public and private sectors is projected to persist and this requires policy intervention – by either making the public sector a more attractive option for specialists (by, for example, improving working conditions during the training period), enabling contracting of private specialists or enabling more dynamic movement between the two sectors.

Target ratios

Without agreed upon target ratios and target ratios that are consistently and clinically informed, it is difficult to recommend a clear path for investment in terms of medical specialists. However, the model consistently shows clear shortages in certain specialties (across different target ratios). It is concerning that the 2012 NDoH HRH Strategy targets are poorly documented and motivated. Target setting is an important process in and of itself because it forces an articulation of the vision for the health sector.

Contributions to knowledge

As part of the project we linked several datasets across both the public and private sectors - a first for the country. The projection of both supply and need is also novel in the South African context. The projection model is characterised by rigorous mathematical modelling – an important foundation for work of this sort. Also, the model has a user-friendly interface which allows for multiple scenarios to be run to test policy interventions (such as changes to the target ratios due to changes in the service delivery design, changes to the training platform and changes to the retirement age). The importance of a user-friendly model should not be underestimated – the model should be used to stimulate debate and discussions so that we can refine our assumptions going forward. The dataset created and shared is valuable for a myriad of different analyses and uses, and we believe this is the most valuable outcome of this piece of work.

Data

It is apparent that South Africa has a long way to go in terms of data readiness for robust HRH planning. Given the complexities, there is a need to move away from the siloed nature of HRH data in the South African health sector. A centralised database should include professionals in both the public and private sectors and should reflect all cadres of health workers.

A simple initial change that could aid HRH planning substantially is to capture more data on health workers in the PERSAL system (for example, RWOPS status and academic qualification).

A health-worker census would more meaningfully capture full-time and part-time dynamics, as well as the intention of health workers to leave South Africa.

It is impossible to plan effectively without data and the extensive work to collect, collate and match datasets has put the country at a strong starting point to begin discussions on health need and investment. This work could not have been possible without the support and guidance of all those mentioned in our acknowledgements section- data is meaningless without context.

HRH planning processes

The absence of effective planning is evident in the dire shortage of physicians, the collapse of certain specialist services and a disjoint between the training platform and the public service.

This review of best-practice HRH planning experiences shows a need for more research on HRH planning processes in countries more comparable to South Africa, e.g. other African or other middle-income countries. Available information on how to go about HRH planning is dominated by insights from the experiences of high-income countries. However, international best practice is well within the reach of the South African health system.

As we move into NHI, with all its requisite policy changes and system reorganisation, we have a unique opportunity to correct these issues. Effective HRH planning will be central to the NHI Fund being able to carry out strategic purchasing functions and to remedy inequities in the distribution of resources. We, now more than ever, need HRH modelling that is able to both reflect changing policy and support policy choices.

The needs of the planning environment in South Africa, coupled with the lessons from international best practice outlined in the literature review, inform the following recommendations:

- A regular HRH planning process needs to be institutionalised, including both the public and private sectors. We recommend the establishment of a separate health workforce planning agency. The establishment of a body tasked with ongoing planning would create a structure within which data can be housed securely.
- From the experience of other countries, it seems clear that an inclusive approach, bringing in key stakeholders and experts, is the gold standard for HRH planning. The inclusion of higher training institutions to ensure greater coherence between the training platform and the service-delivery platform is crucial.
- All data and outputs from this process need to be publicly available and open to scrutiny, and recommendations flowing from this process need to be integrated into the management of the health system.
- Our recommended approach to HRH modelling is an estimated gap model that pays careful attention to the need, and not just the demand, for health services. While it may be useful to start with medical specialist modelling, ideally modelling should reflect all cadres of health workers given the policy imperative for multi-disciplinary service delivery. The use of scenarios is recommended to enable the exploration of the impact of policy choices and interventions to address shortages.

While there have been at least three HRH modelling exercises in the public domain in South Africa, there is no evidence that the findings and recommendations flowing from these models have been implemented. The models and some of their assumptions are likely to have become outdated as epidemiology, scope of practice, market, and public provision dynamics have changed. In addition, all previous work has been supply-side focused with limited consideration of the future adequacy of the supply.

We hope this work will start discussions on the need for a less fragmented system and easier ways of measuring and monitoring our HRH supply going forward.

The way forward

There are a range of ways in which the existing work can be taken forward. The first would be to **do a deeper dive into medical specialist modelling**. This would involve:

- Adding a geographical overlay;
- Adding a costing module;

- Adding race as an additional demographic factor;
- Doing further stakeholder engagement and research on the target ratios, and on the epidemiological projections that drive need; and
- The development of a meaningful set of scenarios for each specialty.

The second would be **to extend the work to other cadres of healthcare workers**. There is an urgent need for similar work to be done for **general practitioners (GPs)** and **nurses** – with the ultimate aim of also incorporating pharmacists, dentists, occupational therapists, physiotherapists and other allied health professionals. The effort taken to build a rigorous mathematical model should be leveraged for other cadres. By using the same modelling techniques, the sector can ensure that HRH planning stems from the same theoretical, mathematical and philosophical constructs.

12. References

1. Veller M. Public Health system in dire straits [Internet]. Cape Times. 2018 [cited 2018 Jun 4]. [https://www.pressreader.com/south-africa/cape-times/20180601/281861529185604].
2. National Department of Health: South Africa. Human Resources for Health South Africa 2030: HR Strategy for the Health Sector, 2012/13-2016/17. Pretoria; 2012.
3. Blecher M, Daven, J, Kollipara A, Maharaj Y, Mansvelder A, Gaarekwe O. Health spending at a time of low economic growth and fiscal constraint. In: South African Health Review [Internet]. Health Systems Trust; 2017 [cited 2018 Jul 31]. P.25-39. [http://www.hst.org.za/publications/South African Health Reviews/ HST SAHR 2017 Web Version.pdf].
4. National Department of Health: South Africa. National Health Insurance for South Africa: White Paper. [40955, Government Gazette 624]. [30 Jun 2017]. [Internet]. [31 May 2018]. [https://archive.opengazettes.org.za/archive/ZA/2017/government-gazette-ZA-vol-624-no-40955-dated-2017-06-30.pdf].
5. Hall TL. Why Plan Human Resources for Health? Hum Resource Devel J. 1998;2-2:77-86.
6. Ono T, Lafortune G, Schoenstein M. Health workforce planning in OECD countries: A review of 26 projection models from 18 countries. OECD Health Working Papers, No 62. Paris: OECD Publishing; 2013.
7. Van Greuningen M. Health workforce planning in the Netherlands: How a projection model informs policy regarding the general practitioner and oral health care workforces. 2016: p. 239 [Internet]. [15 Mar 2018]. [https://www.nivel.nl/sites/default/files/bestanden/Health_workforce_planning_Netherlands.pdf].

8. Van Greuningen M, Batenberg RS, Van der Velden LFJ. Ten years of health workforce planning in the Netherlands: a tentative evaluation of GP planning as an example. Hum Resour Health. 2012;10(21).
9. Health Workforce Australia. Health Workforce 2025, Volume 3: Medical Specialties. 2012. P. 414 [Internet]. [Mar 15 2018]. [https://submissions.education.gov.au/forms/archive/2015_16_sol/documents/Attachments/Royal%20Australasian%20College%20of%20Surgeons.pdf].
10. Crettenden IF, McCarty MV, Fenech BJ, Heywood T, Taitz MC, Tudman S. How evidence-based workforce planning in Australia is informing policy development in the retention and distribution of the health workforce. Hum Resour Health. 2014;12(7).
11. Centre for Workforce Intelligence. Securing the future workforce supply: Obstetrics and Gynaecology Stocktake. CfWI: 2015. [Internet]. [Mar 15 2018]. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/507525/CfWI_O_G_stocktake_review.pdf].
12. Koike S, Yasunaga H, Matsumoto S, Ide H, Kodama T, Imamura T. A future estimate of physician distribution in hospitals and clinics in Japan. Health Policy (New York). 2009;92(2-3):244-9.
13. Yuji K, Imoto S, Yamaguchi R, et al. Forecasting Japan's physician shortage in 2035 as the first full-fledged aged society. PLoS One. 2012;7(11):1-8.
14. Suphanchaimat R, Wisaijohn T,Thammathacharee N, Tangcharoensathien V. Projecting Thailand physician supplies between 2012 and 2030: Application of cohort approaches. Hum Resour Health. 2013;11(3).
15. Strachan B, Zabow T, Van der Spuy Z. More doctors and dentists are needed in South Africa. S Afr Med J. 2011 [;101(8):523-8.

16. Econex. NHI Note 4: Supply Constraints. 2009. [Internet]. [Mar 15 2018]. [https://econex.co.za/wp-content/uploads/2015/07/ECONEX_NHInote_4.pdf].
17. Econex. The Human Resource Supply Constraint: The Case of Doctors. Health Reform Note 8; 2010. [Internet]. [https://econex.co.za/publication/health-reform-note-8/].
18. Charlton H. Oncology machines and staff still lack in KZN. News24, 17 January 2018. [Internet]. [4 Jun 2018]. [https://www.news24.com/SouthAfrica/News/oncology-machines-and-staff-still-lacking-in-kzn-da-20180117].
19. Van Dyk J. Cancer Treatment in the North is impossible. Bhekisisa, 1 June 2018. [Internet]. [4 Jun 2018]. [http://bhekisisa.org/article/2018-06-01-00-cancer-treatment-in-the-north-west-is-impossible].
20. Ebrahim S. Health department frustrates medical graduates waiting for internships. Mail & Guardian, 18 April 2017. [Internet]. [4 Jun 2018]. [https://mg.co.za/article/2017-04-18-medical-interns-frustrated-over-lack-of-placements].
21. Matsabu T. Admin failures over medical internships prompts health department to get early start on 2019 placements. Business Day, 16 January 2018. [Internet]. [4 Jun 2018]. [https://www.businesslive.co.za/bd/national/health/2018-01-16-admin-failures-over-medical-internships-prompts-health-department-to-get-early-start-on-2019-placements/].
22. Ashmore J, Gilson L. Conceptualizing the impacts of dual practice on the retention of public sector specialist- evidence from South Africa. Hum Resour Health. 2015;13(3).
23. Voce A, Bhana R, Monticelli F, et al. District Clinical Specialist Teams. In: Padarath A, English R, editors. South African Health Review 2013/14. Durban: Health Systems Trust; 2014.
24. Competition Commission of South Africa. Health Market Inquiry- provisional findings and recommendations report. Pretoria: Competition Commission, 2018. [Internet]. [6 Aug 2018]. [http://www.compcom.co.za/wp-content/uploads/2018/07/Health-Market-Inquiry-1.pdf].

25. Department of Health and Social Care. Workforce planning for health, public health and social care. Gov.uk, 15 March 2016. [Internet]. [5 Jun 2018]. [https://www.gov.uk/government/collections/workforce-planning-for-health-and-public-health-and-social-care].
26. Cormack M. Health Workforce 2025: Workforce projection for Australia. 2012. [Internet]. [15 Mar 2018]. [http://www.oecd.org/els/health-systems/5_2012-0977_Presentation_FINAL%20CEO%20Briefing_OECD.pdf].
27. National Department of Health: South Africa. National Health Insurance in South Africa Policy Paper. [34523, Government Gazette 554]. [12 Aug 2011]. [Internet]. [31 May 2018]. [https://www.greengazette.co.za/documents/national-gazette-34523-of-12-august-2011-vol-554_20110812-GGN-34523.pdf].
28. Econex. The Human Resource Supply Constraint: The Case of Nurses. Health Reform Note 9;2010. [Internet]. [4 Jun 2018]. [https://econex.co.za/publication/health-reform-note-9/].
29. Econex. Updated GP and Specialist Numbers for SA. Health Reform Note 7;2010: p. 3-8. [Internet]. [4 Jun 2018]. [https://econex.co.za/publication/health-reform-note-7/].
30. Lopes MA, Almeida AS, Almada-Lobo B. Handling healthcare workforce planning with care: where do we stand? Hum Resour Health. 2015;13(1).
31. Zurn P, Vujicic M, Diallo K, Pantoja A, Dal Poz M, Adams O. Planning for human resources for health: human resources for health and the production of health outcomes/outputs. Cah Social Demogr Med. 2005;45(1).
32. Carroll CB, Pengiran Tengah DSNA, Lawthom C, Venables G. The feminisation of the British neurology: Implications for workforce planning. Clin Med. 2007;7(4):339-42.
33. George G, Reardon C. Preparing for export? Medical and nursing student migration intentions post-qualification in South Africa. AfrJ Prim Health Care Fam Med. 2013;5(1):483.
34. Centre for Workforce Intelligence. A strategic review of the future healthcare workforce:

Informing medical and dental student intakes. 2012. [Internet]. [15 Mar 2018]. [https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/507390/CfWI_healthcare_workforce_medical_and_dental_student_intakes.pdf].

35. Daviaud E. Strengthening PHC Services in the North West Province. 2015. [Internet]. 31 Jul 2018]. [http://www.mrc.ac.za/sites/default/files/files/2016-07-14/StrengtheningPHC.pdf].
36. Hunter J, Thoovakkunon M, Asmall S, Tucker JM, Ravhengani N, Mokgalagadi Y. The Ideal Clinic in South Africa: progress and challenges in implementation. In: Padarath A, English R, editors. South African Health Review 2017. Durban: Health Systems Trust; 2017.
37. National Department of Health: South Africa. Draft HR Strategy for the Health Sector 2012/13-2016/17: Consultation Document. August 2011. [Internet]. [15 Mar 2018]. [https://www.k4health.org/sites/default/files/RSA_%20HRH_Strategy_draft_Aug2011.pdf].
38. National Department of Health: South Africa. Medical Schemes Amendment Bill. [41726, Government Gazette 636]. [21 Jun 2018]. [Internet]. [16 Jul 2018]. [https://www.gov.za/sites/default/files/41726_gon636s.pdf].

Appendix 1: Research protocol summary[21]

Title: Managing the demand: projecting medical specialist staff need under NHI

Names:

Ms Shivani Ranchod[1]: Chief Executive Officer: Percept Actuaries and Consultants

Ms Jodi Wishnia[2]: Public Health Consultant: Percept Actuaries and Consultants

Dr Anja Smith[3]: Economics Consultant: independent contractors to Percept Actuaries and Consultants

Date: 02 May 2018

[1]Actuarial Science, Commerce Faculty, University of Cape Town
[2] Centre for Health Policy, School of Public Health, Faculty of Health Sciences, University of Witwatersrand, Johannesburg, South Africa
[3] Department of Economics, Stellenbosch University

1. Introduction

Workforce planning is an essential part of any well-functioning health system, but the need in South Africa is accentuated by maldistribution of resources between the public and private sectors, underserved geographical areas, historically disadvantaged institutions and the current funding crisis. The health system is also facing major health reforms as the country moves toward implementing National Health Insurance (NHI) – this will have an impact on both the supply-side and demand-side of the system. This project aims to quantify and predict the need for medical specialists in South Africa, under various policy scenarios, including NHI.

[21] Full protocol can be provided on request

2. Positioning of this project

This project is funded by the Discovery Foundation, who currently provide funding in the form of bursaries to medical doctors wishing to specialise in South Africa. Percept Actuaries and Consultants ("Percept") have been selected as the consultants for the project. The project has a 'reference group', which consists of key role players in the South African health sector to ensure the findings are valuable for the sector as a whole. We wish to thank the organisations and members of the reference group for the valued contribution:

- Discovery Foundation: Prof. Marian Jacobs, Ms. Andronica Mabuya and Ms. Lisa Temkin-Todes
- Colleges of Medicine: South Africa: Prof. Mike Sathekga
- Committee of Medical Deans: Prof. Martin Veller
- UCT Health Sciences faculty: Dr. Reno Morar
- Discovery Health: Dr. Maurice Goodman

The reference group acts as an oversight and advisory body to ensure the project meets the needs of the funder and of the key stakeholders within the health sector.

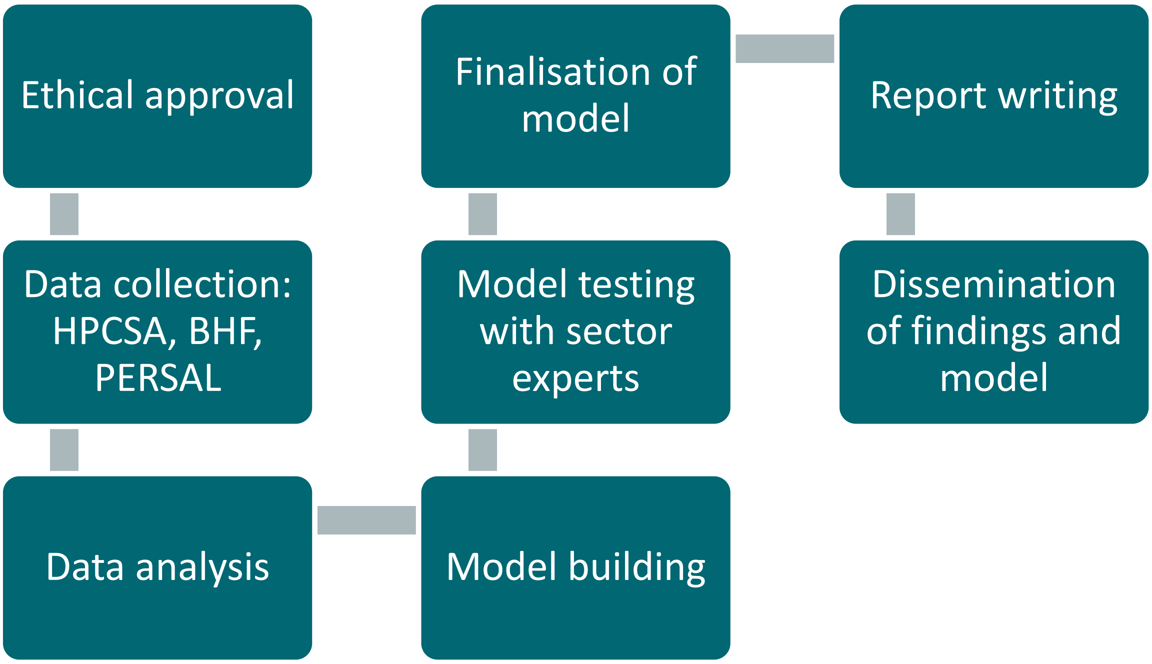
3. Aim and Objectives

Aim: The aim of this research is to build a mathematical model that accurately estimates the medical specialist need for South Africa under a variety of scenarios, to inform planning for training and funding of medical specialists in South Africa, by July 2018

Objectives:

1. To develop an Excel-based mathematical model that accurately predicts the need for medical specialists in South Africa under various policy scenarios;
2. To provide recommendations on training and funding needs, by specialist type, for South Africa to improve access to specialist care for those who need it; and
3. To document existing literature on the topic and disseminate the findings to key policy makers for decision-making.

4. Study flow chart



5. Methods

5.1. Quantitative Research Approach

The project will use a quantitative research approach to achieve its aim of building a mathematical model that accurately estimates the medical specialist need for South Africa under a variety of scenarios, to inform planning for training and funding in South Africa, by July 2018. Quantitative methods are best suited for this project, given that the project aims to take existing numerical data in the form of databases and analyse it for statistical meaning and relationships, in the pursuit of understanding the current spread of specialists across the health sector and the gap in terms of need [1]. The study design is descriptive in nature, given its aim to understand the current spread and level of specialists and attempt to estimate relationships between certain variables (policy changes around work hours for example) [2].

5.2. Method of Data Collection and Instruments

To determine year 'T', or the baseline year, the researchers will need to collect and crosswalk various datasets for the public and private health sector in South Africa, to accurately map the current number, type and productivity of medical specialists. South Africa does not have a single repository or holder of health workforce data. Rather, data is housed in various parts of the health system. Given the siloed nature of the public and private health systems in South Africa, this project will require data from several statutory and regulatory bodies as well as private-sector healthcare funders (medical schemes). Figure 2 below shows a graphic depiction of the databases required to accurately estimate the baseline availability of medical specialists in the country by specialist type, province, and sector. For both sectors, the project will need the Health Professions Council of South Africa (HPCSA) database of registered specialists. Payroll information from public provincial departments of health, through the PERSAL system, will be used to identify registered specialists who are working in the public health system. For the private sector, the Board of Healthcare Funders (BHF) database will be necessary, as this body is responsible for accrediting medical professionals working in the private health sector with practice numbers, without which they are unable to work. Importantly, the BHF database also distinguishes between group and individual practices, allowing for a more granular understanding of the number of specialists in the private sector. This database will be triangulated through the use of medical scheme claims data, to ascertain which of the specialists are still practising and at what intensity.

5.3. Data de-identification process

Data from the HPCSA, BHF and the PERSAL system will contain South African identification numbers (or passport numbers in the case of non-South African residents), and hence allow for personal identification of individuals. Medical scheme data will contain practice numbers, which for small practices could, with some effort, also allow for personal identification. Accordingly, a deidentification protocol will be employed to ensure that no such personal identification is possible.

A trusted third party (yet to be confirmed) will be employed to receive a list of all ID numbers in the HPCSA database and all practice numbers in the BHF database, and to employ an algorithm, unknown to the researching team, to map these identifiers onto a generated unique ID which cannot be reverse-engineered to map back onto any personally identifiable data. The mapping of these ID/practice numbers onto a unique ID will then be provided by the trusted third party directly to the data providers (the ID number mapping to the HPCSA and PERSAL system; the practice number mapping to the medical schemes; and both mappings to the BHF). The data providers will then provide the required data fields mapped onto these unique IDs, and NOT to the personal identifiers.

The data will be stored on an Amazon Web Services S3 bucket, with server-side encryption via the AES-256 protocol, or other equivalent secure cloud-based storage and access solution, with permissions granted only to members of the researching team.

5.4. Research Participants

This project will not have research participants per se. The Deans of medical schools will be the only individuals who are involved. All other data will derive from existing databases from the regulatory and statutory bodies, as well as private companies.

6. Timelines

This research project aims to begin in May 2018 and end in July 2018, dependent on ethical approval and data access.

Appendix 2: Ethical clearance letter[22]

0112749281 16:02:36 27-06-2018 1 /7

University of the Witwatersrand, Johannesburg

Human Research Ethics Committee: (Medical)
FWA Registered No IRB 00001223

SECRETARIAT: Suite 189, Private Bag x2600, Houghton 2041, South Africa Tel: +27-11-274 9200 Fax: +27-11-274 9281

21 June 2018

FAXED & COURIERED

Ms S Ranchod,
Percept Actuaries and Consultants
RADAR DAD 107
17 Queenspark Avenue
Salt River, Cape Town

Fax: 086 577 3469

Dear Ms Ranchod,

PROTOCOL: N/A - MANAGING THE DEMAND: PROJECTING MEDICAL SPECIALIST STAFF NEED UNDER NHI

ETHICS REFERENCE NO: 180506

RE : FINAL ETHICS APPROVAL

This is to certify that the above-mentioned trial has been approved by the University of the Witwatersrand, Human Research Ethics Committee (HREC), and the Protocol/Expert Reviewer. Date of Meeting where trial was reviewed: 25 May 2018.

The University of the Witwatersrand, Human Research Ethics Committee Approval Granted for the above mentioned study is valid for five years. Where required by Sponsor to have approval on a more frequent basis it remains the responsibility of the Sponsor and Investigator to apply for continuing review and approval, or for the duration of the Trial.

1. It is the responsibility of the Sponsor and Principal Investigator to ensure, where required, that relevant approvals are in place and compliance with the following is adhered to before a trial may begin:

- If trial is being conducted in Provincial Health facilities: Approval from the Hospital CEO / Clinic Manager / District Research Committee (whichever is applicable) be obtained.
- The study is submitted onto The National Health Research Database (NHRD).
- The relevant approvals are uploaded onto the NHRD system: Ethics Approval, SAHPRA Approval, Hospital CEO / Clinic Manager / District Research Committee Approval.

* A copy of the SAHPRA Approval and/or SAHPRA Notification letter must be submitted to the Ethics Secretariat Office for record purposes (IF SAHPRA APPROVAL / NOTIFICATION IS APPLICABLE).

* The study is conducted according to the protocol submitted to the University of the Witwatersrand, Human Research Ethics Committee. Any amendments to the protocol must first be submitted to the Human Research Ethics Committee for approval.

* During the study, the University of the Witwatersrand, Human Research Ethics Committee is informed immediately of :

- Any Unexpected Serious Adverse Events or Unexpected Adverse Drug Reactions, which, in the Investigator and/or the Sponsor's opinion are suspected to be related to the study drug. (Refer to POL-IEC-001 and SOP-IEC-005, Item 3.4).
- Any data received during the trial which, may cast doubt on the validity of the continuation of the study.

[22] Full letter can be furnished on request

Appendix 3: High-level specialist ratio analysis

The HPCSA de-identified data showed 12,674 specialists and 1,539 subspecialists. With a South African population of 57.656 million in 2018, as estimated by the Thembisa model[23], this suggests a specialist and subspecialist to population ratio of about **24.7 per 100K** (**22 per 100K** for specialists only). This does not account which sector the specialist works in and therefore the inequity in access between the public and private sectors. It also, for the reasons set out in the report, is likely to materially overstate the supply of specialists and the extent of this can only be ascertained once the final linked dataset is obtained.

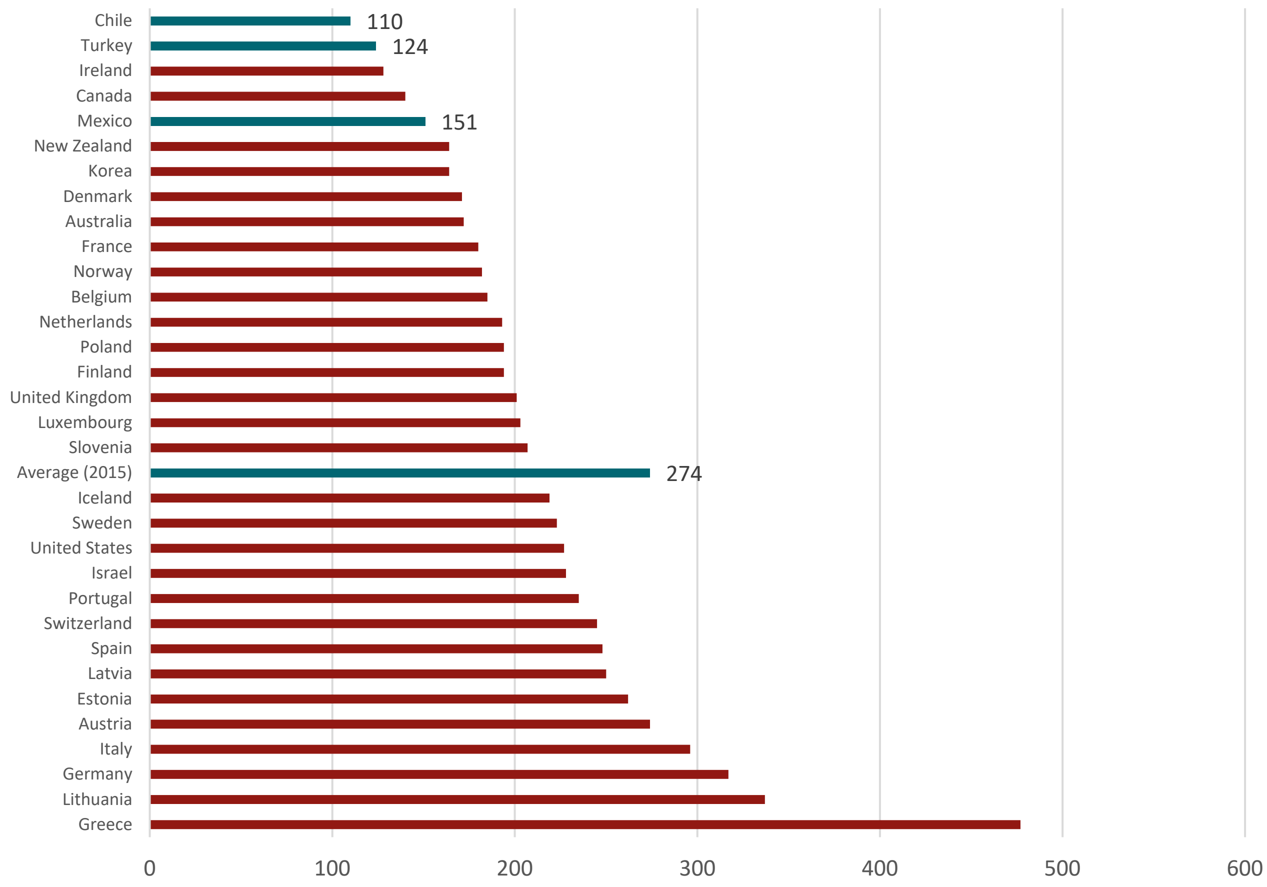
The question of how much is enough, or what the ideal ratio is of specialists to population is a challenging one. The average OECD[24] specialist-to-population ratio for 2015 (the latest year with comprehensive data available) was 274 per 100K (Figure 1, below). The country with the lowest such ratio in the OECD database was Chile[25] with **110 specialists per 100K**. Current HPCSA data calculations show South Africa has slightly more than a quarter of Chile's relative number of specialists (a relevant comparison given Chile's historical status as an upper-middle-income country). South Africa has less than a tenth of the OECD average specialists per 100K.

[23] Johnson LF, May MT, Dorrington RE, Cornell M, Boulle A, Egger M and Davies MA. (2017) Estimating the impact of antiretroviral treatment on adult mortality trends in South Africa: a mathematical modelling study. *PLoS Medicine*. 14(12): e1002468

[24] A comparison to WHO data may have been more appropriate given the wider range of countries included in WHO databases. However, the WHO reports on medical doctors (GPs) and specialist together (collectively referred to as physicians). The OECD database is the most comprehensive global database containing data on medical specialists only.

[25] Other comparator countries to SA have been indicated in Figure 1 and include Turkey and Mexico.

Figure 24: Specialist medical practitioners per 100K (OECD, 2015)

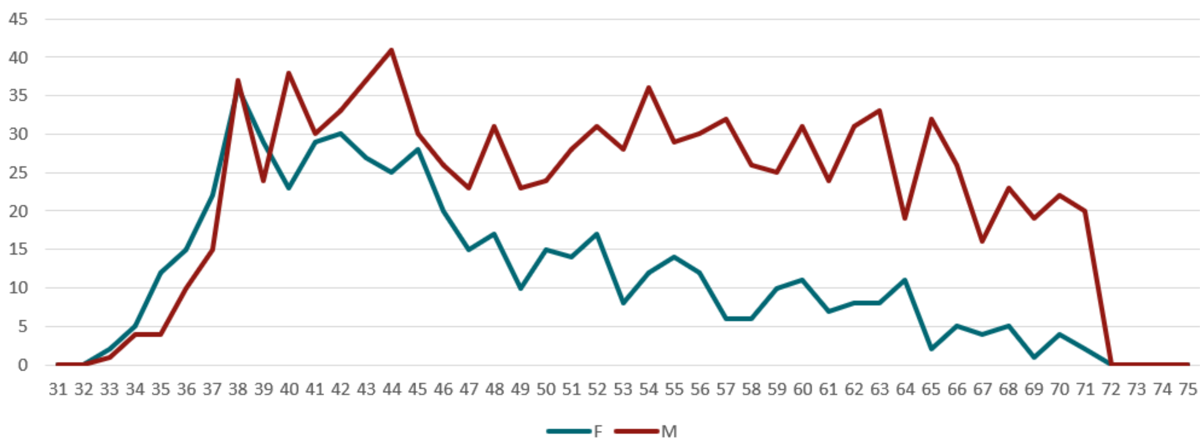


However, work commissioned by the National Department of Health in 2013, estimated a target ratio of 20 medical specialists per 100,000. However, this was within a restructured system where hospitals were allocated staff according to acuity of beds rather than how they have ben gazetted. There is also a likelihood that this target took into account the supply constraints in South Africa and was deemed a more pragmatic target than the OECD or other middle-income countries.

According to this HPCSA dataset, roughly two-thirds of the current specialist supply are men and a third are women, with an interesting age pattern as highlighted in Figure 2 below. Between the ages of 30 and 38 years, women make up the majority (58%) of specialists. From 39 years onwards this starts to decline, going from 47% at age 39 to 23% at age 60. We believe that this reflects the historical male-dominated nature of the medical profession, and the subsequent rapid feminisation reflecting in the younger years. It may also reflect the reproductive stage of a women's life and the subsequent family responsibilities that often remain with women.

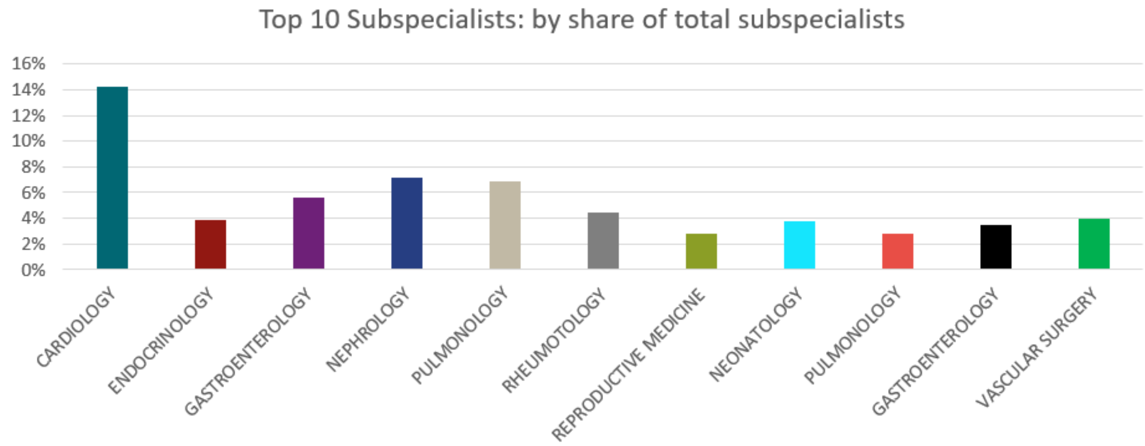
Figure 25: The age distribution of medical specialists in South Africa by sex (HPCSA, 2018)

The picture within subspecialists is similar, with males dominating the space from around 40 years old.



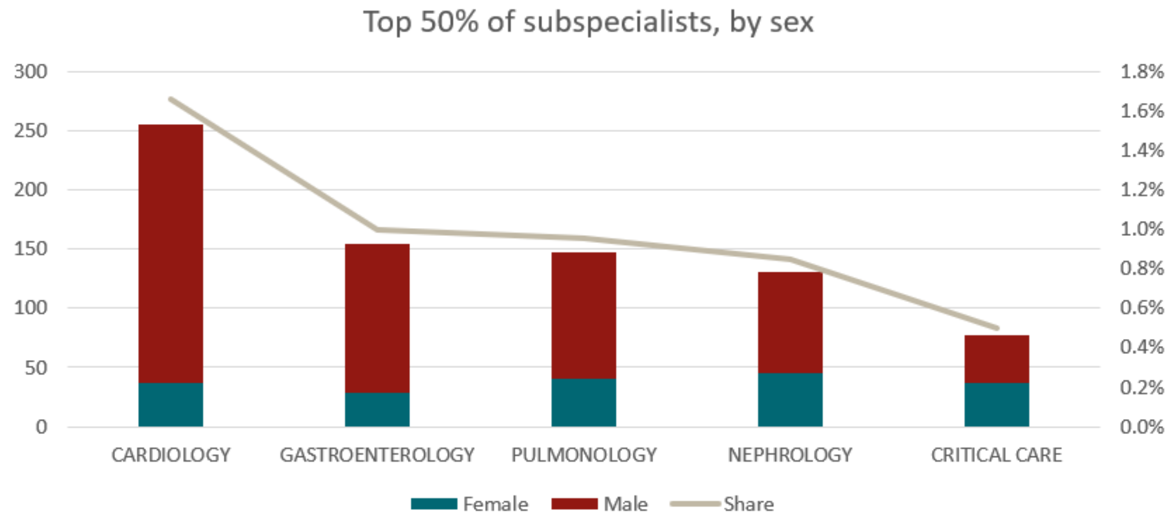
The figure below shows the top 10 subspecialties. Cardiology is shown as a popular choice when sub-specialising.

Figure 26: Top 10 sub-specialties



In addition, males by far make up the largest share of subspecialists as shown in the figure below for the top 50% of subspecialties in terms of the numbers registered to train in them.

Figure 27: Top 50% of subspecialists, by sex



Appendix 4: Demand-side specialist target ratio assumptions

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
Anaesthetists				Lancet Surgery Commission does not give an ideal anaesthetists ratio/threshold for surgeons only. Clusters surgeons with anaesthetists and obstetricians .McClain et al 2013: "Across all LMICs included in the literature, national general surgeon density ranged from 0.13 to 1.57 per 100,000 population. Obstetrician density ranged from 0.042 to 12.5 per 100,000, and **anaesthesiologist density ranged from 0 to 4.9 per 100,000."** Australia had anaesthesia ratio of **16.3 per 100,000** in 2015 (Medical Workforce 2015 plus UN Population data). SA Society of Anaesthesiologists suggested ratio of **5.0.**	3.70	0.65	10.32	5.00	Use upper limit in Lancet Surgery Commission review. This is about half the current private sector ratio and higher than HRH public sector target ratio. Rounded 4.9 (to full number) corresponds to figure suggested by SA Society of Anaesthesiologists.
Cardiothoracic Surgeons				Can compare to Australian cardiology data, but not sure if appropriate (specialty definition).	0.30	0.06	0.63	0.40	0.4 (11% of surgeons, based on current public sector relationship)
Clinical Pharmacologist					-	0.01	0.10	0.10	No clear benchmark or ratio available. Assume a required ratio of 0.1.
Dermatologists			1.9	Australia had dermatology ratio of **1.9 per 100,000** in 2015 (Medical Workforce 2015 plus UN Population data).	0.40	0.07	1.50	1.00	Use current SA private sector ratio as benchmark and lower somewhat as lower benefits in public sector for dermatology as compared to current private.
Emergency Medicine				Australia had emergency medicine ratio of **5.8 per 100,000** in 2015 (Medical	0.20	0.13	0.17	1.00	Poor quality data on emergency medicine specialist in private sector and the current

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
				Workforce 2015 plus UN Population data).					private sector target ratio artificially low. Assume a required ratio of at least 1.0 per 100,000 of the population (more than double the current public sector ratio), given much higher ratio in Australia.
Family Physician					0.20	0.66	3.78	2.00	No international benchmarks or target ratios available. Ratio of 2.0 almost half that in private sector.
Forensic Pathologist					0.60	0.12	-	1.2	No clear international benchmarks or target ratios available. We double the HRH target
Medical Geneticist					0.21	0.01	-	0.21.	No clear international benchmarks or target ratios available. Use HRH Strategy target ratio of 0.21.
Neurologists			1.9	Australia had neurology ratio of **1.9 per 100,000** in 2015 (Medical Workforce 2015 plus UN Population data).	0.20	0.04	0.77	0.77	No clear international benchmarks or target ratios available. Use current private sector ratio of 0.77. Much lower than Australian actual ratio.
Neurosurgeons					0.50	0.09	1.19	1.20	No clear international benchmarks or target ratios available. Use current private sector ratio of 1.2 – this number also same one as based on relationship between current private neurosurgeons to neurologists. Slightly more than double the HRH target ratio.
Nuclear Physicians					0.10	0.07	0.29	0.20	No clear international benchmarks or target ratios available. Double the HRH target (less than private sector target).

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
Obstetricians and gynaecologists	7	31	2.42	South African Society of Obstetrics and Gynaecology: "Best estimate is we need a little bit less than current private rate, but for the total (paying and non-paying) population. Do not know where that will bring you but would estimate that **between 8 and 10/100 000 adult women** is a realistic aim." Use Thembisa model estimate of SA women aged 15-49 in 2018/19: 13 157 534. But need to change this into total population estimates. Have worked on 9 per 100 000 adult women	1.70	0.62	6.97	2.40	Use population-level target ratio recommended by SA Society of Obstetrics and Gynaecology. Higher than HRH target ratio and current public sector ratio, but much lower than current private sector ratio.
Ophthalmologists			2.50	Response from Ophthalmology Society based on ratios in UK 24 years ago. Lower than SA private sector ratio, but MUCH higher than HRH report target ratio. Australia had **ophthalmology ratio of 3.6 per 100,000** in 2015 (Medical Workforce 2015 plus UN Population data).	0.50	0.41	1.91	1.90	Use current private sector ratio as upper limit (recommended target)
Orthopaedic Surgeons			4.9	Australia had orthopaedic surgery ratio of **4.9 per 100,000** in 2015 (Medical Workforce 2015 plus UN Population data).	1.60	0.36	5.57	2.40	2.4 (68% of surgeons, current public sector relationship)
Otorhinolaryngologist					1.10	0.13	2.06	2.06	Use current SA private sector ratio as target ratio.
Paediatric Surgeons					-	0.04	0.08	0.26	0.26 (8% of surgeons which is the current public sector relationship)
Paediatricians	4	37			2.10	0.90	4.86	4.00	Use lower-bound OECD ratio. Almost double HRH target ratio and lower than current private sector ratios.

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
Pathologists			7.57	Australia had ratio **one pathologist per 13,215** of population in 2013. Could not find an ideal global norm or detailed data on this (**Royal College of Pathologists of Australia**). Ratio presented in literature column based on this. Much higher than HRH report target ratio, no private sector data to compare with.	1.00	0.45	3.43	2.00	In absence of other data to inform the ratio, we double the HRH target ratio
Physicians			2.8	**Society of Consulting Physicians:** Physician can see 15 patients per day. Look at the number of people that are seen by physicians per day currently (medical aid data or public service data or combination) and do your calculations from there. Australia had general medicine (physician) ratio of **2.8 per 100,000** in 2015.	2.40	0.95	9.76	2.80	Use Australian ratio as target ratio. Slightly higher than HRH target, but much lower than current SA private sector ratios.
Plastic Surgeons					0.30	0.08	1.39	0.53	No clear international benchmarks or target ratios available. 15% of surgeons, which is the current public sector relationship.
Psychiatrists	1	50	3.0	**South African Society of Psychiatrists**, significant thought went into this. Starting point was Norms Manual published by the NDOH from Lund and Flisher's (2006) models, adjustments made according to pops and services not included in norm.	1.00	0.38	5.60	3.00	SA Society of Psychiatrists suggested target ratio of 3.0. Much higher than HRH target ratio and much lower than current SA private sector ratio.
Public Health Specialists					0.40	0.12	-	0.25	No clear international benchmarks or

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
									target ratios available. Double current actual public sector ratio.
Radiation Oncologists					0.20	0.08	1.28	1.28	No clear international benchmarks or target ratios available. Use current SA private sector ratio. This is a critical area given future increase in cancer burden.
Radiologists	3 (Italy)	31 (Greece)		Literature shows radiologist ratios typically expressed per number of procedures (e.g. MRI scan) or equipment. No clear per population ratio guidance. Lowest and highest OECD data presented in columns to the left obtained from data presented at HASA 2019 conference from the Royal College of Radiologists (2016). UK ratio was **7 per 100,000** Data for Turkey and Mexico (countries closer to SA i.t.o. economic development) not presented..	1.50	0.48	4.73	2.0	Lowest OECD actual ratio was 3. Suggest ratio of at least 2.0 for South Africa – huge technology improvements coming that will imply fewer radiologists required.
Surgeons				Lancet Surgery Commission does not give an ideal surgery ratio/threshold for surgeons only. Clusters surgeons with anaesthetists and obstetricians. McClain et al 2013: "Across all LMICs included in the literature, national general surgeon density ranged from **0.13 to 1.57 per 100,000** population." Australia had general surgery ratio of **5.5 per 100,000** in 2015 (Medical Practitioners Workforce, 2015 plus UN	2.40	0.53	4.84	3.5	Range of surgeon/surgery ratios from Lancet Surgery Commission focused on LMIC countries lower than HRH target ratio. But these are actual and potentially sub-optimal ratios. Suggest a ratio of 3.5. Lower than Australia and current SA private sector ratios, but higher than HRH ratio.

	OECD ratios		Literature and SA societies		SA lower, medium and upper limits (per 100,000)				
Specialties:	Lowest OECD	Highest OECD	Ratios from literature review and inputs from SA societies	Notes to ratios from literature review and inputs from SA societies, plus own reconciliation of numbers	HRH report (beginning 2011) target ratios: total SA population model, public sector service delivery model per 100,000	Current (2019) actual: public	Current (2019) actual: private	Recommended target ratio (2019)	Notes - recommended ratio (2019)
				population data).					
Urologist					0.30	0.10	1.96	1.00	No clear international benchmarks or target ratios available. Allow for at least one urologist per 100,000. HRH target ratio much lower, but SA private sector ratio much higher.
Total					22.91	7.54	73.19	40.86	Overall best-case target ratio thus five times the size of current actual public sector ratios and slightly less than double the size of HRH report target ratios. But a third or less that of Mexico (151 per 100,000) or Turkey (124 per 100,000) as per OECD 2015 data.

Appendix 5: Summary of the registrar data analysis

1. Available datasets

At the start of this project, we requested data from the following institutions to try and estimate the registrar pool:

1.1. University data

We requested data from each university that runs an MMed programme. We provided a template to guide what information we required. The table below shows the responses to the data request.

Table 27: Universities that were contacted

University	Response	Data Received
Witwatersrand (Wits)	Willing to give data	Data received
Cape Town (UCT)	Willing to give data	Data received
Free State (UFS)	Willing to give data	Data received
Stellenbosch (SU)	Willing to give data	Data received
KwaZulu-Natal (UKZN)	Willing to give data	Data received
Pretoria (UP)	No response	No data
Limpopo	No response	No data
Sefako Makgatho	No response	No data
Walter Sisulu	No response	No data
Nelson Mandela	Do not have any MMed students yet	N/A

The table below shows the detail of the datasets we did received. Free State did not give us specialisation data and Kwazulu-Natal (UKZN) did not give us year of study.

Table 28: Data received from participating universities

University	Able to complete template in full	Missing data
Witwatersrand	Yes	N/A
Cape Town	Yes	N/A
Free State	No	Specialist type
Stellenbosch	Yes	N/A
KwaZulu-Natal	No	Data by calendar year and not by academic year of study. We received total registered each calendar year by age, sex and specialisation. We also received the number that graduated each year, by sex, age and specialisation. We were then given a separate dataset that shows the age and sex distribution by specialisation, but this is not broken down by year of study or calendar year- only by two study periods, which are not defined.

From the four universities we received sufficient data from, we had a total of 3,324 registrars in South Africa. This formed our base dataset, to get the share of age and sex by specialisation and year of study.

1.2. College of Medicines: South Africa dataset

From the CMSA we received information on exams (pass or fail included), by sex and specialisation, for 2015, 2016 and 2017. The data does not include information on which year of study the person was registered for in their MMed. However, the CMSA was able to give us the university the person was registered with when they wrote their first or final exam. This helps to close the gap for the missing four university datasets. The table below shows the share of MMed students writing either their first or final exams, by university- according to the CMSA data, for the year 2017.

We scaled up the final university dataset by 27.8%, based on share of MMed students writing their exams from UP, LP, UFS, Sefako Makgatho and Walter Sisulu. **The total registrars for South Africa are therefore estimated at 4,606.**

Table 29: Share of students by university

University	Share of MMed students
Cape Town	13%
KwaZulu-Natal	30%
Stellenbosch	9%
Witwatersrand	21%
Free State	6%
Limpopo	1%
Pretoria	10%
Walter Sisulu	4%
Sefako Makgatho	7%
Total	100%

2. Using the datasets to estimate the registrar pool

For the model we need three key data points for registrars:

1. **Total starting population of registrars** in South Africa: this allows us to estimate the availability of specialist[26] services currently within the public health sector

[26] From stakeholders, we have assumed that registrars do provide some level of specialist services during their training.

2. **Entrants into the registrar pool:** this allows us to estimate the number of registrars entering training (indicated by registration with a university for an MMed degree), ensuring the model continues to estimate the correct number of registrars in the system in the future
3. **Exits from the registrar population:** this allows us to estimate how many registrars complete their training and move into the specialist population

1.3. Total starting population of registrars

For this we used both the university data we received and the CMSA data to scale up to include all universities training MMed students. As mentioned, from the four universities we had 3,324 registrars. When scaled, the total registrar number for the country increased to 4,276 for the 24 specialties included in this project. We then excluded the supernumeraries, based off data from the CMSA.

The last piece is that, of these registrars in the system, we needed to estimate what level of specialist services they are providing within the public sector. We assumed that the first years functioning at 60% of a specialist, given that many have already completed medical officer time in their unit and given the nature of the public health system where doctors are often required to work outside of scope due to the high volume and low staffing. For the 2nd-6th years, we assume an average of 80%, which was based off an increase of 10% per year of study and then weighted by population size in each year of study. Therefore, for 2018, we estimate a total full-time equivalent specialist for each of the specialisations as shown below (76% of the total registrars in the system). Although this is the reality in a highly resource constrained environment, it is not ideal to be using specialists-in-training-for full specialist services.

1.4. Entrants into the registrar pool

We use the first year MMed data from the universities (and scaled using the CMSA data) to estimate the number of new first years each year. The final registrar starting dataset has 928 first year students, about 22% of the total number of registrars. The table below shows the first-year distribution by specialisation.

Table 30: First year MMed students

Specialisation	Number of first years
'R- ANAESTHETISTS'	144
'R- CARDIOTHORACIC SURGEONS'	6
'R-CLINICAL PHARMACOLOGIST'	6
'R- DERMATOLOGISTS'	18

Specialisation	Number of first years
'R- EMERGENCY MEDICINE'	40
'R- FAMILY PHYSICIAN'	36
'R- MEDICAL GENETICIST'	11
'R- NEUROLOGISTS'	10
'R- NEUROSURGEONS'	8
'R- NUCLEAR PHYSICIANS'	24
'R- OBSTETRICIANS AND GYNAECOLOGY'	108
'R- OPHTHALMOLOGISTS'	22
'R- ORTHOPAEDIC SURGEONS'	48
'R- OTORHINOLARYNGOLOGIST'	17
'R- PAEDIATRIC SURGEONS'	11
'R- PAEDIATRICIANS'	83
'R- PHYSICIANS'	104
'R- PLASTIC SURGEONS'	10
'R- PSYCHIATRISTS'	60
'R- PUBLIC HEALTH MED'	14
'R- RADIATION ONCOLOGISTS'	28
'R- RADIOLOGISTS'	40
'R- SURGEONS'	67
'R- UROLOGIST	14
Grand Total	928

1.5. Exits from the registrar pool

We then used the 2017 dataset for those who wrote and **passed** their final exam to try and estimate the exit rate from registrar training. We apply a flat exit rate of 21.5% from the 2nd-6th year registrars, based off CMSA data, for all specialties and sex. The data was too anomalous to provide an exit rate by sex and specialty separately.

Using these methods above, we were able to estimate both the registrar pool in its entirety, despite not receiving all the data required and were able to project both the registrar and specialist pipeline. We would recommend that in future, the university analysis includes several years to allow for better trend determination.

www.percept.co.za