LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Train to retain: the role of specialty training in stemming Malawi's medical brain drain

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ABSTRACT

Background

There is a growing awareness of the need to retain health workers in low-and middle-income countries. This is particularly the case in Malawi, with few doctors and historically high emigration. Previous retention efforts have focused on salary supplementation and expansion of undergraduate training. There has been little focus on training new doctors to become specialists, despite evidence of its value to Malawian junior doctors. In light of the considerable investment into medical education and retention, this thesis investigates the role of specialty training in stemming Malawi's medical brain drain.

Methods

A tracing study was carried out to locate all Malawian doctors who graduated between 2006 and 2012. Literature reviews and qualitative interviews informed the design of a discrete choice experiment exploring junior doctors' preferences for different types of training posts. Nearly all eligible doctors in Malawi participated in the survey. The results were incorporated into a Markov model of the Malawi medical workforce as part of a cost-effectiveness analysis of expanded provision of specialty training.

Results

The odds of leaving the public sector and Malawi rose with time after graduation, with most of those outside Malawi in specialty training. Junior doctors had strong preferences for different types of specialty training, with subgroups showing distinct preferences.

Doctors would require substantial compensation to undertake training only in Malawi or in less popular specialties. Despite this, expanding training within Malawi was the most cost-effective means to retain doctors in the long-term, although more costly than current government spending.

Conclusions

Almost all Malawian junior doctors desire to specialise, but not all specialty training is valued equally. Expansion of specialty training in Malawi, however, would lead to higher returns on investments in medical education. More cost-effectiveness modelling and a "whole-career" perspective to policy interventions would strengthen health workforce policy in low-resource settings.

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Abbreviations

AIC	Akaike information criterion
AIDS	Acquired immunodeficiency syndrome
BIC	Bayesian information criterion
CEA	Cost-effectiveness analysis
CHAM	Christian Health Association of Malawi
COM	College of Medicine-University of Malawi
DCE	Discrete choice experiment
DHO	District health officer
DMO	District medical officer
EHRP	Emergency Human Resource Programme
GBP	Pounds sterling
GDP	Gross domestic product
GP	General practitioner
HIC	High income countries
HIV	Human immunodeficiency virus
HRH	Human resources for health
KCH	Kamuzu Central Hospital
LMIC	Low- and middle-income countries

LSHTM	London School of Hygiene & Tropical Medicine
MCH	Mzuzu Central Hospital
MMed	Master’s of Medicine
MOH	Ministry of Health, Malawi
MPH	Master’s in Public Health
MWK	Malawian kwacha
NAC	National AIDS Commission
QECH	Queen Elizabeth Central Hospital
SD	Standard deviation
SE	Standard error
SWAP	Sector-wide approach
UK	United Kingdom
USA	United States of America
USD	United States dollars
WHO	World Health Organization
WTP	Willingness to pay
WTS	Willingness to stay
ZCH	Zomba Central Hospital

1 INTRODUCTION

1.1 THE MALAWIAN MEDICAL WORKFORCE

"There are allegedly more Malawian doctors in Manchester than in Malawi."

(Joint Learning Initiative 2004, p.18)

First documented in a 2004 report on the crisis in human resources for health (HRH), this oft-quoted statistic has been subsequently discredited of any factual basis (Lizi, Lwanda et al. 2013). Yet its persistence in the global health consciousness reflects the development of the Malawian medical workforce, where a lack of domestic training capacity has necessitated a reliance on the medical education of other countries (Muula and Broadhead 2001, Broadhead and Muula 2002). And it is from this training (particularly in the United Kingdom) that many doctors never return to Malawi (Muula and Broadhead 2001, Lizi, Lwanda et al. 2013).

In response, the first medical school was established in Malawi in 1991 (Muula and Broadhead 2001, Broadhead and Muula 2002). Yet no more than 25 doctors per year were produced until 2006, leading to one of the lowest doctor-to-population ratios worldwide at one doctor for every 45,000 people (Zijlstra and Broadhead 2007, World Health Organization 2015). Once qualified, doctors were sent to train as specialists outside Malawi, with a continued tendency to remain there after completion of training (Zijlstra and Broadhead 2007). The cumulative impact of emigration and low production on an already fragile health system was acknowledged by the Malawian Ministry of Health (MOH) in 2004:

> *"The current situation with regard to human resources in the health sector has been described in various terms such as critical, dangerously close to collapse, collapsed, and meltdown. By any term used, the situation can legitimately be described as critical."*
>
> *(Ministry of Health 2004, p.6)*

In response, the government of Malawi and a coalition of development partners set up an innovative six-year Emergency Human Resources Programme (EHRP) (Palmer 2006, McCoy, McPake et al. 2008). Among other measures, this doubled doctors' salaries and tripled the number of medical students (Management Sciences for Health 2010). At the same time, fledgling programmes to train specialists were established at the College of Medicine-University of Malawi (COM), although most still required substantial periods of training outside Malawi (Zijlstra and Broadhead 2007).

In 2010, an evaluation of the EHRP showed a slowing in nursing emigration, yet no equivalent assessment was undertaken for doctors (Management Sciences for Health 2010). This was despite concerns that junior doctors were leaving both the public sector and Malawi, often in pursuit of specialty training opportunities outside Malawi (Ministry of Health 2004, Zijlstra and Broadhead 2007). Indeed, while the number of first-year medical students enrolled at COM had grown by two thirds over the programme, there had been no provision for a proportionate increase in specialty training (Management Sciences for Health 2010). Data from 2009, the latest available, show a worsening of Malawi's physician density during this period to one for every 53,000 people (albeit against a context of high population growth).

Taken as a whole, there is insufficient evidence to conclude that the primarily financial incentives provided under EHRP have been sufficient to retain junior doctors in Malawi. Without more information on the preferences of junior doctors, a considerable investment of public funds into medical education may be lost through sustained emigration. This dilemma is not unique to Malawi. Many countries in sub-Saharan Africa have scaled up the production of doctors in order to overcome low stocks and high outflows, despite a lack of evidence to inform retention policies after qualification (Mullan, Frehywot et al. 2011, McPake, Scott et al. 2014, World Health Organization 2015).

Of the many factors that influence retention, one that may be particularly pertinent to recently graduated doctors is access to specialty training. There is good evidence that doctors value the opportunity to specialise and pursuit of such training is influential in emigration decisions. Yet its use as a policy lever has been relatively under-investigated in comparison to other incentives. A body of research exploring the importance of specialty training to Malawian junior doctors would be able to inform future retention efforts not only in this country, but also the region.

1.2 SCOPE OF THESIS

This thesis examines the role of specialty training in the postgraduate job choices of Malawian junior doctors. It seeks to deepen the understanding of the value of specialty training and its potential as a policy lever to improve the retention of doctors in low- and middle-income countries (LMIC). Rather than a narrow disciplinary focus, this thesis applies methods commonly used in health economics to a health systems research question. Policy options are evaluated from the perspective of decision-makers in LMIC managing limited resources.

This is a research paper-style thesis and thus incorporates both published and unpublished journal papers, linked by supporting material. While this inevitably leads to some repetition in contextual information and cited literature, I have endeavoured to keep this at a minimum.

1.3 OUTLINE OF THESIS

The next three chapters place this thesis in context. Chapter 2 reviews several areas of literature pertinent to this thesis. Chapter 3 presents the results of a systematic review undertaken to assess the application of discrete choice experiments (DCE) to health workforce issues. Chapter 4 describes the Malawian setting in more depth in order to frame this body of research.

Chapter 5 then goes on to outline the aims and objectives of this thesis. It provides the conceptual framework underpinning this research, as well as an overview of the methods used to fulfil these objectives.

Chapters 6 to 9 present the main results. Chapter 6 describes the tracing study that sought to provide empirical evidence for the reported movement of junior doctors out of Malawi and the public sector. This also identified the sampling frame for the subsequent DCE.

Chapter 7 details the development of the DCE survey tool, while Chapter 8 presents the DCE survey results. These results along with local cost data were then incorporated into a cost-effectiveness analysis (CEA) of specialty training for retaining Malawian doctors, described in Chapter 9.

Chapter 10 draws together the major findings of the thesis to provide a critical assessment of its contribution to knowledge. The implications for both research and policy are discussed, along with future areas of research. Overall, it is hoped that this thesis goes some way to answering the question posed by the MOH in 2004:

> *"If we believe that education and training are expensive, we should calculate the cost of neglecting them."*
>
> (Ministry of Health 2004, p.2)

2 LITERATURE REVIEW

In this chapter, several relevant bodies of literature are reviewed to lay a foundation for the subsequent work. We start with an overview of the broad HRH literature, followed by a labour market perspective of this topic. The evidence for possible strategies to retain health workers is then examined using a labour economic lens, before a review of significant work in emigration. Specialty training is then defined, along with possible mechanisms through which such training could improve retention. Finally, approaches to investigating the effectiveness of specialty training on retention are outlined, concluding with a summary of key gaps in the literature.

2.1 THE HEALTH WORKFORCE "CRISIS"

Three seminal reports in the last decade focused the attention of the global health community on the "crisis" in the health workforce around the world.

The first, "Human Resources for Health: Overcoming the Crisis" (Joint Learning Initiative 2004), identified a global shortage of health workers. Building on previous cross-country analyses that identified a positive relationship between health worker density and population health outcomes (Robinson and Wharrad 2000, Robinson and Wharrad 2001, Anand and Barnighausen 2004), this report found a level of 2.5 health workers [1] per 1,000 population was associated with a high coverage of measles vaccination and skilled birth attendance. This level was then suggested as the minimum threshold of health workers required in order to deliver essential health services. 75 countries with less than this ratio were thus designated "low-density" countries. By estimating the number of health workers required to meet the threshold in low-density countries, the global shortage was quantified at 4 million health workers, with sub-Saharan Africa alone requiring 1 million additional workers.

The 2006 World Health Report "Working Together for Health" built on this theme by repeating the analysis for skilled birth attendance. 57 countries below a new threshold of 2.28 health workers per 1,000 population were said to be facing a "critical shortage" (World Health Organization 2006). An additional 4.3 million health workers were now needed globally, including a near doubling of the health workforce in sub-Saharan Africa. These new workers would require an average country's annual health spending per person to increase by 11% to cover training costs and over 75% to cover salaries.

The final report, "Scaling Up, Saving Lives", asserted that the primary cause of the crisis was a chronic underproduction of health workers (Task Force for Scaling Up Education and Training for Health Workers 2008). In particular, the production of doctors in sub-Saharan Africa has been extremely low for many years. For example, Ethiopia was training about 200 doctors a year at that time for a population of around 75 million,

[1] Although health workers have been defined as "all people engaged in the promotion, protection or improvement of the health of the population", data availability led to the analysis in these reports focusing on doctors, nurses and midwives. (Dal Poz et al, 2007)

compared to more than 6,000 in the UK for a population of 60 million. Half of the known medical schools in the region produced less than 100 graduates annually (Mullan, Frehywot et al. 2011). Twenty-four countries had just one medical school and eleven had none (Mullan, Frehywot et al. 2011). Building on the conclusions of the previous two reports, the authors called for a rapid scale-up in the production of health workers to meet the global shortage.

In response to the growing awareness of the importance of the health workforce, many countries considerably expanded their production of health workers. This was particularly the case in doctors in sub-Saharan Africa, with 76% of 168 known medical schools in the region reporting higher enrolment in 2009 compared to 2004 (Mullan, Frehywot et al. 2011). For example, the University of Bamako in Mali boosted its number of medical graduates from 50 per year in 1998 to 350 in 2007 (Van Dormael, Dugas et al. 2008). Between 2000 and 2009, 33 new medical schools were established in the region (Mullan, Frehywot et al. 2011).

An underlying assumption of all these reports and country efforts, however, is that greater training outputs will lead to increased service provision. This does not necessarily hold, as we will see in the next section.

2.2 AN ALTERNATIVE PERSPECTIVE OF THE SUPPLY CRISIS

While estimates of health worker shortages based on worker-to-population ratios are simple and intuitively appealing (Dal Poz, Kinfu et al. 2007), they disregard two important factors: (i) health workers are economic actors with behaviours and preferences operating in national, regional and international labour markets; (ii) the demand for health workers is not solely based on population health needs. With these limitations in mind, more recent literature has sought to redefine the HRH literature away from shortage-based advocacy and towards a more nuanced theoretical framework based on labour economics (Vujicic and Zurn 2006, Andalón and Fields 2011, Andalón and Fields 2013, McPake, Maeda et al. 2013, McPake, Scott et al. 2014, Sousa, Scheffler et al. 2014).

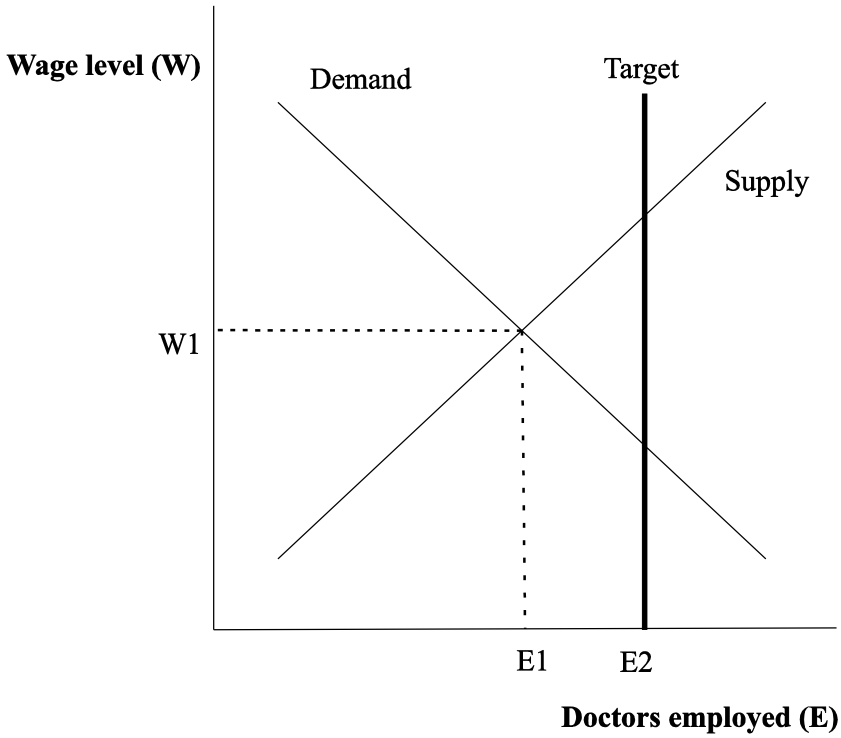
Within this framework, the health workforce employed in a country is determined by the interaction of supply and demand in a labour market. A labour market exists where workers sell their services to an employer for compensation (McPake, Maeda et al. 2013). The demand for workers is reflected in the wages that employers are willing and able to pay their staff. While population health needs usually contribute towards the demand for health workers, it is also influenced by political, social, and fiscal factors (Vujicic and Zurn 2006). When the amount of labour supplied by health workers equals the amount demanded by employers at the going wage level, the market is said to be in equilibrium[2] (McPake, Maeda et al. 2013).

Figure 2.1 illustrates this market for a single cadre, doctors. The supply curve is upward sloping as the number of doctors willing to work for an employer (E) is predicted to increase with higher wage levels (W), *ceteris paribus.* The demand curve is downward

[2] It should be recognised that the supply of health workers is just one aspect of the labour production function, which also depends on the productivity of those workers, the skill mix between and within cadres, and their distribution across levels of care and geographical areas. These issues are beyond the scope of this literature review and will not be considered further here.

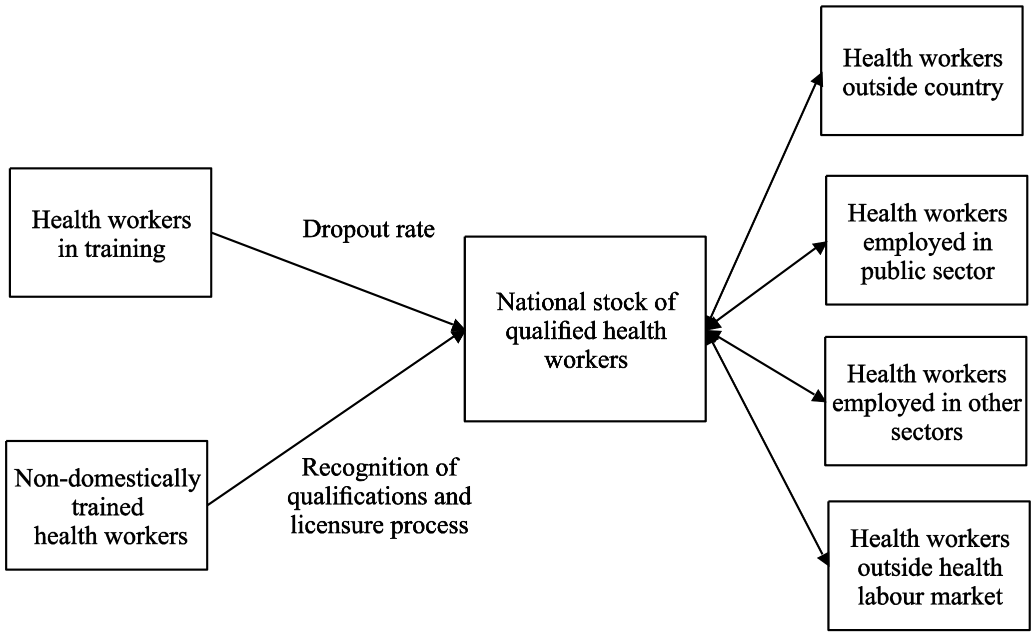
sloping as fewer doctors can be employed as wages go up within a fixed budget envelope. The point where the demand and supply curves cross is the market equilibrium point (W1, E1). This could lie to either side of a target employment level (E2) based on a needs-based measure such as health worker-to-population ratios (Vujicic and Zurn 2006). In practice, there are several features of health labour markets that often prevent equilibrium, particularly in LMIC (Vujicic and Zurn 2006).

Figure 2.1 A labour market for doctors



First, it is important to recognise that health workers have multiple options in terms of selling their labour (Figure 2.2) (Vujicic and Zurn 2006). Health workers are assumed to be rational agents seeking to maximise their utility, and as such are expected to sell their services to the employer offering the most attractive conditions. This employer could be in the public sector, but could equally be a private provider or other organisations. While in many countries the government holds a largely monopsonistic position as an employer, health workers always have the option to exit the health labour market, i.e. by working in other sectors or indeed not working at all. If conditions are more appealing in other countries, health workers can emigrate to meet demand in entirely different labour markets. While increased production leads to a larger stock of qualified health workers[3], it does not necessarily lead to increased service provision in that country (Vujicic and Zurn 2006, Andalón and Fields 2011). For this, with the exception of compulsory service

Figure 2.2 Labour market options for qualified health workers in a country



(see below), employers will need to offer compensation that is more competitive (i.e. attractive to health workers) than these other options. This requires knowledge of health workers' preferences.

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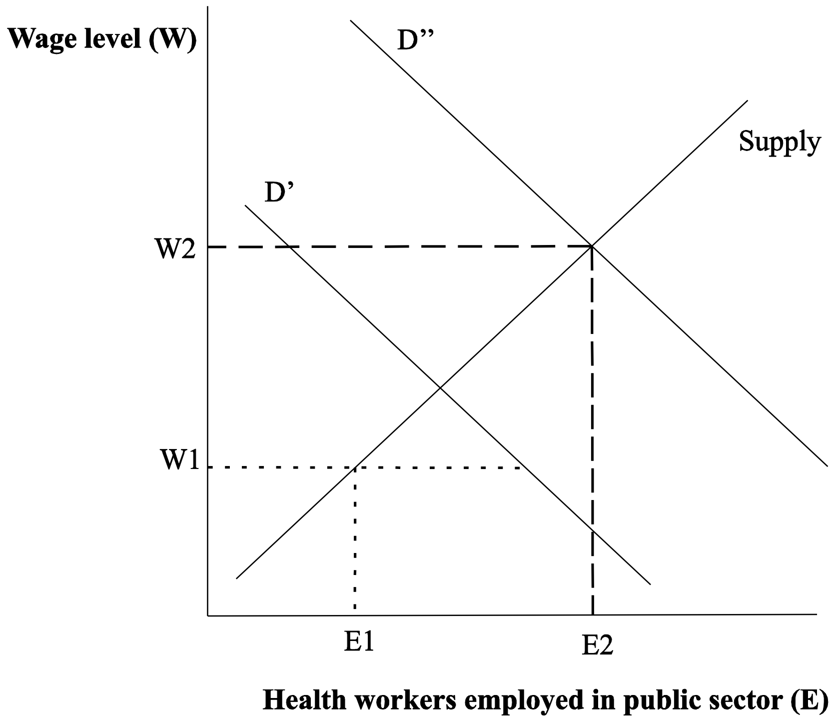
[3] Dependent on the training dropout rate. Likewise, recruitment of non-domestically trained health workers is dependent on the registration and licensure processes in that country. While employment of such workers can be restricted to the public sector (see section on compulsory service), this may decrease the supply.

Compared to other employers, the public sector often has less flexibility in the financial compensation it can offer to health workers, for reasons explained below. When the wage offered in public sector jobs is low (e.g. W1 on Figure 2.3), workers may choose to work for other employers or not to work at all if this level is below their reservation wage[4]. The number of workers willing to work for the public sector is low (E1), meaning that at this wage level (W1) the quantity demanded (D') will exceed the labour supplied, a situation known as an economic shortage. An expanding stock through increased production is unlikely to relieve this situation, unless new workers have lower reservation wages.

Figure 2.3 The public sector labour market for doctors



Notes: *D = Demand*

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[4] The lowest wage level at which a worker would be willing to accept a particular type of job (Borjas 2008)

In order to meet a needs-based target of employment (E2), a government would need to increase its budget (shifting the demand curve to the right, D'') to be able to offer wages at a level (W2) that would ensure the supply of health workers meets demand. This may be beyond the financial resources available for health in LMIC. If a government is unable or unwilling to increase the wage offered, an alternative is to offer non-wage compensation to make public sector jobs more competitive (McPake, Scott et al. 2014). This requires information on what health workers value apart from the financial return on their jobs.

A final feature of health labour markets in LMIC is supply constraints. Professional cadres can take several years to train and are subject to strong regulation. Training institutions for these cadres in many LMIC have only been established relatively recently, with much lower outputs compared to high-income countries that reduce economies of scale (Task Force for Scaling Up Education and Training for Health Workers 2008). The cost of undergraduate training in many countries is heavily subsidised by the government (Mullan, Frehywot et al. 2011). This creates the situation where the public sector absorbs much of the cost of producing health workers without necessarily recouping this investment through service provision, thus reducing the efficiency of government spending (Hongoro and McPake 2003, Sousa, Scheffler et al. 2014). This situation is exacerbated where production is scaled up without the conditions available that are most likely to attract these new health workers to the public sector.

Such features illustrate why a labour market approach can deepen our understanding of the health workforce "crisis" and the most effective strategies to retain health workers.

Yet the data required for such analyses are scarce in LMIC (McPake, Maeda et al. 2013, McPake, Scott et al. 2014). Far more information is needed on health workers' remuneration, movement between labour market options, and responsiveness to wage and non-wage compensation in order to generate evidence-based policy. This is particularly important for the public sector. While health workers employed outside the public sector in LMIC still contribute to the health production function, there are generally fewer constraints on the job conditions that can be offered by these employers. Research on the most effective policies to retain health workers within the constraints commonly faced by LMIC governments thus offers a baseline that may also inform policy in other sectors. This thesis will therefore focus on the retention of doctors both within a country and specifically within that country's public sector. The next section reviews common strategies employed by governments to this end.

2.3 RETAINING HEALTH WORKERS

The strategies employed by governments to retain health workers can be broadly divided into three categories: (i) compulsory service, (ii) provision of incentives and (iii) reduction of emigration. While pre-service strategies such as selective admission or changes to undergraduate training may play a role in retention, this section will focus on qualified health workers.

2.3.1 Compulsory service

Compulsory service programmes for health workers typically mandate public sector employment for a specified period of time, most commonly in underserved areas. More than 70 countries have some type of compulsory service programme (Frehywot, Mullan et al. 2010). In a few countries, compulsory public sector service is the only labour market option for native health workers (e.g. Cuba) or non-domestically trained health workers, (e.g. Australia [5]). Compulsory service may be a condition of licensure (for both independent and private practitioner), linked to training (either undergraduate or postgraduate), or encouraged with incentives. For doctors, a review of compulsory service programmes revealed that a common incentive was higher priority for entry to or funding for specialty training. For example, in Tamil Nadu, increased priority is given for every two years served in tribal areas (Frehywot, Mullan et al. 2010).

Evidence on the impact of compulsory service programmes is scarce, with most arising from observational studies in high-income countries (Bärnighausen and Bloom 2009, Frehywot, Mullan et al. 2010). While programme evaluations show increased supply to underserved areas (Frehywot, Mullan et al. 2010), a meta-analysis of programmes linked to a range of financial incentives found around three in ten participants did not fulfil their service commitment (Bärnighausen and Bloom 2009)[6]. Difficulties faced by compulsory service programmes include their unpopularity with health workers, vulnerability to gaming and corruption, and effective enforcement in LMIC (Koot and Martineau 2005, Frehywot, Mullan et al. 2010, Lemiere, Herbst et al. 2010).

[5] Australia requires some international medical graduates to spend ten years working in an underserved district.

[6] The associated systematic review found some evidence to suggest that participants were more likely to work in underserved areas after the programme period than non-participants, although all studies bar one were from high-income countries.

2.3.2 Provision of incentives

The World Health Organization has described incentives as "all the rewards and punishments" faced by a health worker (World Health Organization 2000), but a better definition in this context is "the factors and/or conditions within health professionals' work environments that enable and encourage them to stay in their jobs, their profession and their countries" (Global Health Workforce Alliance 2008). Incentives can be categorised into financial and non-financial, and combined into an incentive "package". While the main effect considered here is retention in the public sector compared to other sectors, incentives can also help to minimise exits from the labour market. For example, subsidised childcare, access to healthcare (e.g. free antiretroviral treatment) or long service benefits for public sector workers could all support health workers to participate in the labour market.

As shown above, the most important incentive from a labour market perspective would be to raise salaries. Surveys show salaries paid by private facilities or non-governmental organisations in sub-Saharan Africa are often several-fold higher than those paid in the public sector (McCoy, Bennett et al. 2008). Comparisons of wage levels for health workers across countries show wide disparities, for example doctors in the USA earn 20 times more than doctors in the Ukraine and 25 times more than doctors in Ghana even when adjusted for purchasing power (Vujicic, Zurn et al. 2004, Tijdens, de Vries et al. 2013)[7]. Indeed, negative aspects of some public sector posts, for example a rural location or high workload, may require even higher wages compared to other jobs in order to

[7] The findings of the study by Tijdens et al. should be viewed cautiously due to the non-representative sample and self-reporting of wages and working hours.

compensate health workers for this disutility. This theory is known as compensating wage differentials, although empirical evidence from other sectors is mixed (Rosen 1986, McPake, Scott et al. 2014).

Many LMIC, however, have limited capacity to raise public sector wages. Rapid increases to government wage bills relative to gross domestic product can lead to macroeconomic instability, and countries with International Monetary Fund programmes may be subject to wage bill ceilings for this reason (Vujicic, Ohiri et al. 2009, Soucat, Vujicic et al. 2013). Moreover, wages are often not flexible due to employment of health workers as part of the civil service in many LMIC, with a common salary scale for all workers regardless of market conditions (Henderson and Tulloch 2008, McPake, Maeda et al. 2013, Soucat, Vujicic et al. 2013). Uplifts to wages for health workers can therefore be politically difficult, even if the fiscal impact appears small. Agyepong et al. describe the domino effect caused by initially exceptional salary supplements for Military of Defence doctors in Ghana that were soon expanded to all doctors, then other cadres, and finally the entire public sector (Agyepong, Kodua et al. 2012)[8]. Finally, while support from development partners can be used to supplement wages and/or allowances, this can be unpredictable and short-term, with governments unable to match the wage increases if funding is withdrawn (McCoy, Bennett et al. 2008, Soucat, Vujicic et al. 2013). In sum, these constraints mean that public sector wages often do not capture all the advantages and disadvantages associated with these jobs (McPake, Scott et al. 2014).

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[8] The initial USD1.5 million budget allocated for the supplements rose to USD84 million seven years later (Agyepong, Kodua et al. 2012).

Another consideration is the potential perverse effect of financial incentives on the motivation of health workers. It has been proposed that some health workers derive utility from simply carrying out their job, the so-called "economics of vocation" (Heyes 2005). Such individuals may first self-select into health worker training and then into the public sector, accepting a lower wage level than would be expected from a labour market perspective (Dixit 1997, Delfgaauw and Dur 2008). Incentives that offer increased remuneration for what are largely vocational acts risk "crowding out" such intrinsic motivation, either through selection or changing existing workers into primarily wage seekers (Deci and Ryan 1985, Frey 1993, Frey 1997, Kalk 2011).

Attention has therefore turned to non-financial incentives, defined as holding little or no monetary value compared to the direct or indirect monetary transfer of financial incentives (Kingma 2003, Mathauer and Imhoff 2006). Examples include better supervision, availability of basic equipment, and clear career progression. Such incentives would be expected to combine with wages and other financial incentives as part of a health worker's overall utility function from a job, leading to a broader definition of the "compensation" offered by employers in a labour market (McPake, Maeda et al. 2013). Although such incentives have a low monetary value to an individual health worker, it is important to recognise that their effective implementation may still incur considerable cost to the government. Moreover, for some incentives often categorised as non-financial, such as opportunities for further training or promotion, the monetary transfer (in the form of higher salaries) may simply occur later. Nonetheless, incentives that hold less tangible monetary value may be more attractive to ministries of finance and development partners in many LMIC.

At this juncture, a comparison of the relative effectiveness of different financial and non-financial incentives on health worker retention would be illuminating. Unfortunately, the literature consists mainly of descriptive case studies or scale surveys[9], with few empirical studies (McPake, Maeda et al. 2013, McPake, Scott et al. 2014). As an alternative, a cross-country comparison of descriptive studies could suggest which incentives may be effective in public sector retention, given that these incentives are likely to be related to workers' demands and thus preferences. Such a review has been carried out for non-financial incentives for east and southern Africa and the results are summarised in Table 2.1 (Dambisya 2007). As can be seen, training dominated the non-financial incentives offered to health workers in these countries at that time[10]. While training can be provided within working hours as in-service training, formal postgraduate training is the more frequently provided incentive.

From this evidence, postgraduate training appears to be valued by health workers. There are different perspectives on why postgraduate training holds such value. In the HRH literature, postgraduate training is often viewed as strengthening the ability to perform in a job (Mathauer and Imhoff 2006, World Health Organization 2006). From a labour economics perspective, it would be regarded as investment into an individual's human capital: the unique package of skills and knowledge acquired through education

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[9] Surveys asking health workers to rank or rate different factors.

[10] These results should be viewed cautiously as the analysis was based on a review of available literature, which may not have given an accurate reflection of each country's situation at that time.

Table 2.1 Non-financial incentives offered in east and southern Africa

INCENTIVE	COUNTRY															
	Angola	Botswana	Cameroon	DRC	Kenya	Lesotho	Malawi	Mauritius	Mozambiq	Namibia	South	Swaziland	Tanzania	Uganda	Zambia	Zimbabwe
Postgraduate training		■	■		■	■	■	■			■			■	■	■
In-service training			■	■		■	■				■			■	■	■
Sabbatical/Study leave			■			■					■			■		■
Research opportunities														■		■
Manageable workload											■	■				■
Resources & equipment			■								■					
Better built environment		■									■					
Better IT & communication					■				■							
Occupational health					■											
Security at work						■		■								■
Improved supervision								■		■	■					
Recognition of work					■	■		■								
Psychosocial support											■					
Mentoring														■		
Consistent & timely salary			■													
Job description							■	■		■				■		■
Substantive contract										■		■				
Employee representation in management decisions						■	■					■				■
Flexible working hours							■				■					
Flexible or longer leave					■						■		■			

Source: *Dambisya (2007).* ***Notes:*** *DRC = Democratic Republic of Congo; IT = Information technology; shaded squares indicate presence of incentive*

and training (Becker 1993, Borjas 2008). A forward-looking individual will seek to maximise the returns on human capital investments over their lifetime (Radu 2008). Given that remuneration for health workers is generally higher outside the public sector or in other countries (McCoy, Bennett et al. 2008), it would be expected that these labour market options would be more attractive to those looking to maximise the returns on their undergraduate training. Yet if opportunities for further investments into human capital are largely or only available in the public sector, individuals may make a rational decision to defer short-term gains for the opportunity to undertake further training that is likely to lead to higher lifetime returns overall. Retaining health workers in the public sector is not just a question of competing with other sectors, however, but also other countries. We will now examine the impact of emigration on public sector retention.

2.3.3 Reduction of emigration

With expertise that is in demand globally, many health workers choose to leave their country of training and sell their skills in other labour markets (Hagopian, Thompson et al. 2004, Stilwell, Diallo et al. 2004, Mullan 2005, Bhargava and Docquier 2006, World Health Organization 2006, Mills, Kanters et al. 2011). One fifth of African-born doctors were estimated to be living in nine common destination countries[11] in 2000 (Clemens and Pettersson 2008). In England, 13.7% of National Health Service (NHS) clinical staff of known nationality[12] are foreign nationals, rising to 25.6% of all doctors and 37.1% of locums[13] (Health & Social Care Information Centre September 2013). Table 2.2 disaggregates these figures by geographical region, showing that sub-Saharan health workers make up 6.3% of NHS doctors of foreign nationality in England. A study of doctor registration records in the United States of America (USA) found that the migration of doctors trained in sub-Saharan Africa has been increasing since 2000 for all

[11] UK, USA, France, Australia, Canada, Portugal, Belgium, Spain and South Africa.

[12] Data by country of training were not available.

[13] Non-contracted doctors.

Table 2.2 NHS staff of foreign nationality, selected cadres and areas

Geographical area	Foreign nationals as percentage of cadre			
	Clinical staff	Doctors (all)	Nurses	Allied health professionals
Asia (total)	42.2	52.5	42.3	21.5
India	19.6	28.7	16.6	13.0
Philippines	11.3	0.1	21.3	3.7
Africa	17.6	10.5	23.0	13.5
Sub-Saharan Africa	16.1	6.3	23.0	13.3
Eastern Europe	6.2	7.2	5.2	4.9
Rest of world	34.0	29.7	29.5	60.0

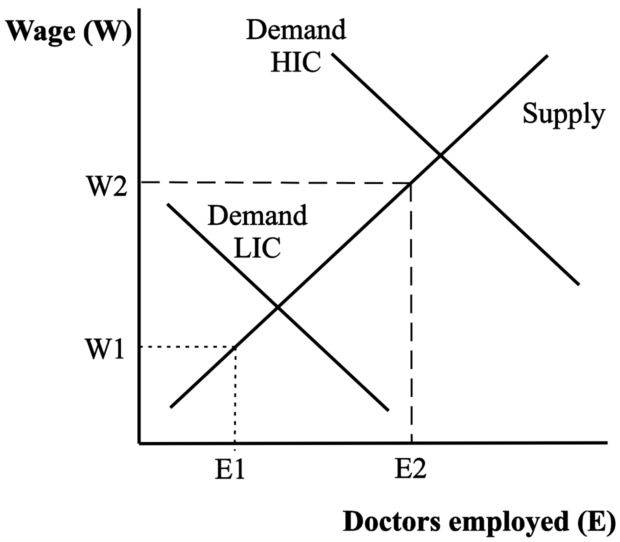
Source: *The Health & Social Care Information Centre, author's analysis.* ***Notes:*** *Headcount data from September 2013 (latest available). Data represents clinical staff with known nationality. Regions and subregions based on United Nations groupings (United Nations Statistics Division 2013)*

countries except South Africa (Tankwanchi, Özden et al. 2013).

Early career appeared to be a particularly vulnerable time for emigration. Tankwanchi et al. found that doctors from sub-Saharan Africa worked for an average of 6.4 years in their country of training before emigrating to the USA. For those graduating since 2000, this dropped to just 2.4 years (Tankwanchi, Özden et al. 2013). A survey by George et al. of 1619 non-European Union doctors working in the NHS revealed that nearly half had qualified in the last seven years (George, Rozario et al. 2007).

Figure 2.4 illustrates the dynamics of these competing labour markets for an example low- and high-income country. With a larger health budget, high-income countries are able to employ more health workers even at non-clearance wage levels (E2 compared to E1). Those countries with an unmet demand for labour may recruit health workers trained in poorer countries. The wages offered to these workers (W2) may be similarly constrained by government payscales or overall health expenditures, however are likely to be higher than domestic wage levels (W1).

Figure 2.4 Competing labour markets for doctors



Notes: *LIC = low-income country; HIC = high-income country*

From a demand-side perspective, richer countries could reduce their reliance on foreign-trained health workers through increased domestic production, although the forecasting required for sustained workforce levels has been shown to be challenging even in health systems with abundant data (Van Greuningen, Batenburg et al. 2013, Amorim Lopes, Santos Almeida et al. 2015). A plethora of voluntary codes have been drawn up to discourage the active recruitment of health workers from source countries (Stilwell, Diallo et al. 2004, Pagett and Padarath 2007, World Health Organization 2010). Limited trend data show decreased immigration associated with these codes, but it is difficult to ascribe causality (Buchan, McPake et al. 2009, Tankwanchi 2015). More substantive changes have followed changes to immigration rules, notably the end of exemption for UK postgraduate medical training posts from work permit requirements (Department of Health 2006) and a points-based system for non-European Economic Area nationals (NHS Employers 2015).

From a supply-side perspective, we first need to know more about the migration decisions of health workers.

2.3.4 Migration decisions of health workers

The literature describes a fairly consistent set of factors influential in the migration decisions of health workers (Awases, Gbary et al. 2004, Astor, Akhtar et al. 2005, Bärnighausen and Bloom 2009, Anarfi, Quarey et al. 2010). These are commonly grouped into two sets of factors: “push” (motivating health workers to emigrate from source countries) and “pull” (attracting health workers to destination countries) (Padarath, Chamberlain et al. 2003, Awases, Gbary et al. 2004). Both can be further divided into factors that are endogenous or exogenous to the health system (Padarath, Chamberlain et al. 2003). While better remuneration is an important reason for intended or past migration, a host of endogenous non-financial reasons are also thought to be influential. These include training opportunities, resource levels, workload, job security, promotion prospects, and management styles. Exogenous factors include living conditions, general security, political repression, economic decline, and children's educational opportunities (Bärnighausen and Bloom 2009).

A recent extension to this categorisation is "stick" and "stay" factors. Stick factors encourage people to remain in their home country despite strong push and pull factors, while stay factors deter individuals from returning to their home country after emigration (Padarath, Chamberlain et al. 2003). Stick factors are quite wide-ranging, encompassing incentive systems, professional networks, social aspects such as status and prestige, cultural norms and family commitments, and barriers to migration such as the cost of relocation, recognition of clinical qualifications, language in a destination country and different clinical practices (Padarath, Chamberlain et al. 2003). Stay factors include lack of information on job opportunities, disruption to children's education and adaptation to living conditions.

To assess the relative influence of these factors on migration decisions of doctors in particular, I carried out a systematic review of studies examining the reasons for intended or actual emigration in doctors[14]. Out of 152 identified studies, just 16 met the inclusion criteria. Nearly all of these were small-scale qualitative or multi-response surveys, making it difficult to compare the importance of different factors (Ballard, Laurence et al. 2004, Brown and Connell 2004, Astor, Akhtar et al. 2005, Chikanda 2005, Hagopian, Ofosu et al. 2005, Kolcic, Polasek et al. 2005, Oberoi and Lin 2006, Akl, Maroun et al. 2007, Ayegi 2007, Kangasniemi, Winters et al. 2007, Bezuidenhout, Joubert et al. 2009,

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[14] The search strategy for this review is summarised in Appendix A.

Oman, Moulds et al. 2009, Anarfi, Quarey et al. 2010, Josko, Kasperczyk et al. 2011, de Silva, Samarasekara et al. 2014).

One excluded study worth noting surveyed a range of health workers with migration intentions in six sub-Saharan African countries (Awases, Gbary et al. 2004). As expected, remuneration was frequently cited as a reason for emigration, however other factors were as or sometimes more important, such as the desire to gain international experience/further training and better working or living conditions[15]. Vujicic et al. built on this study by using the proportion of health workers with migration intentions identified by the survey as an indication of the potential supply to destination countries, comparing this with wage differentials between source and destination countries and concluding that the elasticity of migration with respect to wage compensation was close to zero in this dataset (Vujicic, Zurn et al. 2004). This analysis, however, disregards important aspects of migration such as migration networks (discussed below) and the influence of non-wage compensation. For example, the one large-scale study identified by my review asked non-European Union doctors working in the NHS to give one main reason for migrating to the UK (George, Rozario et al. 2007). Over three quarters of doctors selected “training opportunities”, with just 7.2% citing better pay[16].

In summary, the literature on causes of health worker emigration is largely atheoretical, with a paucity of empirical studies examining the relative influence of different factors.

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[15] No disaggregation by cadre was available. Discrepancies in sampling data collection limit the representativeness and cross-country comparability of this survey.

[16] Indian doctors were heavily overrepresented in the sample, however.

The next section provides a brief overview of relevant migration theories and their application to health workers.

2.3.5 Theories of migration

The classic migration theory in labour economics is the human capital approach (Borjas 2008). Here, migration is viewed as a rational investment decision by an individual to obtain returns on human capital (Sjaastad 1962, Borjas 2008). Workers compare the present value of lifetime earnings in their source country (LE^S) to possible lifetime earnings in their destination country (LE^D), multiplied by probability of employment in each location (P^D, $P^{S)}$ and taking into account the costs of migration (MC) (Sjaastad 1962, Radu 2008). These costs can be both financial (e.g. cost of travel) and socio-psychological (e.g. cultural ties, moving away from family), with the latter analogous to the stick factors described above (Borjas 2008, David, Janiak et al. 2008, David, Janiak et al. 2008, Radu 2008). The net gain to migration is thus given by:

$$\text{Net gain} = P^{D*}LE^D - P^{S*}LE^S - MC \qquad (1)$$

If the net gain is positive, the worker is likely to emigrate (Borjas 2008). This model explains the tendency of health workers to migrate during their early careers, as expected returns are discounted over the remaining lifetime (Hagen-Zanker 2008). Given the disparity in potential lifetime earnings and demand by high-income countries, however, one would predict the emigration rate of health workers to be higher than that observed in empirical studies unless migration costs are very high. The model is limited by its disregard for non-financial sources of compensation, seen to be important above, and its assumptions of rational decision-making and perfect information (Hagen-Zanker 2008).

Behavioural models of migration, in contrast, assume more subjective decision-making that incorporates more than purely economic considerations (Hagen-Zanker 2008). For example, the stress-threshold model states that individuals aspire to a threshold level of utility, with the utilities associated with different destinations dependent on incomplete and subjective knowledge (Wolpert 1965). Health workers may therefore make less than optimal migration decisions based on their subjective utility evaluations. The value-expectancy model predicts that an individual's migration decision depends on the value placed on potential rewards of migration multiplied by the expectations that migration will actually lead to these rewards (Crawford 1973). Values and expectations vary by individual, but are also influenced by societal norms. For health workers, these norms may include those of their professional community, such as the prestige associated with training in high-income countries, as well as wider society. While these theories are less rigid than the human capital approach, a unifying assumption is that decisions are made at an individual level (Hagen-Zanker 2008).

The New Economics of Labour Migration, in contrast, reformulated migration as a decision made at a household level with consideration of the benefits and costs for the entire family (Stark and Levhari 1982, Stark 1984, Stark and Bloom 1985, Stark 1991). This theory would predict that health workers from relatively poorer families would be more likely to migrate so as to improve overall household income, despite being relatively high earners on an individual level. Migration is also framed as one mechanism to smooth risks across a household (Hagen-Zanker 2008). Health workers may migrate in spite of higher risks to the individual in the short-term in order to reduce the medium- and long-term risks to a household (Stark and Levhari 1982).

While this consideration of risk incorporates a time dimension, the dynamic nature of migration has been mainly expounded by sociological theories (Hagen-Zanker 2008). After a difficult pioneer period, migration is seen to be perpetuated by meso-level factors such as migrant networks that essentially lower migration costs (Massey 1990, Goss and Lindquist 1995). The social capital available to new migrants in established migrant communities may also overcome “stick factors”. (Faist 1997, Faist 2000). When networks are established, migration can become cumulative (Massey 1990), as seen by the trend of increasing emigration of doctors to the USA (Tankwanchi, Özden et al. 2013). The inverse of cumulative migration is the magnet effect, whereby non-emigrant health workers exert a powerful influence on other actual or potential migrants due to role modelling and the social capital of a growing professional community (Bailey, Mandeville et al. 2012). Finally, macro-level factors, such as demand from high-income countries, immigration restrictions and economic development, can lead to period effects in migration (Hagen-Zanker 2008).

In conclusion, the current paradigm of migration in HRH literature is overly simplistic when viewed against the wealth of theory from other disciplines. There has been little attempt to integrate the extensive literature on migration decisions from economics, psychology and sociology. Indeed, the list of factors used to explain health worker migration today stems from one of the earliest migration theories by Lee, which was quickly abandoned in other fields in favour of more theoretical models (Lee 1966). What little empirical evidence is available points to the influence of postgraduate training opportunities in migration decisions, particularly for doctors. The mechanisms by which such training could lead to public sector retention will be examined below, but first we will explore the definition of this term for doctors.

2.4 POSTGRADUATE MEDICAL TRAINING

In the broadest sense, postgraduate medical training can refer to all training after graduation from undergraduate medical training, including:

- the period after qualification but before registration and licensure as an independent medical practitioner, often referred to as internship;
- a formal period of training in a particular specialty, known as specialty training[17];
- academic courses undertaken after graduation, which may be part of specialty training. For example, specialty training in public health can consist of a master's degree and/or doctorate rather than a formal training programme (IJsselmuiden, Nchinda et al. 2007, Chastonay, Zesiger et al. 2015);
- the development of expertise in a subspecialty once qualified in a particular specialty (General Medical Council Intelligence Unit 2011);
- continuous professional development[18], which refers to the lifelong maintenance of knowledge and skills (Peck, McCall et al. 2000).

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[17] Also known as residency training. In this thesis, training in general medical practice to become an accredited general practitioner (GP) or family physician is considered as specialty training.

[18] Also known as continuous medical education.

Most commonly, however, postgraduate training is taken to refer to specialty training (Burch, McKinley et al. 2011, Mullan, Frehywot et al. 2011).

2.4.1 Specialty training

Specialisation is defined as "the adoption of an increasing level of expertise in a specific disciplinary area by a select group of the profession" (Nancarrow and Borthwick 2005). Medicine began to divide into recognisable specialties from the late-19th century onwards (Gritzer and Arluke 1985, Halpern 1988, Cassel and Reuben 2011). While the dominant biomedical narrative for the emergence of specialties is the division of labour required by the expansion of medical knowledge, skills and technologies, alternative explanations include the desire to establish control over new areas of the healthcare market (e.g. paediatrics) and legitimising hegemony over allied health workers in that area (Gritzer and Arluke 1985, Halpern 1988). Due to different tolerance for medical fragmentation (Cassel and Reuben 2011), countries now vary in the specialties and subspecialties that they recognise, from 150 in the USA to 35 in New Zealand (General Medical Council Intelligence Unit 2011). Table 2.3 shows those recognised by the European Union, in addition to general practice (European Parliament and the Council of the European Union 2005).

Competency in a specialty is transferred through a standardised programme of specialty training, although this is not always a requirement to work in a specialty area (Halpern 1988). Training usually lasts a minimum of three years, although can be up to eight years with extra time required for subspecialisation (World Health Organisation Regional Office for Europe 1989, European Parliament and the Council of the European Union 2005, Royal College of Paediatrics and Child Health 2010). Training requirements can

Table 2.3 Specialties and subspecialties recognised by the European Union

SPECIALTY	SUBSPECIALTY
Accident and emergency medicine	
Anaesthetics	
Clinical neurophysiology	
Clinical pharmacology	
Medicine	Allergy medicine
	Cardiology
	Dermatology
	Dermatovenerology
	Endocrinology
	Gastroenterology
	General/internal medicine
	Genito-urinary medicine
	Geriatrics
	Haematology
	Infectious diseases
	Neurology
	Neuropsychiatry
	Nuclear medicine
	Oncology
	Oral medicine/stomatology
	Physical and rehabilitative medicine
	Renal medicine
	Respiratory medicine
	Rheumatology
	Tropical medicine
Obstetrics & Gynaecology	
Occupational medicine	
Ophthalmology	
Paediatrics	
Pathology	Chemical pathology
	Clinical biology
	Histopathology
	Immunology
	Medical microbiology and virology
Psychiatry	Child psychiatry
	General psychiatry
Public health medicine	
Radiology	
Surgery	Cardiothoracic surgery
	Gastroenterological surgery
	General surgery
	Maxillo-facial surgery
	Neurosurgery
	Otolaryngology (Ear, neck and throat)
	Paediatric surgery
	Plastic surgery
	Trauma and orthopaedic surgery
	Urology
	Vascular surgery

Source: *European Parliament and the Council of the European Union (2005)* include entry and exit examinations, a research thesis, completion of a minimum number of procedures or stipulated training placements, and/or fulfilment of an approved curriculum (Zijlstra and Broadhead 2007, Royal College of Paediatrics and Child Health 2010). Universities, providers, medical regulators and specialty associations may all participate in the delivery and accreditation of specialty training (Halpern 1988, General Medical Council 2015).

2.4.2 Specialty training in sub-Saharan Africa

While the drive to scale up production of health workers led to a spotlight on undergraduate medical training in sub-Saharan Africa, there has been far less attention given to specialty training. The most comprehensive data come from the sub-Saharan African Medical Schools Study. Out of 168 medical schools in the region identified in the survey, 58 (35%) reported that they offered specialty training programmes. In total, 1909 specialty training places were available for the 7861 annual graduates reported to the study (Mullan, Frehywot et al. 2011). This suggests that less than a quarter of the doctors produced every year in sub-Saharan Africa will have access to specialty training within the region[19].

When these places are disaggregated by specialty (Table 2.4), it can be seen that four specialties dominate training provision: internal medicine, obstetrics & gynaecology, paediatrics and general surgery. These form the bulk of teaching in many medical schools and are often known as the "core" specialties (Burch, McKinley et al. 2011, Eze, Okoye

[19] The accuracy of this figure, however, is weakened by underreporting with responses from less than half of medical schools (48.8%, 82/168).

et al. 2011, Egbi and Unuigbe 2014). Even in those specialities, the median number of annual training places is just four or five per school.

Table 2.4 Specialty training places in sub-Saharan Africa, 2009

Specialty	% medical schools offering training*	Total annual training places	Median training places by school	Inter-quartile range	Min	Max
Internal/general Medicine	59.8	263	4	4	0	55
Obstetrics & gynaecology	61.0	247	5	4.5	0	28
Paediatrics	61.0	232	4	5	0	35
General surgery	62.2	212	4	4	0	28
Public health	43.3	179	5	13	0	90
Radiology	38.3	132	3	4	0	60
General / family practice	35.0	96	4	4	0	20
Pathology	31.3	75	3	4	0	8
Psychiatry	34.6	74	2.5	4	0	12
Anaesthetics	38.3	73	3	3	0	8

Source: *The Sub-Saharan African Medical School Study, author's analysis.* ***Notes:*** *Aggregated categories "medical subspecialties" and "surgical subspecialties" excluded from analysis; *percentage of responding medical schools only; Min = minimum; Max = maximum*

Despite restricted domestic training opportunities, there is evidence that an aspiration to specialise is common among medical students in sub-Saharan Africa. When 984 final-year medical students from six sub-Saharan African countries [20] and 876 final-year students from all medical schools in South Africa were interviewed, over nine in ten intended to specialise in both surveys (De Vries, Irlam et al. 2010, Burch, McKinley et al. 2011). Four fifths of medical students in Malawi had chosen a future specialty before graduation (Mandeville, Bartley et al. 2012). Over half of medical students at public medical schools in Angola, Guinea-Bissau and Mozambique wanted to train in a core specialty, despite only 21 annual training places in these countries reported to the sub-Saharan African Medical Schools Study (Ferrinho, Sidat et al. 2011).

It is likely that the undergraduate teaching environment plays a role in these aspirations. In many countries, the bulk of undergraduate medical training is taught by hospital specialists in urban secondary- or tertiary-level facilities (World Health Organization 2010). These role models, who are often Western nationals in sub-Saharan Africa, have been shown to be influential in the specialty choice of new doctors (Burack, Irby et al. 1997, Wright, Wong et al. 1997). Yet at current levels of specialty training, the majority of graduates will not be able to emulate their role models without emigration.

2.4.3 Specialty training and public sector retention

It is clear that doctors value specialty training and that at least some emigration is fuelled by the search for training opportunities. Expansion of domestic specialty training capacity may therefore be an effective incentive for public sector recruitment and retention. With

[20] South Africa, Nigeria, Kenya, Democratic Republic of Congo, Tanzania and Uganda – although South Africa was overrepresented in the sample.

references to the literature reviewed above, this could work through three mechanisms: (i) linking entry to specialty training to a period of compulsory public sector service; (ii) increasing the attractiveness of public sector jobs compared to other sectors if this is perceived to be the most reliable route to funded specialty training; (iii) reducing emigration both before and after specialty training. Specialty training can be viewed as an additional investment into an individual's human capital. Doctors may defer emigrating in order to make an extra investment into their human capital, providing public sector service in the meantime. After completion of training, specialists will have better earning potential in their country of training due to higher remuneration and opportunities for private practice. Moreover, the likelihood of family commitments is higher, widening the locus of the migration decision to the household as well as increasing stick factors.

On the other hand, expanding access to specialty training may act against public sector retention in the long-term. As further training is often associated with costs such as tuition fees or financial benefits foregone, as well as a reduced working life, specialists are likely to want a higher return on their human capital investment. For those countries with a large private sector, this may be achieved more easily outside the public sector. It is also more likely to be achieved in high-income countries, where demand for the rare skillset of specialists is also likely to be greater than for generalist doctors. A greater training investment by a low-income country may therefore actually increase the risk of emigration to a high-income country. Distinguishing between these mechanisms, however, is hampered by the lack of studies examining the uptake of and retention following specialty training in LMIC.

A final consideration is the capacity of weaker health systems to absorb more specialists. Specialists usually receive higher remuneration in the public sector, which may not be sustainable in LMIC over a larger stock (McCoy, Bennett et al. 2008). The skillset of specialists is also most effectively deployed in hospitals with access to higher-technology equipment. The common demotivating factors of insufficient resources and equipment in public sector facilities may be thus magnified for specialists, triggering exit (Mathauer and Imhoff 2006). Indeed, the most appropriate skill mix for a health system characterised by preventable diseases and poor access to healthcare is unlikely to be a top-heavy doctor cadre that operates most effectively in secondary care. Moreover, the investment in a particular skill-mix among specialists introduces inflexibility into the medical workforce, reducing its ability to adapt to changing disease burdens. Judgements made on skill-mix today need to take account not only of current service needs, but also those likely to arise over the working life of specialists. The rapidly evolving epidemiological profile in many LMIC make this a particularly difficult task.

In conclusion, expansion of specialty training may not be the most efficient use of public resources in the long-term. Many medical students in sub-Saharan Africa, however, train in environments that promotes aspiration to specialist status. Scaling up the production of doctors without due consideration of these expectations could also be considered a poor use of resources. Therefore, expansion of specialty training can be viewed as a potential stopgap mechanism to recoup costs sunk into undergraduate training until longer-term measures to modify career objectives can be put in place.

2.5 INVESTIGATING THE EFFECTIVENESS OF SPECIALTY TRAINING

As seen from the literature above, a range of incentives are likely to be at least somewhat effective at public sector retention. The key issue for policymakers is the relative effectiveness of different incentive policies in order to more efficiently allocate scarce resources. There are three broad approaches that could be taken to investigate this question.

First, an experimental approach would distribute incentives randomly to different groups of doctors and observe the effect on retention. Purposively allocating incentives to some individuals and not others, however, is politically difficult within a workforce. Clustering by facility or geographical area could potentially reduce the risk of contamination and associated worker unrest, and decentralisation processes may facilitate natural or planned experiments, however both would be dependent on country size and engagement with trade unions and/or professional associations. In any such study, power would be severely constrained by the stock of doctors in most sub-Saharan countries.

Few intervention studies appear to have been undertaken, and none to my knowledge have focused on training strategies. One systematic review searched for studies of the effects of increased salary on performance of civil servants (doctors, nurses, mid-level cadres and teachers) in LMIC (Carr, Leggatt-Cook et al. 2011). Performance here was widely defined to encompass differences in absenteeism, moonlighting, accepting informal payments, traditional outcome measures such as quality of care, and public sector retention. No study on health workers met the inclusion criteria on quasi- or experimental study design, and those that narrowly missed inclusion were focused on clinical outcomes rather than retention. A later Cochrane review identified no rigorous studies that investigated the effect of higher salaries, other financial incentives, specialty training scholarships or bonding on movement of health workers between public and private sectors in LMIC (Rutebemberwa, Kinengyere et al. 2014).

The second approach would be an observational study that tracked the labour market decisions of doctors and correlated these with the availability of different incentives. As noted above, such studies have been carried out to examine the effectiveness of compulsory service programmes that incentivised uptake, including through the provision of direct financial incentives and funding of undergraduate or specialty training (Bärnighausen and Bloom 2009). These studies have generally compared participants and non-participants in a programme offering one type of incentive, however, rather than several incentives concurrently. Even if such a study were carried out, it would be challenging to distinguish the independent effect of each incentive, as well as controlling for cohort effects and other factors such as facility type, would be challenging. Moreover, the paucity of physician tracking data in many LMIC would make at least retrospective studies logistically difficult[21].

In light of these issues, many researchers investigating health workforce policy in LMIC have turned to a third approach: stated preferences. In contrast to the "revealed preferences" from experimental or longitudinal studies, these studies use hypothetical

[21] 81% of sub-Saharan African medical schools with graduated doctors had no formal system to track graduates in 2009 (Mullan, Freyhwot et al. 2011).

scenarios to assess preferences for different goods or services. Such studies have been increasingly applied in health policy to overcome the lack of market data, with two main techniques employed: contingent valuation and DCEs (Gerard, Ryan et al. 2008). In contingent valuation, participants are asked to state how much they would be willing to pay for a hypothetical good or service. In DCEs, participants are presented with hypothetical scenarios that describe a good or service and asked to make a choice between them. The scenarios are created based on characteristics found to be important to participants and constructed using experimental design techniques (Ryan 2004). Econometric analysis then models respondents' preferences as a linear additive function of these characteristics (Drummond, Sculpher et al. 2005).

DCEs offer several advantages over contingent valuation, including a more comprehensive characterisation of respondents' utility function through the trade-offs between individual attributes (Gerard, Ryan et al. 2008). Furthermore, experimental design enables identification of the independent effect of each attribute. Survey results can also be obtained in a shorter timeframe than other study designs, increasing their policy relevance (Ryan, Kolstad et al. 2012). DCEs are thus an appealing method to investigate the value placed on specialty training by doctors compared to other incentives, under the assumption that these preferences correlate with the potential effectiveness of different retention policies. The next chapter reviews the literature on the use of DCEs to inform health workforce policy.

2.6 CONCLUSIONS AND GAPS IN THE LITERATURE

This chapter has located the production and retention of doctors within a labour market framework. While a range of strategies have been used to retain doctors in the public sector, there is little empirical evidence on their relative effectiveness to guide policymakers. Indeed, this literature review highlights the general paucity of data to support health labour market analyses in LMIC.

In recent years, there has been a substantial investment into undergraduate medical training in sub-Saharan Africa. This has not been matched by a proportionate increase in specialty training. Yet specialty training has been identified as an important factor influencing doctors' labour market decisions. Doctors unable to access specialty training in the public sector may move to other jobs or other countries, reducing the efficiency of public spending. The use of specialty training as a policy lever to promote retention of these new doctors has seen little investigation to date.

Given the value placed on specialty training by doctors, it is possible that other job characteristics would be traded in exchange for better access to such training. In the next chapter, we review the studies that have most closely examined the trade-offs made by health workers in labour market decisions: DCEs.

3 SYSTEMATIC REVIEW

3.1 INTRODUCTION

A review of DCEs focused on health workforce issues was first carried out in 2009, however this took a narrative rather than systematic approach (Lagarde and Blaauw 2009). A systematic update of this area was considered timely for several reasons. First, it would document a reported increase in DCEs applied to HRH. Second, it would allow an assessment of the quality of DCEs in HRH given efforts to disseminate the design and analysis of DCEs beyond the research community (Wainright 2003, Bryan and Dolan 2004, Louviere and Lancsar 2009, Jaskiewicz, Deusoom et al. 2012, Ryan, Kolstad et al. 2012). While there had been attempts to list the factors influencing quality of DCEs (Lancsar and Louviere 2008) and evaluate those in health in general (de Bekker-Grob, Ryan et al. 2012, Clark, Determann et al. 2014), no rigorous assessment had been made of the quality of health workforce DCEs. Finally, a systematic review would allow identification of design features specific to this application of DCEs, such as the optimal number of hypothetical scenarios for health worker populations, as well as common errors in study design or application. This would offer useful generalisable lessons for the field, as well as a strong foundation for the design of the current study.

In light of this rationale, I undertook a systematic review of the use of DCEs to inform health workforce policy. Appendix B details the complete search strategy and Appendix C lists the experts contacted to identify further studies. This review was subsequently published in BMC Health Services Research and is reproduced in this format here, along with several supplementary online files. The remainder of this chapter includes some additional analysis not included in the published paper, as well as an update of the review for the purposes of this thesis.

3.2 RESEARCH PAPER AND ADDITIONAL FILES

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RESEARCH PAPER COVER SHEET

PLEASE NOTE THAT A COVER SHEET MUST BE COMPLETED FOR EACH RESEARCH PAPER INCLUDED IN A THESIS.

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Thesis Title	Train to retain: the role of specialty training in stemming Malawi's medical brain drain

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RESEARCH ARTICLE Open Access

The use of discrete choice experiments to inform health workforce policy: a systematic review

Kate L Mandeville*, Mylene Lagarde and Kara Hanson

Abstract

Background: Discrete choice experiments have become a popular study design to study the labour market preferences of health workers. Discrete choice experiments in health, however, have been criticised for lagging behind best practice and there are specific methodological considerations for those focused on job choices. We performed a systematic review of the application of discrete choice experiments to inform health workforce policy.

Methods: We searched for discrete choice experiments that examined the labour market preferences of health workers, including doctors, nurses, allied health professionals, mid-level and community health workers. We searched Medline, Embase, Global Health, other databases and grey literature repositories with no limits on date or language and contacted 44 experts. Features of choice task and experimental design, conduct and analysis of included studies were assessed against best practice. An assessment of validity was undertaken for all studies, with a comparison of results from those with low risk of bias and a similar objective and context.

Results: Twenty-seven studies were included, with over half set in low- and middle-income countries. There were more studies published in the last four years than the previous ten years. Doctors or medical students were the most studied cadre. Studies frequently pooled results from heterogeneous subgroups or extrapolated these results to the general population. Only one third of studies included an opt-out option, despite all health workers having the option to exit the labour market. Just five studies combined results with cost data to assess the cost effectiveness of various policy options. Comparison of results from similar studies broadly showed the importance of bonus payments and postgraduate training opportunities and the unpopularity of time commitments for the uptake of rural posts.

Conclusions: This is the first systematic review of discrete choice experiments in human resources for health. We identified specific issues relating to this application of which practitioners should be aware to ensure robust results. In particular, there is a need for more defined target populations and increased synthesis with cost data. Research on a wider range of health workers and the generalisability of results would be welcome to better inform policy.

Keywords: Discrete choice experiment, Stated preferences, Human resources for health, Health workers, Health professionals

Background

The global inequities in health worker numbers and distribution have been well-described [1-3]. Yet there has been less focus on the tools available to inform the policy mechanisms to improve this situation [4]. Information systems for tracking health workers are weak in many countries, impeding longitudinal studies [1,2]. Qualitative surveys can identify preferred job characteristics but not the relative strength of these preferences [5,6]. Political, ethical and logistical factors limit the opportunities for natural or controlled experiments [4,7]. In light of this limited toolkit, one approach has become increasingly popular amongst researchers in this area: the discrete choice experiment (DCE).

DCEs are a quantitative technique for eliciting preferences [8-10]. They are based on Lancaster's theory that goods and services can be described by their essential characteristics and the value of a good or service to an individual is derived from the combination of these characteristics [11]. In a DCE, participants are presented with descriptions of hypothetical goods and services based on a combination

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of characteristics and asked to select their preferred option. Thus DCEs provide "stated" preference data as opposed to the "revealed" preference data derived from empirical studies examining actual choices [12]. The use of DCEs was pioneered in the fields of market research, transport and environmental economics before being used to explore preferences in health services [13-21]. More recently, they have been applied to the study of labour market decisions and preferences of health workers [22].

In DCEs in health workforce research, participants are usually asked to select between different choice profiles that read like hypothetical job descriptions. Each profile is made up of several attributes which describe the job in question (for example, "salary" or "location") and each attribute takes one of several possible levels (e.g. "salary" could take the levels "basic", "20% increase" or "50% increase"). Choice profiles are usually combined to form choice tasks, in which participants are asked to select their preferred profile (Figure 1 presents an example and key terms used in this review). Participants' choices over a number of alternatives can be analysed to deduce the relative importance of these attributes [22]. DCEs have two main advantages as a methodology over revealed preference data. Firstly, a wide range of attributes can be included in the job descriptions, including some not yet offered. Thus, health worker preferences can be elicited beyond the current situation, and jobs that respond more fully to these preferences can be modelled [23]. Secondly, revealed preference data often display multicollinearity between independent variables, where the most popular jobs are the ones with the best salaries, the best working conditions, and the best locations [24]. In a DCE, the researcher constructs the job descriptions based on an experimental design so that the effect of each individual attribute can be independently assessed in statistical analysis.

A narrative literature review conducted by Lagarde and Blaauw in 2008 found ten studies that employed DCEs to examine health workers' preferences [22]. Since then, two global forums on human resources for health (HRH) have advocated for more research to inform policy on health workers [25,26], a "Rapid DCE" tool has been developed for use in low-income countries [27] and a user guide for conducting DCEs in HRHs for non-specialist practitioners has been published [28]. Yet the dissemination of DCEs as an accessible tool in HRH research may have been at the expense of maintaining methodological robustness. DCEs as a technique are evolving rapidly, with ongoing methodological debates and research [29-31]. DCEs in health economics have been criticised in the past for lagging behind current best practice in other fields of economics, limiting the validity of their results [31-33]. The Lagarde-Blaauw review found that all studies but one used non-optimal experimental designs [22]. In contrast, a 2012 review by de Bekker-Grob *et al.* [30] compared DCEs in health economics published between 2001–2008 to a previous review conducted by the same group between 1990 and 2000 [34]. They found a shift towards more statistically efficient designs and less restrictive econometric models. However, this review only included five of the DCEs identified by Lagarde and Blauuw, with no detailed

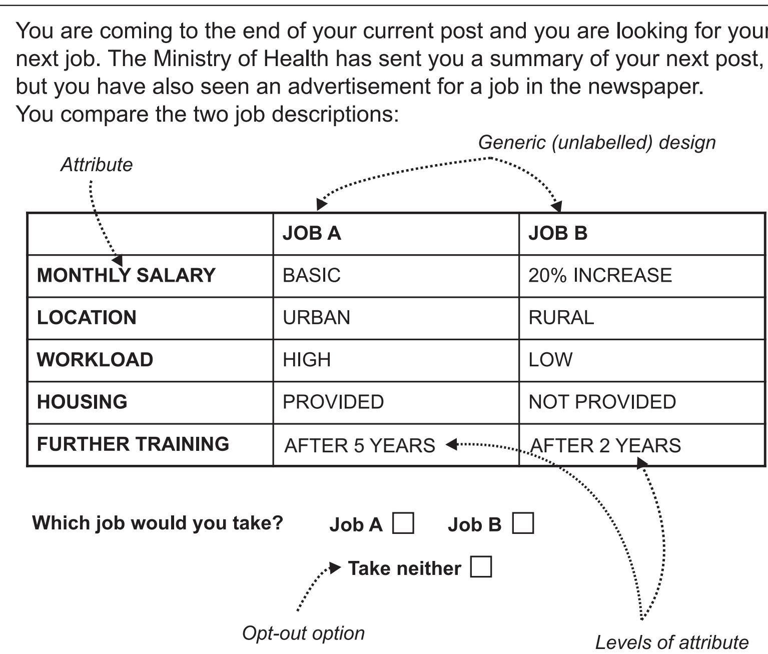

Figure 1 An example choice task in a discrete choice experiment.

analysis of health workforce issues. Due to the rapid developments in this application of DCEs and with renewed focus on health worker shortages due to the universal health coverage agenda, we considered it timely to systematically review the use of DCEs in health workforce policy.

Methods

Search terms

The scope of the review was discrete choice experiments looking at the job preferences of health workers, including doctors, nurses, allied health professionals such as pharmacists, mid-level cadres such as clinical officers, and community health workers. All low-, middle- and high-income countries were included, and there were no limits on date or language.

Search terms were: "health*worker* OR health* personnel OR health* professional* OR human resource* OR staff OR doctor* OR physician* OR clinical OR medic* OR nurse OR midwi?e* OR pharmacist*" AND "discrete-choice* OR choice experiment* OR stated preference* OR job preference* OR conjoint analysis".

Search strategy

We searched the following six databases in order to achieve comprehensive coverage of the healthcare, global health and economics literature: Medline, Embase, Popline, Global Health, Econlit, and Social Policy & Practice. We also searched three grey literature repositories: the HRH Global Resource Center (www.hrhresourcecenter.org/), the Global Workforce Alliance Knowledge Centre (www.who.int/workforcealliance/knowledge/en/), and the National Bureau of Economic Research Working Papers (http://www.nber.org/papers.html). A search was also undertaken for us of a database of studies collated by the University of Southampton (United Kingdom) on the use of DCEs in health.

The titles and abstracts of identified studies were screened for relevance. The full text of relevant studies was assessed for eligibility. Ambiguous cases for inclusion were discussed between two of the authors. References of included studies were checked for further relevant studies.

Contact of experts

In order to identify studies not yet included in databases, we contacted experts in the field. These included the corresponding authors of all studies identified by the earlier review and a number of other researchers known to be involved in DCE work. Forty-four experts were contacted, with one reminder email sent after four weeks.

Assessment of included studies

Review of study characteristics

We followed a framework consisting of the four main stages of a DCE (choice task design, experimental design, conduct and analysis) to construct and pilot forms to extract data for key characteristics of included studies. We took the date of publication as that of the earliest publication of the study, in order to more closely reflect when studies were carried out rather than the delays in the publication process. In contrast, if information differed between versions, we used data contained in the peer-reviewed publication where available.

Assessment of validity

We collated a list of 13 criteria to assess the validity of included studies, here defined as the risk of bias or systematic error (see Additional file 1). We drew on a comprehensive quality checklist constructed by Lancsar and Louviere [29], as well as areas of concern highlighted by previous reviews [30]. As quality checklists are poorly correlated with validity of studies and often measure the quality of reporting rather than that of the underlying research [35,36], we limited these criteria to those we considered a substantive threat to the validity of results. These covered all four key stages of a DCE, as poor validity in one stage cannot be negated by high validity in another. Justification for the choice of these criteria is included in Additional file 1. We assessed whether each criterion for each study was met or not. If the information available for a criterion in any of the study publications was insufficient to judge its achievement, we noted this as a separate category.

Comparison of results

With the increasing number of health workforce DCEs, it would be useful to compare results from studies with similar aims in order to draw broad conclusions from the growing evidence base. Unfortunately, generalisation beyond a single DCE is challenging. It is not possible to directly combine the results of econometric estimations from different studies as coefficients of attributes within a study are interdependent, so to display coefficients from different studies on a linear scale would be misleading [22]. In addition, differences in coefficients from separate datasets may be due to scale variance rather than true differences [4]. It is more appropriate to compare the relative impact of different attributes across studies when the coefficients have been transformed by methods such as marginal willingness-to-pay or probability analyses.

Only studies that met more than three quarters of the validity criteria (10 out of 13) were included in this comparison. This threshold is necessarily arbitrary when the validity of studies is better thought of as a spectrum [35], however this restricted the comparison of results to those studies with few threats to the validity of their results. We compared willingness-to-pay estimates or probability analyses from studies with homogeneous objectives and similar contexts.

No ethical approval was required for this study.

Results

Included studies

Figure 2 details the flow of papers through the study. In total, 1326 records were identified through searching databases and contacting experts. Thirty-one out of 44 experts replied to our survey, a response rate of 70.5%, identifying 17 additional studies. From those screened as relevant, two studies were excluded as no full length report was available despite contacting the authors. Eight studies were excluded as their design or analysis were not discrete choice experiments [37-44]. In total, 27 studies were included: ten identified by the previous Lagarde-Blaauw review and 17 new studies.

Review of included studies

Here we review key study characteristics, commenting on specific methodological debates for this application of DCEs (details of studies and key characteristics are included in Additional file 2). Overall, there were more DCE studies published in the last four years than between 1998 and 2009 (Figure 3). In 2012 alone, there were six new studies.

The majority of new studies (15/17) have been carried out in low and middle income countries (LMIC). In contrast, the Lagarde-Blaauw review found the number of studies carried out in high income countries (HIC) equalled those carried out in LMIC [22]. With over 80% of all DCEs set in LMIC (15/18) published since 2010, the call to produce more evidence for health workforce policy is clearly being heeded. The most common objective was to explore health worker preferences for working in rural and/or remote areas, examined in 17 studies with 16 of these set in LMIC.

Doctors and medical students were the focus of two thirds of DCE studies (66.7%, 18/27) [5,23,45-60]. Two studies [51,58] were from a large longitudinal study of the employment preferences of Australian doctors known as MABEL ("Medicine in Australia: Balancing Employment

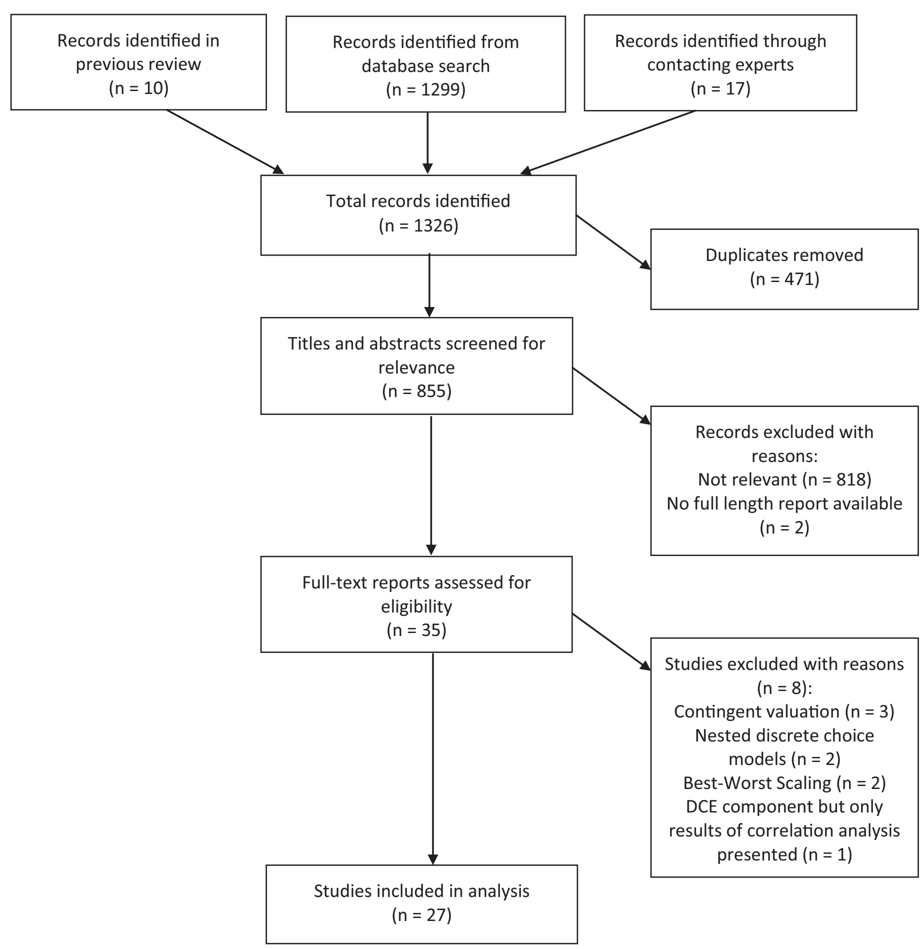

Figure 2 Flow of studies.

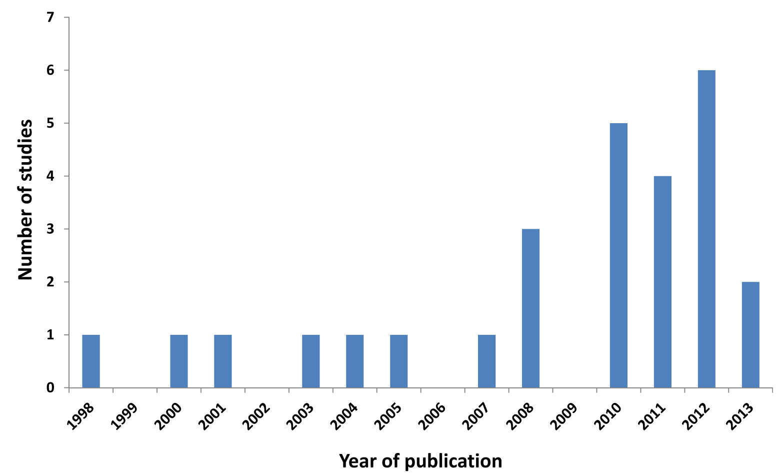

Figure 3 Publication date of included studies.

and Life"). In contrast, mid-level cadres such as clinical officers [6] and medical assistants [59] were the focus of one study each, even though these cadres may present a more cost-effective response to health worker shortages, particularly in rural or remote areas. Moreover, no study has yet focused on community health workers, who as mostly volunteer workers may have very different preferences to salaried health professionals.

Students training to be health workers were included as participants in nearly half of all studies (44.4%, 12/27). No study set in a HIC contained just students as participants, compared to seven in LMIC. Undoubtedly, students offer more convenient survey administration, with relatively large populations in a limited number of locations that are far easier to convene than practicing health workers. Yet with most studies aiming to inform policy for practicing health workers, the extrapolation of utility values from students is concerning. Students nearing the end of their course were often targeted with the justification that they would soon graduate and select jobs based on their current preferences. Even students nearing the end of their training, however, are likely to hold different preferences to qualified workers who have managed a job and salary under prevailing working conditions. For example, Vujicic *et al.* [61] found that the location of workplace (rural/urban) was the most important attribute for doctors in a DCE undertaken in Vietnam, whereas it was long-term education for medical students. Moreover, there were five fold differences between doctors and medical students in willingness-to-pay estimates for some job attributes. Rockers *et al.* found similar differences in preferences for attributes of rural jobs between practising nurses and nursing students in Laos [62]. And whilst the target population is often students nearing graduation, shortfalls in recruitment can lead to students from earlier years being included, increasing the disparity in experiences [59]. Finally, two studies pooled results for students and graduates from the same cadre for at least part of the analysis [53,59]. This is likely to lead to less valid results and overestimation of the willingness of qualified health workers to accept certain conditions.

Choice task design

A third of studies (33.3%, 9/27) identified attributes and levels through a combination of literature/policy reviews and qualitative work with target participants and policy-makers, which is best practice to obtain valid and policy-relevant attributes [63,64] (Table 1). The vast majority (85.2%, 23/27), however, conducted some qualitative work

Table 1 Choice task design of included studies

Design aspect	Specification	Number of studies (%)
Preparatory work	Literature review	20 (74.1)
	Participant qualitative work	23 (85.2)
	Policymaker qualitative work	16 (59.3)
	All three methods	10 (37.0)
Type of choice	Binary	21 (77.8)
	Ternary	1 (3.7)
	Quaternary	2 (7.4)
	Mixed binary/ternary	3 (11.1)
Attributes	5	3 (18.5)
	6	8 (29.6)
	7	12 (44.4)
	8	4 (14.8)
Labelling	Generic	20 (74.1)
	Labelled	7 (25.9)
Opt -out option	Yes	8 (29.6)
	No	19 (70.4)

(focus groups or interviews) with representatives of the target population. This is important to ensure the attributes and levels chosen are salient to the target population, encouraging engagement with the choice task presented [29].

Three out of four studies (77.8%, 21/27) presented a binary choice task to participants, with only three studies using higher-order choices of ternary [53] and quaternary [57,65] choices. Yet labour markets for health workers are complex [66]. Along with the option to remain in their current job, health workers can internally migrate between locations or sectors or overseas, the latter of particular concern in LMIC. In a novel approach, Lagarde *et al.* [65] presented four labelled profiles in different sectors and locations to South African nurses: overseas, public rural, public urban, and private urban. Although there is evidence that increasing task complexity (such as adding more alternatives) can decrease quality of choice responses [29,67], the cognitive dissonance created by a less realistic representation of the job market available to participants may in itself produce less valid choices.

Choice tasks can also include an *opt-out*, in the form of a "choose none" or a *status quo* ("choose my current job") option [29]. Nearly one in three studies in this review (8/27, 29.6%) included such an option, compared to just one in the Lagarde-Blaauw review. Three studies presented a two stage choice to participants, one as a forced binary choice between two presented profiles and one ternary choice containing an opt-out [68-70]. The inclusion of an opt-out option can avoid a "forced choice" which assumes that one of the alternatives offered must be taken up and may falsely increase the strength of preference associated with alternatives, distorting related welfare estimates [29,31,71-74]. Indeed, the instruction to "assume these are the only options available to you" is a common way of framing a choice task. In real life, however, health workers always have many options in the labour market, including the *status quo* of staying in their current job or withdrawing from the health labour market altogether. This holds true even for students or new graduates. Although consumption of the good or service on offer can rarely be assumed in DCE applications in health, except for perhaps comparing new treatments versus current treatments, it is arguably more pertinent here. After all, labour market decisions are complex decisions with significant consequences, frequently associated with major disruptive effects on an individual's status quo, and the total number made over a lifetime is comparatively few compared to other types of decisions. Maintaining this status quo by opting out of a choice between job profiles may seem very attractive, and its inclusion more closely reflects the real world market. This is especially important for measures of relative attribute impact such as willingness to pay for desirable job characteristics (see below). The disadvantage is that the researcher risks not obtaining sufficient information on preferences to estimate the analytical model if an opt-out option is chosen by the majority of participants. The use of a two stage choice, with both a forced choice and a choice with an opt-out option, seems pragmatic until sufficient information is gleaned on the likely distribution of responses. Scott *et al.* used this approach for a DCE on Australian GPs embedded within the MABEL survey [70], but went on to construct the status quo for each participant through responses to other questions gathered in the larger survey. This innovative use of accompanying survey data meant that no information was lost when participants chose the status quo option, as attributes and levels for this alternative could be defined on an individual level. If the status quo varies within the target population, then participants should be asked to identify their status quo through survey questions in order to model these alternatives [29]. Researchers should be careful to frame the choice task in a way that does not downplay the opt-out option, in order to increase accuracy of welfare estimates.

Choice tasks profiles can be *generic*, e.g. "Job A" versus "Job B", or *labelled* e.g. "Rural clinic" versus "Urban hospital" (Figure 1). Generic designs were used by the majority of studies (74.1%, 20/27), although seven studies featuring a labelled design in the last three years [4,52-54,57,65,69]. All of these studies presented rural versus urban alternatives, except the above study by Lagarde *et al.* that also included jobs overseas and in private facilities [65]. The use of labelled designs in this way can enhance realism for participants by allowing alternative-specific attributes to be defined in order to avoid unrealistic combinations that might lead to participant confusion and/or disengagement with the questionnaire (for example, the availability of private practice in rural posts) [4,54,56,75]. Labelled designs can also provide choices between additional qualities associated with the labels by participants, but not captured by the limited number of attributes [75]. The drawback is that these qualities are not delineated, so researchers cannot be certain if their interpretation of the label matches that of the participants. In addition, label-specific attributes/levels are correlated with the label, and therefore their utilities cannot be distinguished in the analysis [75]. This may not be a disadvantage, however, if the policy aim is to investigate preferences for specific job types in a given market (e.g. rural/urban/overseas) or how individuals value the same attribute in different posts. In contrast, a generic choice is more appropriate where the research interest is the trade-off between different attributes for one particular type of job.

Experimental design

The assessment of experimental design was hampered by poor reporting (Table 2). All studies used a fractional

Table 2 Experimental design of included studies

Design aspect	Specification	Number of studies (%)
Design plan	Main effects only	4 (14.8)
	Main effects + interactions	1 (3.7)
	Not clearly reported in text but main effects only in primary analysis	20 (74.1)
	Not reported and unclear from analysis	2 (7.4)
Design source	SAS	11 (40.7)
	Sawtooth Software	5 (18.5)
	SPEED	3 (11.1)
	IBM SPSS Statistics	2 (7.4)
	Sloane's orthogonal array	1 (3.7)
	Not reported	5 (18.5)
Design of choice tasks	Orthogonal array (all using one constant comparator)	8 (29.6)
	Efficient design	15 (55.6)
	Not clearly reported	4 (14.8)
Number of choice tasks	<10	8 (29.6)
	10-15	6 (22.2)
	16-20	13 (48.1)

SPEED = Stated Preference Experiment Editor and Designer.

factorial design to decrease the total number of possible attribute and level combinations to a more manageable number, with SAS software (www.sas.com, 40.7%, 11/27) the most popular design source. Only one study reported using interaction terms within its fractional factorial design so as to be able to identify the modification of the preference for one attribute based on the level of another [6], with the vast majority (88.9%, 24/27) assessed as including main effects only (the primary effect of each attribute). The inclusion of interaction terms increases the number of choice tasks required to make accurate estimates [28,29] and it is not common practice in health economics DCEs, with only 5% of studies including two-way interactions between attributes in the Bekker-Grob review [30]. Yet preferences for attributes of health workers' jobs may well depend on the level of other attributes. For example, free transport may be more highly valued in a rural area than an urban post. Thus it is likely to be inaccurate, albeit pragmatic, to assume that the main effects of attributes are not confounded by each other. The inclusion of selected interaction terms in design plans should be encouraged, based on those that are most likely to be conceptually valid.

The majority of studies (55.6%, 15/27) used an efficient design to design their choice tasks, including every study from 2010 onwards that reported design type bar one [60]. This uses an algorithm to maximise the statistical efficiency of the design, and corroborates the increase in this design approach identified by de Bekker-Grob *et al.* Eight studies (29.6%) employed an orthogonal design, which uses an orthogonal array to generate choice profiles and then one of several methods to allocate profiles to choice tasks [10]. In all these studies, a constant comparator approach was used to construct choice tasks, whereby one profile is selected to be paired in each choice task against the remaining choice profiles. This is in contrast to de Bekker-Grob *et al.*, who found just one in three studies using orthogonal arrays using this approach. Its popularity here may be an attempt by researchers to represent a *de facto* status quo option, with one choice profile used to correspond to the prevailing or baseline job conditions. This approach, however, is inefficient and discards much information on choices between attributes, rather than using a constant "neutral" opt-out alternative [22].

Efficient designs also have the advantage of being able to incorporate prior estimates of parameter values rather than setting these at zero. This increases the efficiency of the design through a Bayesian approach, with estimates usually obtained through pilot studies [30,51]. In contrast to de Bekker-Grob *et al.* who found no studies employing this feature, two health workforce DCEs incorporated priors from a pilot survey, both from the MABEL survey [51,58]. Given that the limited number of health workers in LMIC and the logistical difficulty of administering surveys to practising health workers, practitioners should consider the use of priors to order to increase the precision of value estimates for small sample sizes [30].

Nearly half the studies (48.1%, 13/27) presented between 16 and 20 choice tasks to participants, with a mean of 12. Blocking was employed by ten studies, usually to decrease the number of choice tasks to less than ten. The number of choice tasks presented to participants is usually restricted due to fears over choice complexity and cognitive burden that may reduce the quality of responses [29]. Amongst a target population that has uniformly completed tertiary education courses characterised by frequent testing, however, higher numbers of choice tasks may be handled without any ensuing loss of engagement. It would be interesting to compare the responses from the same group of health workers to varying number of choice tasks.

Conduct

Three quarters of studies (20/27, 74.1%) reported piloting their surveys before full rollout. There was great variation in piloting, however, with pilots ranging from a small focus group of one subgroup within the target population [59] to a four stage procedure with a final random sample of 1091 participants [70]. Piloting is an important part of DCEs, allowing verification of presentation, comprehension, coverage of attributes and levels, complexity, likelihood of the selection of an opt-out option, and data collection for priors as discussed above [29]. The development of a standard checklist for piloting DCEs would be worthwhile, allowing for contextual differences. In particular, pilots should attempt to include representatives from all subgroups of health workers to be analysed in the final sample (e.g. differences in gender, locations, seniority) to ensure that differences in understanding are not leading to variation in preferences associated with these subgroups.

The mode of administration of DCEs is likely to be important both for the response rate and understanding of the task (Additional file 2). Seven studies used postal surveys to contact large numbers of health workers, all in HIC [5,23,47,48,51,70,76]. Two of these studies also included online questionnaires [51,70], although three studies used computer-assisted surveys on student populations in LMIC [45,56,77]. In LMIC, response rates were generally very high, with a mean of 83.2% (range 65.2% to 100%, the latter from a study set in China as reported by authors [60]), compared to 49.3% (16.8 – 65.0%) in HICs. Unsurprisingly, response rates were significantly lower for graduates (mean of 62.7%, range 16.8 – 100%) than for students (mean 84.1%, range 62.7 – 100%), underscoring the potential for distortion if results from these two subgroups are combined. Surveys were most commonly self-administered with supervision by researchers (10/27, 37.0%), a format that allows participants to ask questions for clarification but complete the survey in their own time.

Total sample sizes (Additional file 2) ranged from 102 doctors in Peru [57] to 3727 general practitioners in Australia [58]. Whilst sampling follows the same principles as for other primary data collection i.e. ensuring the sampling frame and sampling strategy are representative of the target population(s), sample size calculation is an ill-defined area within discrete choice experiments. Although various rules of thumb were formed from modelling experience [8,29], these have become less relevant with the advent of efficient designs that can take into account limited sample sizes [63]. Indeed, a very large sample encompassing wide variability in preferences may lead to less precise results than a small, more homogeneous sample [63]. For health workers, more attention should be placed on the representativeness of the sampling frame in order to extrapolate results to the general population, and the sampling strategy to ensure adequate size of subgroups if significant *post hoc* analysis by different characteristics is planned [29,63].

Analysis

For a succinct summary of modelling approaches to health DCEs, see de Bekker-Grob *et al.* [30] and Amaya-Amaya *et al.* [63]. While most studies pre-2010 relied on random effects probit or logit models [63], mixed logit has been the most common econometric model more recently, used in 11 studies (39.3%) after 2010 (Table 3). Mixed logit relaxes the restrictive assumptions of the commonly used multinominal logit model by allowing for heterogeneity of preferences for attributes between participants, which is likely to be high in the fairly diverse health worker populations covered by many of these studies. It does this by introducing an individual-level utility estimate for each attribute calculated from the mean utility estimate for that attribute and an individual-specific deviation from the mean [29,70]. Although flexible, the mixed logit model has a number of challenges, such as the choice of parameters to define as random. Moreover, the size of these individual-specific variances are likely to vary within and between participants, reducing the precision of utility estimates rather than increasing it. The latent class model has the same advantage over the multinominal logit as mixed logit, however assumes that there are two or more classes (or groups) of participants underlying the data with more homogeneous tastes. The distribution of participants belonging to these classes is not known to the researcher, but is assumed to be related to observed variables such as attitudes and/or socio-demographic characteristics [63]. Latent class models have been used only rarely in health DCEs, with none from this review and just one in de Bekker-Grob *et al.* [30], however

Table 3 Analysis of included studies

Analytic aspect	Specification	Number of studies (%)*
Econometric model	Probit	1 (3.7)
	Logit	2 (7.4)
	Random effects probit	7 (25.9)
	Multinomial logit	1 (3.7)
	Conditional logit	3 (11.1)
	Mixed logit	11 (40.7)
	Generalised multinomial logit	4 (14.8)
	Errors component mixed logit	1 (3.7)
Analysis software	Stata	16 (59.3)
	NLogit/LIMDEP	5 (18.5)
	SPSS	2 (7.4)
	Not reported	4 (14.8)
Relative attribute impact analysis	Probability analysis	16 (59.3)
	Welfare measures	12 (44.4)
	Marginal rates of substitution	5 (18.5)
	Partial log-likelihood analysis	1 (3.7)
	Compensating differentials	1 (3.7)
	Wage equivalents	1 (3.7)
	None	2 (7.4)

*Total for each category greater than total number of studies as some studies used more than one econometric model or relative attribute impact analysis.

this model offers much to health workforce DCEs. As described earlier, quite heterogenous populations are typically included in health DCEs, for which latent class models may be able to separate into subgroups with more similar (and accurate) preferences depending on characteristics, for example years of work experience or growing up in a rural area. Four studies (14.8%) used an extension of mixed logit, generalised multinomial logit models, with three of these finding a better fit to data than comparator mixed logit or logit models [51,54,58,62]. Generalised multinomial logit models are able to account for scale heterogeneity of preferences as well as taste heterogeneity, i.e. utility estimates might vary between individuals not only because of differences in preferences, but also due to differences in variance. Some individuals may be much more certain of their choice than others or use decision heuristics that reduce variance, whilst other participants may not understand the task well or make mistakes that increase variance [70]. Fiebig *et al.* [78] assert that this model can better account for responses from these "extreme" participants, providing an improved fit to the data. This is undoubtedly an attractive feature for DCEs examining labour market decisions (where participants may be more uncertain) in populations of workers that are typically time-poor and highly pressurised (thus perhaps more likely to employ decision heuristics or make mistakes). This may explain its popularity here, with four studies employing it compared to none in de Bekker-Grob *et al.* [30].

As the importance of different attributes cannot be compared directly using parameter estimates due to confounding with the underlying utility scales, the relative impact of attributes is usually examined by converting estimates to a common scale [79]. There are a number of methods to do so, including probability analysis, welfare measures and marginal rates of substitution. Probability analysis and welfare measures were the most popular methods in this review, with 16 (59.3%) and 12 (44.4%) studies employing them respectively. It is surprising that more studies did not calculate welfare measures, given all studies included a monetary variable. Ten out of these 12 studies (83.3%) did not include an opt-out/status quo option, however, which as discussed above is likely to distort welfare measures due to the overestimation of preferences resulting from a forced choice [29]. Despite over half of studies including a time variable, no study presented a marginal rate of substitution for time, in the form of willingness to commit to a post for a defined period. This is an important metric for policymakers, with pragmatic retention policies and incentive packages designed in the knowledge that filling unattractive posts may be for a limited period only.

Nearly all studies using welfare measure(s) framed these as willingness to pay, either marginal (for changes in attributes) or total (for certain alternatives or scenarios). Willingness to pay for health workforce DCEs is rooted in the labour economic theory of compensating wage differentials, which puts forward that differences in wages arise to compensate workers for nonwage characteristics of jobs, for example risk or lack of social amenities [47,80]. In health workforce DCEs, negative willingness to pay represents the additional amount of income required to compensate a health worker for a job with negative characteristics. For example, Scott *et al.* [70] modelled a range of unattractive job postings with accompanying negative total willingness to pay values. Conversely, positive willingness to pay is the amount of income that a health worker would forego in order to take up a job with desirable characteristics. For example, Vujicic *et al.* [50] estimated the marginal willingness to pay by doctors in Vietnam for various desirable job characteristics, such as urban location and adequate equipment.

However, two thirds of these studies (66.7%, 8/12) used a current income level accompanied by either actual or percentage increases on this baseline. The negative willingness to pay values obtained in these studies may be overestimates due to the endowment effect. This states that desirable goods are more valuable when they are part of one's endowment, i.e. individuals put more value on the loss of something they own or have experienced than its acquirement when they have not experienced it [81]. In this situation, health workers may more easily give up hypothetical additional compensation rather than a decrease in their actual salaries. Compensating wage differentials may be more accurate when a level is included in the monetary attribute to represent a decrease in current income, as seen in four studies for at least some participants [5,47,70,82].

More recent studies tended to extend the probability analysis by simulating different policy scenarios, particularly predicting the uptake of jobs in rural areas under different incentive packages. Lagarde *et al.* [54] went further by examining the uptake of rural jobs by Thai doctors under different incentive policies for i) the original population; ii) three hypothetical populations with differing proportions of doctors with rural/urban backgrounds; iii) undergraduate training in Bangkok as opposed to outside the capital. Sivey *et al.* [51] investigated specialty choice for junior doctors in Australia with an unlabelled design consisting of attributes describing various job aspects, but then used data from the accompanying survey sent to all Australian doctors to set typical levels for the same attributes for specialist doctors versus general practitioner (e.g. regular continuity of care for general practitioners). The researchers went on to predict the uptake of general practitioner training under different changes to three policy-amenable attributes: procedural work, academic opportunities, and salary. This study is also the first, to our knowledge, to use revealed preference data from the survey on the proportion of junior doctors actually choosing general practice to calibrate their model, so that the predicted choice probabilities matched the actual choices before starting the policy simulations. This comparison with revealed preference data is to be welcomed [30], although it is rare for DCE practitioners (particularly in LMIC) have access to such comprehensive data.

Five studies combined predictions from a probability analysis with cost data in order to assess the cost impact of favoured policy options [46,49,55,65,82]. Chomitz *et al.* compared a small number of policy options to improve the maldistribution of doctors in Indonesia with little detail on costings, and reported that bonuses for working in remote or very remote posts would be cheaper to provide than specialist training. In a more detailed analysis, Vujicic *et al.* [82] found that rural allowances would be more cost-effective for attracting nurses to rural posts in Liberia than providing housing or improving equipment. Rao *et al.* [55] showed that reserving postgraduate training places was the most cost-effective policy to encourage both doctors and nurses to take up rural jobs in India, with a higher predicted uptake at a lower cost than salary increases. Lagarde *et al.* [65] combined predicted probabilities from two DCEs, one simulating the current labour market in South Africa and the South African component of the multi-country analysis of policy tools to attract nurses to rural areas [4]. These were used in a Markov model to simulate the distribution of nurses in the labour market over time under different policy scenarios using rural nurse-years as the effectiveness measure. The results showed that salary increases are dominated by non-wage interventions, and "upstream" measures (i.e. recruiting individuals more likely to choose rural posts willingly, such as those with rural upbringings) are more cost-effective than "downstream" interventions, with the most cost-effective policy being the recruitment of students with rural backgrounds.

Assessment of included studies

Figure 4 presents the validity assessment for all included studies. Overall, whilst the conduct and analysis of studies were more robust than expected, there were significant weaknesses in choice task design. For example, attributes should have no conceptual overlap, i.e. they should be conceptually distinct and vary independently of each other, otherwise their effects are likely to be correlated [5]. For example, Mangham and Hanson [68] excluded the attribute "promotion prospects" that was identified as important in preparatory work because promotion was closely associated with another included attribute "opportunity to upgrade qualifications." Attributes should also be uni-dimensional, i.e. encompass only one aspect of a characteristic in order to obtain maximum information from the choices made and increase interpretability. Rao *et al.* [55], for instance, included an "Area" attribute that comprised the location's accessibility, educational facilities for children and the provision of quality housing: from which it would be difficult to unpack the significance of any preferences for this attribute. We identified conceptual overlap in a third of studies and only half of studies had uni-dimensional attributes. This prevalence may be due to the difficulty in reducing complex labour market decisions into a handful of attributes, in comparison to arguably more discrete health products or patient services. However, it should be noted that preparatory qualitative work and piloting receive far less attention in the DCE literature compared to experimental design and analysis, despite their importance in ensuring that choices are salient to the target population and therefore equal contribution to the robustness of results [29,64].

As discussed above, target populations for HRH studies are often based on logistical factors rather than appropriateness for the research objective. Another important consideration before extrapolating preferences of participants to the general population is the representativeness of the target population. It was anticipated that this would be a particular issue in HRH DCEs, with remote health facilities or rural training schools excluded in preference for more accessible locations. However, the vast majority of sampling frames were found to be representative of target populations. Indeed, national censuses of health workers were quite frequently employed, which likely reflects the overall paucity of health workers in LMIC.

Assessing the validity of experimental design and analytic approach acutely highlights the "moving target" of best practice in DCEs described by Louviere and Lancsar [31]. Studies that employed the best practice at that time are now judged against subsequent advances in the field. For example, a constant comparator was common in earlier studies, although now recognised not to respect level balance and associated with identification problems [31]. Earlier studies also tend not to account for the panel nature of DCE data with serial correlation of choices between the same participants, which can now be adjusted for through an appropriate model or random effects specification. Even recent studies assessed here to have few threats to validity may be judged more critically in a few years, due to the rapid evolution of the field.

Comparison of results

Out of the 13 studies assessed as meeting more than half the validity criteria, eight had the common objective of determining factors important in the attraction of health workers to rural areas in LMIC and appropriate relative attribute impact analysis available. We used the probability

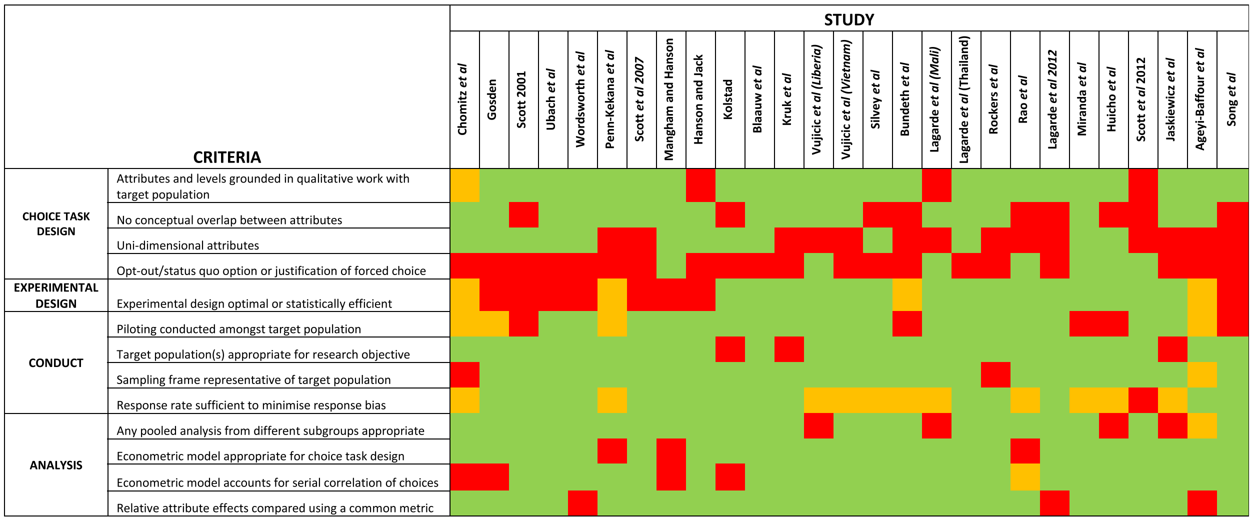

Figure 4 Validity assessment of included studies.

analysis for uptake of a rural post where available (six studies) and willingness-to-pay estimates (two studies) in order to compare preferences for different attributes and their levels (see Additional file 3).

This summary broadly indicates the importance of rural allowances/bonuses and opportunities for further training for the uptake of rural posts, and the unpopularity of time commitments or "bonding", although it is difficult to conclude further as the range of other included attributes varies widely across studies. Despite using relative analytic measures rather than direct coefficients, such summaries should be treated with caution due to the likely variation in coding practices between studies. Moreover, comparing results from labelled designs to those from generic designs can be problematic as participants may take into account additional, unmeasured factors when comparing labelled alternatives.

Discussion

There has been a dramatic increase in the number of studies using DCEs to investigate health workforce policy. Twenty-seven studies were identified in this review, with more studies published in the last four years than during 1998–2009. This is the first systematic review of DCEs applied to health workforce policy to our knowledge. Whilst earlier studies may have lagged behind best practice in the field, many of the more recent studies apply state of the art features of design and analysis to address particular issues of health workforces.

Overall, there needs to be more recognition of the heterogeneous nature of health worker experiences, leading to more careful definition of target populations. First, a significant number of studies extrapolated results from students to draw conclusions about the job preferences of qualified health workers. In one study, this even included first year students due to difficulty in recruiting later years [59]. Second, certain study samples included qualified workers with large disparities in professional experience. For example, in one study, the experience of health workers surveyed ranged from 0.42 to 32 years [53]. Previous qualitative research has shown that job preferences of new healthcare graduates are very different from those of even mid- or late-career professionals [83,84]. Third, several studies pooled the results from different cadres of health workers despite evidence of significant differences in preferences or income (which would affect willingness to pay estimates) [59,69,82]. Researchers need to be aware that increasing disparity in professional and life experiences will lead to more heterogeneous job preferences, requiring more sophisticated econometric modelling and more careful interpretation to draw valid conclusions. Such variation may in fact mask any true preferences, negating the value of the research. The expediency of combining groups of health workers to obtain an adequate or convenient sample size is outweighed by the benefits of more robust conclusions for a narrower and well defined study population.

Whilst nearly all studies investigated the relative impact of attributes through willingness-to-pay and/or probability analyses, only five studies went on to combine impact measures with cost data to assess cost-effectiveness of policy options to varying degrees. Just one study to date has used Markov modelling to estimate the cost effectiveness of policies over the long run [65]. The paucity of cost effectiveness analysis likely reflects the difficulty in obtaining accurate cost data (direct and indirect) for salaries and other incentives such as training, in addition to the lack of information on career paths to populate a long-term Markov model [65]. This is particularly relevant in LMIC where weak human resource information systems are often a trigger for the use of DCEs over longitudinal studies in the first place. However, cost-effectiveness analysis provides crucial information for policymakers wishing to capitalise on the preferences revealed by DCEs. Indeed, some authors have argued for more use of the willingness to pay values from DCEs in cost-benefit analysis in order to provide fuller evaluation of policy options to decision makers (although concerns have been raised about the use of a price proxy) [30,85].

All studies included here failed at least some criteria on our validity assessment. This underscores the technical requirements of DCEs for all four stages, but particularly for choice task design. Given that the DCEs reviewed here have been carried out mainly by experienced researchers and that the field is still under great flux, the move to disseminate the use of DCEs more widely amongst non-specialist practitioners may be risky [28].

The strengths of this review include its comprehensive search for studies, both published and unpublished. Virtually all known researchers in this field were contacted in order to identify studies in the grey literature, with seven such studies included in the review. This is also, to our knowledge, the first time that a comparison has been made of results from DCEs in HRH. There may, of course, be other relevant studies not identified through our search strategy. This was also the first attempt to assess the validity of DCEs in order to exclude those with significant potential of bias from the comparison of results. There may be debate over our selection of criteria, although we feel these represent the most important threats to validity over the four stages of DCEs. We welcome further efforts to refine these criteria.

Implications for research

No study has yet returned to examine how job preferences change over time in the same population. This would provide welcome insights, as would DCEs on a wider range of health workers. Further training after qualification is clearly important to health workers, with over half of designs including such an attribute in some form. Yet no study has yet compared different forms of further training, for example short-term study leave for courses versus specialist training for doctors. Given the necessity of training for career progression for most health workers, it is likely that health workers place different values on various types of training and this could be explored in future research. Lastly, our attempt to compare results of similar studies was limited, despite using more comparable preferences from predicted probabilities and willingness-to-pay estimates. Methodological research on the generalisability and synthesis of results is urgently needed to allow policymakers to make better use of the growing body ofevidence [30].

Implications for policy

The correlation between health workers' stated preferences in DCE studies and revealed preferences of longitudinal studies is still uncertain, although one study here made novel use of accompanying survey data to enhance the realism of policy simulations [51]. In other fields, a number of studies show a good correspondence between predictions derived from stated preference models and actual market behaviour [9,16,86]. In HRH, this would translate to acceptance of jobs with valued incentive packages or after implementation of preferred policy changes. It is unclear, however, what a discrepancy between stated and revealed preferences would indicate in the case of HRH policy. Willingness to accept a hypothetical post does not always translate into actual acceptance due to many other aspects of policy implementation, imperfect labour market information and life circumstances that can influence a later career decision. What DCEs do provide is constructive information on health worker preferences for exploratory analysis of policy options, thus allowing limited resources to be deployed based on better evidence. Investment into information systems to keep track of health workers and their career choices should not be neglected, however, so that data can be gathered on the impact of implemented policies.

Conclusions

Discrete choice experiments have become a popular study design to investigate health worker preferences, with several advantages in this field. We identified specific issues relating to this application of which practitioners should be aware to ensure robust results. In particular, there is a need for more defined target populations and increased synthesis with cost data. Research on a wider range of health workers and the generalisability of results would be welcome.

Additional files

Additional file 1: Criteria to assess validity of included studies. These are the criteria, with justification, used to assess the validity of studies included in the review.

Additional file 2: General characteristics of included studies. This table summarises key characteristics of the studies included in the review.

Additional file 3: Comparison of results for a subset of similar studies. This is a comparison of the results from relative attribute impact analyses in a subset of studies with low risk of bias and the common objective of investigating health workers' preferences for jobs in rural areas in low- and middle-income countries.

Abbreviations

DCE: Discrete choice experiment; HIC: High-income countries; HRH: Human resources for health; LMIC: Low- and middle-income countries.

Competing interests
The authors declare that they have no competing interests.

Authors' contributions
KH and ML conceived this study, and all authors contributed to its design. KLM carried out the review and analysis, and wrote the first draft of the manuscript. ML and KH commented on the manuscript. All authors read and approved the final manuscript.

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Additional file 1 Criteria used for assessment of validity of included studies

SECTION	CRITERIA	JUSTIFICATION
CHOICE TASK DESIGN	Choice of attributes and levels grounded in qualitative work with target population	Attributes and levels should be salient to the target population to ensure comprehension and engagement with the choice task
	No conceptual overlap between attributes	Attributes should be conceptually distinct and vary independently of each other, otherwise effects will not be independent
	Uni-dimensional attributes	Attributes that encompass several aspects of an attribute introduce variability into the choice process as participants may focus on different aspects and the resulting preferences can only be interpreted as applicable to all dimensions
	Inclusion of an opt-out or *status quo* option or justification of forced choice	Choices that force participants to accept an unappealing job are likely to lead to overestimation of preferences
EXPERIMENTAL DESIGN	Experimental design optimal or statistically efficient	Designs that are not optimal or efficient will led to less accurate preferences
CONDUCT	Piloting conducted among target population	Validity of choice task design and questionnaire features should be tested with participants from target population and subgroups
	Target population(s) appropriate for research objective	Preferences of target population should be sufficient to answer research objective

	Sampling frame representative of target population	Sampling frames that exclude part of the target population may lead to bias in preferences
	Response rate sufficient to minimise response bias	A low response rate may indicate selection bias among participants, whose preferences may not be representative of the target population
ANALYSIS	Any pooled analysis from different subgroups appropriate	Pooled analyses from very heterogeneous subgroups may mask marked differences in preferences
	Econometric model appropriate for choice task design	Model should be appropriate for the choice task and number of alternatives presented to participants
	Econometric model accounts for serial correlation of choices	As multiple observations are obtained from each participant, the econometric model should take account of panel nature of data to avoid overestimation of the differences between preferences
	Relative attribute effects compared using a common metric	Preferences for different attributes cannot be compared directly using parameter estimates due to confounding with the underlying utility scales

Additional file 2 **Characteristics of included studies**

Notes: *N/A = Information not available from study publication; GPs = General Practitioners; [a]All information available in report(s) included; [b]848 questionnaires were returned, however 65 were uncompleted therefore response rate taken as 783; [c]Breakdown by subgroup not available; [d]5 records lost, leaving total functional sample size of 302; [e]Medical students excluded from peer-reviewed publication; [f]Total sampling frame of junior doctors not available; [g]Numbers given are for target sample: however, it is unclear whether response rate was 100%; [h]Conference abstract only, not full length paper; [i]Also contains data on Thai nurses published in Blaauw, Erasmus et al. (2010); [j]Nurses and midwives and nursing/midwifery students analysed as one group in report (Jaskiewicz, Phathammavong et al. 2012), but nurses and nursing students included in peer-reviewed publication and analysed as separate groups (Rockers, Jaskiewicz et al. 2013).*

Authors & earliest publication date	Peer-reviewed publication	Study Setting	Health worker cadre and type	Sample size (total)	Survey mode[a]	Response rate	Study objective
Chomitz, Setiadi et al. (1998)	No	Indonesia	Medical students (final-year)	585	Self-administered questionnaire supervised by researchers	N/A	To understand doctors' preferences regarding various possible incentives, in particular to attract them to rural or remote places

Gosden, Bowler et al. (2000)	Yes	England	Doctors (GPs)	172	Self-administered postal questionnaire	58.7% (172/293)	To investigate GP preferences for practice and job characteristics, in order to understand what factors might improve GP recruitment in under-served areas
Scott (2001)	Yes	UK	Doctors (GPs)	783	Self-administered postal questionnaire	65%[b] 783/1206	To investigate GPs' preferences for financial and non-financial incentives
Ubach, Scott et al. (2003)	Yes	Scotland	Doctors (hospital consultants)	1793	Self-administered postal questionnaire	61.3% (1793/2923)	To examine hospital consultants' preferences for various job characteristics to inform workforce policy
Wordsworth, Skatun et al. (2004)	Yes	Scotland	Doctors (GPs)	1292	Self-administered postal questionnaire	50.0% (1292/ 2574)	To identify the relative value given by sessional GPs to various job characteristics, in order to inform issues on recruitment and retention of GPs
Penn-Kekana, Blaauw et al. (2005)	No	South Africa	Nurses (maternity)	147	Self-administered paper-based questionnaire	N/A	To explore the relative importance of various job characteristics on nurses' decisions about where to work
Scott, Bond et al. (2007)	Yes	Scotland	Pharmacists (community)	914	Self-administered postal questionnaire	56.4% (914/1621)	To examine the preferences of community pharmacists for

							existing and potential new roles in primary care
Mangham and Hanson (2008)	Yes	Malawi	Nurses	107	N/A	97.3% (107/110)	To determine the range and relative importance of various factors that affect nurses' job choices in the public sector
Hanson and Jack (2008), Hanson and Jack (2010)	Yes	Ethiopia	Doctors Nurses	283 642 **(925)**	Interviewer-administered paper-based questionnaire	70.7% (219/283) N/A for nurses	To estimate the effects of possible policy interventions to improve the supply of doctors and nurses in rural areas
Kolstad (2008), Kolstad (2010)	Yes	Tanzania	Trainee clinical officers (final-year)	307	Self-administered paper-based questionnaire supervised by researchers	96% (307/320)	To estimate clinical officers' job preferences in order to understand how rural jobs can be made more attractive
Blaauw, Erasmus et al. (2010)	Yes	Kenya South Africa Thailand	Nursing students (final-year)	345 377 342 **(1064)**	Self-administered paper-based questionnaire supervised by researchers	74.5% (1064/1429)	To determine the relative effectiveness of financial and non-financial strategies to increase nurse recruitment to rural areas
Kruk, Johnson et al. (2010)	Yes	Ghana	Medical students (fourth-year)	302	Computer-assisted, self-administered questionnaire,	99.0% (307/310)[d]	To investigate the job attributes that influence medical students' preferences for rural job postings

					supervised by researchers		
Vujicic, Alfano et al. (2010a)	No	Liberia	Nurses (various including nurse anaesthetist and midwives)	197[c]	Interviewer-administered, paper-based questionnaire	N/A	To provide evidence for policy options to attract nurses to rural posts
Vujicic, Alfano et al. (2010b), Vujicic, Shengelia et al. (2011)	Yes[e]	Vietnam	Doctors Medical students (final-year)	292 105 **(397)**	Interviewer-administered, paper-based questionnaire	N/A	To investigate the preferences of doctors and medical students for rural posts in order to support the development of rural retention policies
Sivey, Scott et al. (2010), Sivey, Scott et al. (2012)	Yes	Australia	Doctors (junior i.e. not entered specialist training)	532	Self-administered postal paper-based or online questionnaire	N/A[f]	To examine the preferences of junior doctors who have not yet entered a specialist training program for different attributes of specialties
Bundeth, Neath et al. (2011a), Bundeth, Neath et al. (2011b)	Yes	Cambodia	Medical students Nursing students Midwifery students (all final-year)	82 170 184 **(436)**	Self-administered paper-based questionnaire supervised by researchers	N/A[g]	To explore the financial and non-financial incentives required to post new clinical graduates to remote and rural areas
Lagarde, Traore et al. (2011)	No	Mali	Doctors Medical students (final-year) Midwives	116 114 74	Self-administered paper-based questionnaire	N/A	To investigate the effect of various policy incentives to attract doctors and midwives into rural and periurban areas

			Midwifery students (final-year)	102 **(396)**	supervised by researchers		
Pagaiya, Sriratana et al. (2011), Lagarde, Pagaiya et al. (2013)	Yes	Thailand	Doctors (< 3 years graduated in rural service)	198	Researchers explained questionnaire in person, then participants asked to self-administer questionnaire and return by post	63.3% (198/313)	To measure the preferences of junior doctors for incentives associated with rural/urban jobs
Rockers, Jaskiewicz et al. (2011), Rockers, Jaskiewicz et al. (2012)	Yes	Uganda	Medical students Nursing students Pharmacy students Laboratory technician students (all final-year)	246 132 50 57 **(485)**	Computer-assisted, self-administered questionnaire supervised by researchers	95.0% (246/259) 85.2% (132/155) 98.0% (50/51) 85.1% (57/67)	To investigate the preferences of trainee health workers for job attributes to aid recruitment and retention strategies in rural areas
Rao, Shroff et al. (2012), Rao (2012)	Yes[h]	India (Andhra Pradesh and Uttarakhand states)	Doctors Medical students (final-year) Nurses Nursing students	222 163 238 145	Self-administered paper-based questionnaire supervised by researchers	N/A	To examine the effect of monetary and non-incentives on job choices in order to improve recruitment in rural areas

			(final-year)	**(768)**			
Lagarde, Blaauw et al. (2012)	Yes[i]	South Africa	Nursing students (final-year)	377	N/A	65.2% (377/578)	To investigate the preferences of new nursing graduates for job opportunities in the public sector (rural and urban), the private sector or overseas.
Miranda, Diez-Canseco et al. (2012)	Yes	Peru	Doctors (on short-term contracts)	102	Interviewer-administered questionnaire in person	N/A	To identify job attributes that would attract doctors to posts in rural areas
Huicho, Miranda et al. (2012)	Yes	Peru	Nurses Midwives (both on short-term contracts)	205[c]	Interviewer-administered questionnaire in person	N/A	To identify job attributes that would attract nurses and/or midwives to posts in rural areas
Scott, Witt et al. (2012), Scott, Witt et al. (2013)	No	Australia	Doctors (GPs)	3727	Self-administered postal paper or online questionnaire	16.8% (3727/22137)	To investigate preferences of GPs for rural locations
Jaskiewicz, Phathammavong et al. (2012), Rockers, Jaskiewicz et al. (2013)[j]	No	Lao People's Democratic Republic	**Graduates:** Doctors Medical assistants Nurses Midwives **Students:**	 105 90 249 40	Self-administered paper-based questionnaire, supervised by researchers	 N/A N/A 65.0% (249/383) N/A	To investigate health worker preferences for potential attraction and retention strategies for postings in rural areas

			Medical (5 & 6 year) Medical asssistant (1 & 2 year) Nursing (All years) Midwifery (All years)	329 280 256 105 **(1454)**		N/A N/A 62.7% (256/408) N/A	
Ageyi-Baffour, Rominski et al. (2013)	Yes	Ghana	Midwifery students (final-year)	238	Computer-assisted, self-administered questionnaire	79.8 (238/298)	To understand what would motivate midwifery students to work in rural areas after graduation in order to develop an incentive package
Song, Scott et al. (2013)	Yes	China	Doctors Nurses	282 235 **(517)**	Self-administered supervised by researchers	100% (517/517)	To investigate the job preferences of doctors and nurses working in primary care

Additional file 3 Comparison of results for a subset of similar studies

Notes: *All studies assessed to be of high or moderate quality and with common objective of investigating health workers' preference for jobs in rural areas in low- and middle-income countries); VND = Vietnamese dong; USD = United States dollar; tied rankings indicated by "=";*Rockers, Jaskiewicz et al. (2013) present willingness to pay estimates for single interventions for nurses and nursing students only, whereas Jaskiewicz, Phathammavong et al. (2012) present only packages of interventions*

Authors*	**Analytic approach**	**Results of relative attribute impact analysis (ranked from most preferred to least preferred)**		
Hanson and Jack (2010)	Marginal willingness to pay	**Doctors:** Private practice Superior housing Job in Addis Ababa (national capital) Adequate equipment Two-year time commitment	**Nurses:** Job in zonal capital Adequate equipment Superior housing Improved supervision Two-year time commitment	
Blaauw, Erasmus et al. (2010)	Predicted probabilities of uptake of rural post under different incentives	**Kenya:** 30% rural allowance 20% rural allowance Preferential training opportunities More rapid promotion 10% rural allowance	**South Africa:** 30% rural allowance Preferential training opportunities 20% rural allowance 10% rural allowance Benefit package	**Thailand:** Benefit package Relational management culture More rapid promotion 30% rural allowance Better rural housing 20% rural allowance

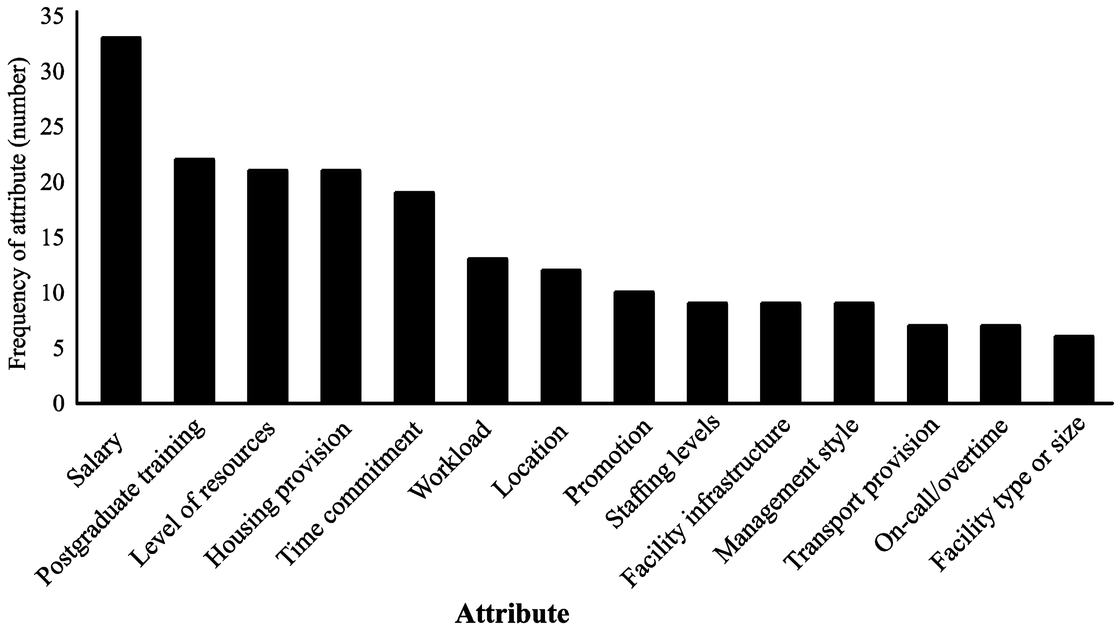
		Better rural housing Relational management culture Benefit package	More rapid promotion Better rural housing Relational management culture	10% rural allowance Preferential training opportunities
Kruk, Johnson et al. (2010)	Predicted probabilities of uptake of rural post under different incentives	Improved infrastructure 100% salary increase Supportive management Study leave after 2 years Utility car provided Allowance for children’s education Superior housing 50% salary increase 30% salary increase No housing (compared to basic housing)		
Vujicic, Shengelia et al. (2011)	Predicted probabilities of uptake of rural post under different incentives	VND 3 million financial bonus VND 2 million financial bonus = Provision of long-term education = Improvement of equipment Provision of short-term training VND 1 million financial bonus Provision of housing VND 500,000 financial bonus		
Vujicic, Alfano et al. (2010a)	Predicted probabilities of uptake of rural post under different incentives	Increase pay by USD150 Increase pay by USD100 Provide housing Provide transportation Increase pay by USD50		

		Improve equipment Increase pay by USD25			
Lagarde, Pagaiya et al. (2013)	Predicted probabilities of uptake of rural post under different incentives	Workplace close to home province Place in quota for specialty training 45% rural incentive Consultant supervision On-call 7 nights per month (compared to 14 nights) 1 year before promotion (compared to two) 30% rural incentive			
Rockers, Jaskiewicz et al. (2012)	Marginal willingness to pay	**Medical students:** Tuition support for training Advanced facility quality 2 year commitment Housing allowance Housing provided Supportive management	**Nursing students:** Advanced facility quality Supportive management Housing allowance = Housing provided Full staff levels 25% understaffed 2 year commitment	**Pharmacy students:** Ownership of private pharmacy Housing provided Housing allowance Advanced facility quality Supportive management 2 year commitment	**Laboratory students:** Advanced facility quality Tuition support for training Housing provided Housing allowance Supportive management 2 year commitment
Miranda, Diez-Canseco et al. (2012)	Predicted probabilities of uptake of rural post under different incentives	75% rural allowance 50% rural allowance Permanent contract after 2 years 20 points for specialisation 25% rural allowance Permanent contract after 4 years 10 points for specialisation			

3.3 COMPARISON OF ATTRIBUTES

While not considered integral to the published review, a tabulation of the most frequent attributes across the included studies was also undertaken to inform the DCE design (Chapter 7). Although the description of attributes varied considerably between studies, the majority could be broadly aggregated into a limited number of categories. All attributes that appeared more than five times are displayed in Figure 3.1. If attributes varied by cadre of health worker within a study, each cadre's set of attributes was counted separately.

Figure 3.1 Comparison of attributes across studies in systematic review



Notes: *In majority of studies, location attribute referred to rural or urban jobs; transport provision includes both access to vehicles and allowances; on-call/overtime includes both reimbursement for and intensity of such work.*

As would be expected in labour market decisions, salary was included as an attribute in all but one study. A time commitment to a post (e.g. through a minimum contract duration) was frequently included as an attribute, although rarely used to produce welfare estimates as noted in the review.

Postgraduate training of some description was the second most frequent attribute, appearing in 22 studies with 12 focused on doctors and/or medical students. I will now examine the use of this attribute in more detail given the focus of the thesis. In nearly all studies, this attribute describes either continuous professional development or specialty training (Table 3.1). In two studies, these training formats were directly traded off, either as two separate attributes or two levels of one attribute. In Vietnam, specialty training led to only one percent greater uptake of rural jobs than continuous professional development, whereas in India reservation of a specialty training place led to a 46% increase in rural job uptake (Vujicic, Shengelia et al. 2011, Rao, Ryan et al. 2013). The remaining studies either guaranteed entry to specialty training after a certain number of years' service or increased the probability of entering training (e.g. through bonus points or a quota system). One study goes so far as to include nine different levels of probabilities, despite evidence for the poor understanding of and difficulty in processing probability by participants (Chomitz, Setiadi et al. 1998, Harrison, Rigby et al. 2014).

Across all studies, however, the characteristics of this possible training are ill-defined. In only one study (Miranda, Diez-Canseco et al. 2012) is the specialty of training specified (Family and Community Medicine), with the rest giving the implicit indication that the training will be in a specialty of the participant's choice. While we cannot exclude that

Table 3.1 Postgraduate training attributes in medical workforce DCEs

Study	Attribute	Levels
Chomitz, Setiadi et al. (1998)	Probability of subsequent specialist training	10% to 90%
Wordsworth, Skatun et al. (2004)	Participation in continuous professional development and training	Enough/Not enough
Kruk, Johnson et al. (2010)	Study leave after minimum number of years of service	2 years'/5 years' service
Vujicic, Shengelia et al. (2011)	Skills development: short-term courses, expert exchange and supportive supervision	No programme/programme
	Long-term education: opportunity to enter advanced medical school	None/After 5 years on the job
Bundeth, Neath et al. (2011a)	Opportunity for specialty training	Yes/No
Lagarde, Traore et al. (2011)	Specialty training in variable number of years after taking up rural service	5/7/10 years' service
Lagarde, Pagaiya et al. (2013)	Reserved quota in the facility for subsequent specialist training	No/Yes
Rockers, Jaskiewicz et al. (2012)	Future tuition	The government will not provide financial assistance for a study programme (e.g. specialty training) after your commitment is over/government will pay full tuition
Rao, Ryan et al. (2013)	Professional development	Short duration training courses for skills development/Easier admission for specialty training through reservation or quota after 3 years of service
Miranda, Diez-Canseco et al. (2012)	Points when applying for a residency in Community and Family Medicine after 3 years in post	10/20 points bonus
Jaskiewicz, Phathammavong et al. (2012)	Continued education	Qualify for further study and financial support after 1year/3 years in rural facility
Song, Scott et al. (2013)	Training opportunity: short-term courses to develop professional skills	Insufficient/some/sufficient

other aspects of training such as location were specified in the instructions to participants, these are not included as levels of the training attribute that participants would need to trade off against other attributes.

3.4 UPDATE TO SYSTEMATIC REVIEW

Subsequent to this review, ten further DCEs examining health workforce issues have been published to my knowledge (Doiron, Hall et al. 2014, Li, Scott et al. 2014, Pedersen and Gyrd-Hansen 2014, Yaya Bocoum, Koné et al. 2014, Efendi, Chen et al. 2015, Holte, Kjaer et al. 2015, Honda and Vio 2015, Kunaviktikul, Chitpakdee et al. 2015, Robyn, Shroff et al. 2015, Scott, Witt et al. 2015). Appendix D summarises key features of these studies, while this section focuses on results related to postgraduate training.

In general, attributes relating to postgraduate training continue to be poorly defined, as found above. For example, a study of general practice posts in Norway found opportunities for professional development was the second most valued attribute of final-year medical students and recently qualified doctors, but few details were available on the nature of this development (Holte, Kjaer et al. 2015). An exception is a study by Honda and Vio in Mozambique that included two postgraduate training attributes similar to Vujicic et al.'s study in Vietnam, with one providing opportunities for "formal education" after five years of work and the other referring to "skills development"[22] (Vujicic, Shengelia et al. 2011, Honda and Vio 2015). The results for a sample of "non-

[22] Described as "on-going, short-term training courses and regular supportive supervision."

physician health professionals" showed a willingness to pay for formal education almost double that for skills development[23]. The study went on to investigate the heterogeneity of these preferences using *post-hoc* interaction terms. Skills development was found to be more highly valued by younger health workers, whereas formal education was valued more highly by those born in district areas[24]. Similar subgroup findings were identified in Thai nurses, whereby younger nurses valued continuous professional education more than older ones[25] (Kunaviktikul, Chitpakdee et al. 2015).

There is some evidence to suggest that doctors may place greater value on "formal" postgraduate training than other cadres. When preferences for rural posts were compared between final-year healthcare students in Indonesia, a guaranteed scholarship for postgraduate training on completion of a rural post was the most valued attribute for medical students, but only the fourth highest for nursing and midwifery students (Efendi, Chen et al. 2015). Surprisingly, however, preferential admission for postgraduate training places had limited impact on the uptake of rural jobs by doctors and medical students in Cameroon, in contrast to the findings of the systematic review (Robyn, Shroff et al. 2015), The authors explain this discrepancy through insights from preparatory qualitative work

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[23] This study is limited, however, by the pooled analysis of an extremely heterogeneous target sample (including nurses, midwives, lab technicians, pharmacists, psychologists, hospital administrators, and students of all these cadres), variation in administration (some interviewer-supervised, some self-completed) and an analysis limited to a conditional logit model.

[24] Although there is a discrepancy between the relevant table and text for this result.

[25] This study suffered from quite vague, multi-dimensional attributes, however, with the most highly valued attribute "work setting" described as "supervisor as requested, autonomy, environment, participation, decision making, empowerment, relationship with physicians, and others".

that indicated a low level of trust by participants in the transparent implementation of such a system.

3.5 CONCLUSIONS AND GAPS IN THE LITERATURE

The review of DCEs examining health workforce issues contained within this chapter highlight several deficiencies in the literature with relevance to this research programme. First, there is some evidence that health workers value postgraduate training opportunities more highly than other job characteristics. There is also some evidence that doctors place greater value on training opportunities compared to other cadres, as well as preferring specialty training to continuous professional development. Yet the composition of the utility of postgraduate training has not been unpacked in any depth to date. This is particularly important in the health labour market where specialty training is usually regulated through accreditation, international recognition of qualifications, and restricted entry. Factors such as structure, location and timing of training are therefore likely to influence the value of this training compared to other attributes. Second, there has been limited examination of heterogeneity in health workers' preference for postgraduate training. It seems likely that health workers would differ in their motivation to undertake further training and thus place different value on this attribute compared to other job characteristics. Finally, there are few DCEs that have examined retention of health workers at a national level, with most in LMIC focused on the recruitment to and retention in rural and remote areas.

4 STUDY SETTING

The questions raised in the two preceding chapters are particularly pertinent in Malawi, a country where considerable investment in medical education and remuneration has taken place against a background of high emigration. In order to anchor the following chapters, I will first describe the context in which this research programme was designed and carried out in more depth.

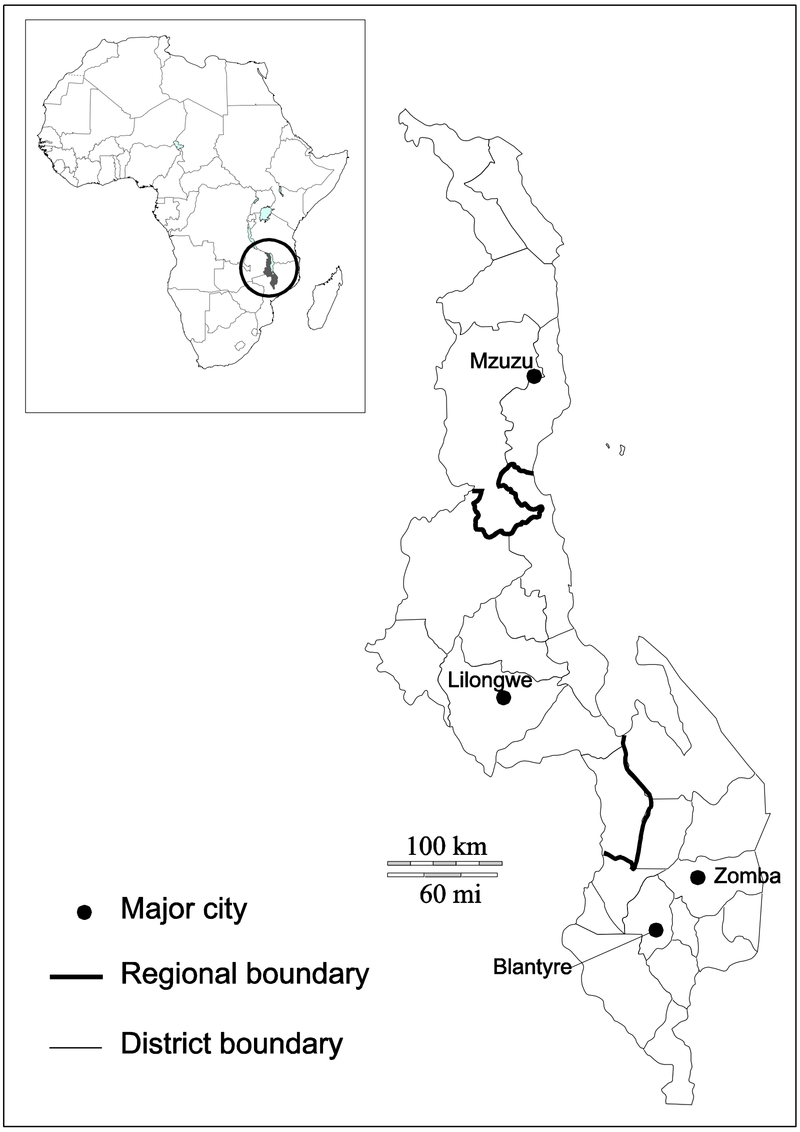
4.1 COUNTRY PROFILE

Malawi is a landlocked country in southern Africa (Figure 4.1). It is one of the world's poorest countries with a gross domestic product (GDP) per capita of USD 253 in 2014 (World Bank 2015)[26]. In 2010, nearly three quarters of Malawi's population was living in extreme poverty (World Bank 2015)[27]. The economy is primarily agriculture-based and highly dependent on tobacco exports (World Bank 2012). Although growth is close to regional averages, inflation rates have been running at over 20 percent since 2012 (Record 2015). Budget support accounted for 14.5% of GDP in 2012/2013 (Record 2015). Following revelations of misappropriation of public funds, however, development partners suspended support in late 2013 and this proportion declined to just 4.4% in 2013/

[26] Current USD.

[27] Defined as living on less than USD 1.25 per day (2005 international dollars), adjusted for purchasing power parity

Figure 4.1 Map of Malawi showing major cities, regional and district boundaries



Notes: *Regional boundaries indicate position of northern, central and southern regions.*

2014 (Record 2015). Public debt now accounts for nearly 70% of GDP, levels approaching those before the last debt relief programme in 2006 (Record 2015).

Malawi is densely populated for its size with 16.8 million people, although 84% of the population lives in rural areas (World Bank 2015). Administratively, it is divided into three regions and 28 districts, with four main cities: Lilongwe (the capital and administrative centre), Blantyre (the commercial centre), Mzuzu and Zomba (these two cities being far smaller than the others). Although there are ethnic divisions along regional lines, there is little friction between tribal groups despite a history of political favouritism (Langhanns 2014). After independence from Great Britain in 1964, Malawi entered three decades of one-party rule under Dr Hastings Banda before the first multiparty elections were held in 1994 (Kalinga 2012). The subsequent period has been characterised by periods of strong policy implementation and good external relations, followed by more autocratic administrations and stagnation of reforms (World Bank 2012). Checks and balances are generally weak, with high levels of corruption and nepotism[28] (Africa Institute for Corporate Citizenship, Malawi Economic Justice Network et al. 2013).

The adult literacy rate in Malawi stands at 60% (World Bank 2015). Three out of four children complete primary school, which has been free since 1994 (World Bank 2012, World Bank 2015). Only a third go on to secondary education, with large disparities in tuition fees between government, faith-based and private schools (World Bank 2015). Access to tertiary education is solely based on performance in secondary school exit examinations performance and extremely competitive, with one of the lowest enrolment ratios in Africa (World Bank 2012). Capacity has recently improved with expanded enrolment at seven public universities and an increasing number of private institutes,

[28] The most high-level of which being the "Cashgate" affair of 2013 concerning systematic misappropriation of development funding by public officials.

however the ratio of publicly subsidised places has declined and the current student loan system is undercapitalised and regressive (World Bank 2012).

4.2 The health sector in Malawi

Malawi has some of the worst health indicators in sub-Saharan Africa, with a maternal mortality ratio of 510 per 100,000 live births and an infant mortality rate of 44 per 1000 live births (World Health Organization 2015). Yet these actually represent remarkable progress, with both indicators declining by nearly half over ten years. Communicable diseases dominate the burden of disease, with an adult prevalence of HIV of 10.3%, although recent surveys have also identified high levels of undiagnosed non-communicable diseases (Ministry of Health and World Health Organization 2010, Institute of Health Metrics and Evaluation 2013, World Health Organization 2015). With rollout of antiretroviral treatment, life expectancy at birth has risen from 44 years in 2000 to 60 years in 2013 (World Health Organization 2015).

Health accounted for 16.2 percent of government expenditures in 2013, which is above regional averages (World Bank 2013, World Health Organization 2015). Out-of-pocket payments accounted for 12% of total health expenditure at that time, with a low incidence of catastrophic health expenditures (World Bank 2013, World Health Organization 2015). The sector is likely to be hit hard by the current aid freeze, however, with external financing comprising nearly two fifths of public health funding in 2012/2013 (World Bank 2013). When off-budget project funding is taken into account, this rises to two thirds of total health spending (World Health Organization 2015).

The delivery of public health services is split between the government (60%) and faith-based organisations (40%) (Ministry of Health 2011). The plethora of denominations that run these mainly rural facilities are represented by the umbrella Christian Health Association of Malawi (CHAM). The MOH covers all staff salaries for Malawian nationals working in CHAM facilities to support the provision of health services in rural areas. While CHAM facilities charge user fees, service-level agreements with the MOH negate these charges for publicly subsidised health care (see below). There are four public general tertiary hospitals[29], one in each of the four main cities (Figure 4.1). Two of these are teaching hospitals with over 1200 beds each (Queen Elizabeth Central Hospital, QECH, in Blantyre and Kamuzu Central Hospital, KCH, in Lilongwe), with the other two being far smaller (Zomba Central Hospital, ZCH, and Mzuzu Central Hospital, MCH). At secondary-level, there are 27 district hospitals (one in nearly every district) and 23 CHAM hospitals (Ministry of Health 2011). Primary care consists of a network of community/rural hospitals, health centres, health posts and dispensaries in rural areas that are staffed by nurses or mid-level cadres such as medical assistants (see below) (Palmer 2006, Ministry of Health 2011). The private sector is small, but includes private practices run by doctors or other health workers and private hospitals in the larger cities (Ngalande Banda and Simukonda 1994).

In 2002, the government adopted a sector-wide approach (SWAP) for health (Ministry of Health 2004) to channel aid funding to support the delivery of an essential health package. This is a prioritised set of mainly cost-effective interventions provided free to all

[29] There is also a tertiary psychiatric hospital in Zomba.

Malawians at public sector health facilities (Ministry of Health 2004, Bowie and Mwase 2011). The original package focused on interventions to tackle the major causes of disease in Malawi, such as vaccination, safe childbirth and treatment of HIV/AIDS, malaria and tuberculosis (Ministry of Health 2004, Palmer 2006). The 2004 – 2010 SWAP work programme concentrated on health system improvements to enable delivery of the essential health package (Ministry of Health 2004, Mueller, Lungu et al. 2011). The 2011 – 2016 Health Sector Strategic Plan continues this programme of work and has redefined the essential health package to include some interventions for non-communicable diseases (Ministry of Health 2011).

4.3 THE MALAWIAN MEDICAL WORKFORCE

Traditional healers were predominant in Malawi until the arrival of missionary doctors in 1861 (King and King 1992). While other cadres of health workers were trained in first missionary and then government institutions, medical training remained the preserve of colonialists (Wendland 2010). While mission hospitals were often staffed by expatriate missionary doctors, government health facilities relied on nurses, clinical officers and medical assistants (Muula and Broadhead 2001)[30].

A handful of students eventually left Malawi on mission scholarships for medical school in the UK and USA, with the first Malawian doctor returning in 1925 (King and King

[30] Training programmes for the latter two cadres started in the colonial era and consist of two years of training for medical assistants and three years for clinical officers. Medical assistants now usually staff health centres, whereas clinical officers lead care in district hospitals.

1992). During a period of federation with Rhodesia[31], some doctors were trained at a new medical school in Harare (Muula and Broadhead 2001). Even after independence from the UK, students continued to be sent there to train, although the oppression of the Banda regime augmented the tendency to remain in those countries after graduation (Muula and Broadhead 2001, Wendland 2010). By 1992, there were 175 doctors in the country, only 25 of whom were Malawian (King and King 1992).

In 1991, funding from a number of bilateral development agencies led to the establishment of COM with a skeleton faculty of British doctors (Muula and Broadhead 2001, Broadhead and Muula 2002). Some teaching initially took place outside Malawi and the first medical students to undertake all five years[32] of training in Malawi graduated in 1999 (Muula and Broadhead 2001). Since then, 689 doctors have graduated – an average of 30 per year. There has been a marked expansion of enrolment from 2011, with class sizes now over 100 (Figure 4.2).

After graduation, doctors work as interns for 18 months in one of the teaching hospitals (QECH or KCH) before obtaining their independent practitioner's licence from the Medical Council of Malawi (Zijlstra and Broadhead 2007). Interns rotate between four specialty departments (Obstetrics & Gynaecology, Paediatrics, Surgery and Internal Medicine) and also spend three months as part of a district hospital team.

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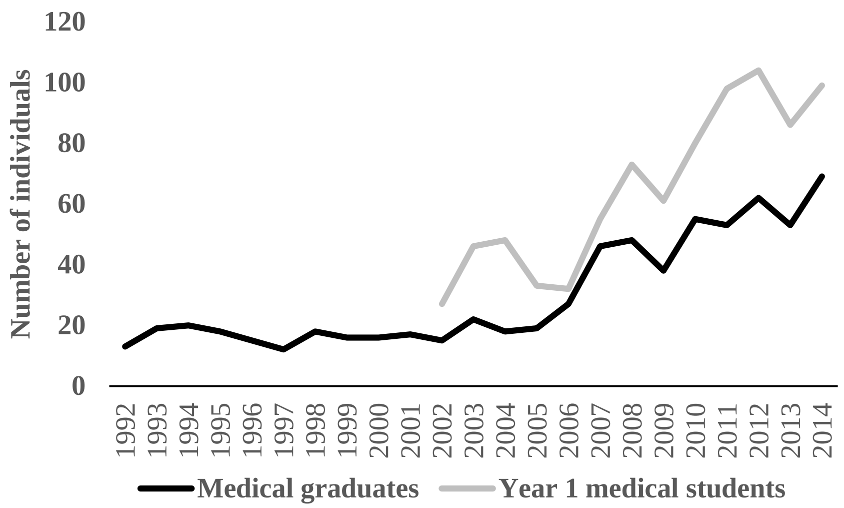
[31] Modern-day Zimbabwe and Zambia.

[32] As many secondary school leavers struggled with the science content of the early training years, an additional "foundation" or access year was established for these students in order to bridge the knowledge gap.

Figure 4.2 Medical graduates and Year 1 medical students at COM, 1992 – 2014



Source: *COM Registry data*

After internship, doctors who remain in the public sector may be posted to a specialty department at a central hospital or a district hospital. Here, doctors may work as a district medical officer (DMO), responsible for clinical care of patients. They may also be promoted to the district health officer (DHO) position, responsible for district public health programmes and management of the district health team. District posts have been traditionally underserved, with high turnover and vacancies (Ministry of Health 2004). Later in their careers, doctors can also be posted to administrative posts within MOH.

If doctors decide to leave the public health sector, there are a number of options (Table 4.1). Graduates may be recruited onto the COM teaching staff or into the Malawi Defence Force. Although these are within the public sector, they are funded by other ministries and will not be counted as the public health sector for the purposes of this thesis. There are numerous research projects underway in Malawi and graduates are often recruited to work as research doctors. Likewise, NGOs often recruit local doctors to serve on their projects, as do development partners. Doctors are allowed to work in the private sector after completion of internship. Some work as in-house doctors for commercial companies or private hospitals. Others set up independent or group practices. Doctors who remain in the public sector can spend a limited amount of time in dual practice, with specialists frequently undertaking clinical sessions in private hospitals. Junior doctors often perform locum shifts in private hospitals that pay higher rates than equivalent shifts in public facilities.

Table 4.1 Sectors and organisations in Malawi that recruit COM graduates

Sector	**Organisation**
Public health sector	Ministry of Health clinical posts
	Ministry of Health administrative posts
	CHAM
Public sector, non-health	College of Medicine
	Malawi Defence Force
Non-public sector	Research organisations
	Non-governmental organisations
	Development partners
Private sector	Commercial companies
	Private hospitals
	Private practices

Whatever their sector of employment, all doctors and specialists in Malawi are required to be registered with the Medical Council of Malawi (Government of Malawi 1987). Two professional organisations exist[33], both of which have focused up to now on education and professional development. There has been little history of collective bargaining or industrial dispute by doctors. This mirrors generally low support for trade unionism in Malawi, with only two percent of those in formal employment holding union membership in 2013 (National Statistical Office of Malawi 2014). Following isolated strikes by newly graduated doctors due to non-availability of subsidised accommodation, however, the Medical Doctors' Union of Malawi was established two years ago.

In 2001, a review of the location of the 134 COM graduates up to that point found that one third were outside Malawi (Muula and Broadhead 2001). Most of these were in specialty training (38/42), whereas four had completed training or left for other reasons. A further 19 doctors had returned to Malawi after specialty training, meaning that two fifths of graduates had pursued specialty training overall. In 2006, a similar stocktake identified locations for 245 out of 254 graduates, with over a third outside Malawi (Zijlstra and Broadhead 2007). In total, 49 were in postgraduate training and 19 were specialists in Malawi[34], indicating that at least one quarter had pursued specialty training[35]. Out of those in Malawi and post-internship, just over half were working in the public sector (65/123) (Zijlstra and Broadhead 2007). In 2008, a survey of COM medical

[33] The Society of Medical Doctors in Malawi and the Medical Association of Malawi.

[34] Interestingly, the same number as five years earlier, indicating that the stock of specialists had not been enlarged by the greater number of graduates who had completed specialty training.

[35] Both estimates of specialty training uptake are conservative due to right censoring (as there has been less follow-up time for the most recently graduated) and inclusion of interns who are not eligible for training.

students found that nearly 40% had plans to leave Malawi after graduation[36] (Mandeville, Bartley et al. 2012). More than four fifths intended to specialise in the future, with over a third hoping to pursue specialty training outside Africa.

Poor retention of doctors in Malawi and the public sector, compounded by the low number of graduates across all cadres, led to concerns that human resources - rather than funding - would be the largest constraint in delivering the essential health package (Palmer 2006). A third of budgeted posts across the health sector were reported to be vacant in 2004, rising to 85% for surgeons and 100% for pathologists (Ministry of Health 2004). When assessed against predefined staffing norms, only nine percent of facilities were ready to implement the essential health package. Rural areas were worse off, with four districts without any doctors at all (Ministry of Health 2004). Strengthening the health workforce in the form of the Emergency Human Resource Programme therefore became one "pillar" of the SWAP work programme (Ministry of Health 2004).

4.4 THE EMERGENCY HUMAN RESOURCE PROGRAMME

The EHRP was a comprehensive plan from 2004 to 2010 with the aim of increasing health worker-to-population ratios to those of neighbouring Tanzania (Management Sciences for Health 2010). It cost USD 96 million over the programme period, with the two largest donors the UK's Department for International Development and the Global Fund to Fight AIDS, TB and Malaria (Management Sciences for Health 2010). It comprised five main

[36] The survey was limited by a response rate of 48%, weighted towards the pre-clinical years.

Table 4.2 Major elements of the Emergency Human Resources Programme

ELEMENT	DESCRIPTION	COST (USD)
1	Improving incentives for recruitment and retention of Malawian staff in government and mission hospitals through a 52% taxed salary top-up for 11 professional cadres	34.3 million
2	Expanding domestic training capacity by over 50% overall, including tripling the number of medical students, and investment in infrastructure	53.4 million
3	Using international volunteer doctors and nurse tutors as a stop-gap measure to fill critical posts	6.4 million
4	Providing technical assistance to bolster capacity and build skills within the Ministry of Health‘s human resources planning, management and development functions	1.5 million
5	Establishing more robust monitoring and evaluation capacity for human resources in the health sector	113,000

Source: *Management Sciences for Health (2010)*

elements (Table 4.2), the most radical element of which being a 52% salary supplement[37] (known among health workers as “SWAP”) for 11 priority cadres of health workers, including doctors.

This top-up was initially disbursed as an allowance to allow restriction to health workers within Malawi’s civil service pay scale, with plans to eventually delink remuneration

[37] Due to a lack of negotiation with the central tax agency, this top-up was taxed and the net increase was nearer 30-35% (Management Sciences for Health, 2010).

decisions to a separate Health Services Commission. Other financial incentives included expanded access to rent-free staff housing and staff transport at central hospitals[38] (Palmer 2006). After the end of the programme, the cost of the salary top-ups were absorbed by the MOH (Management Sciences for Health 2010, Ministry of Health 2011). This had a substantial budget impact, with salary costs rising to half of public health spending in 2012/13 from one quarter in 2006/07 (World Bank 2013).

Another major element of the programme was the training of new health workers. Subsidy of tuition fees and investment in infrastructure allowed expansion of training capacity with the number of graduates from supported institutions increasing by 39% over the programme period (Management Sciences for Health 2010). As the focus was on "short-term" measures, funding for postgraduate training was not included as part of the programme design, despite recognition of concerns over career progression among health workers (Management Sciences for Health 2010). Instead, expatriate volunteers were recruited to fill critical posts, particularly those of medical specialists. This was discontinued after the end of the programme, with the MOH concluding that sufficient national staff had been trained to fill these posts (Management Sciences for Health 2010).

The official EHRP evaluation was hindered by a lack of baseline data and the failure to implement a monitoring system as part of the programme (Management Sciences for Health 2010). A requirement for nurses to request certification from the Nurses and Midwifery Council before work outside Malawi allowed a tentative conclusion that

[38] A planned rural hardship allowance was not implemented (Management Sciences for Health, 2010).

emigration of nurses may have slowed during the programme period (16 nurses in 2009 requested certificates[39] compared with 108 in 2003) (Management Sciences for Health 2010). No equivalent requirement exists for doctors, however, and no primary data collection was undertaken on the location of medical graduates. The evaluation concluded that the doctor-to-population ratio should have risen to 2.03 per 100,000, just below that of Tanzania, if all doctors trained had remained in the country (Management Sciences for Health 2010). Without further investigation, however, it is not possible to draw conclusions about the programme's impact on retention of doctors.

4.5 SPECIALTY TRAINING FOR DOCTORS

Despite the new national medical school, Malawian medical graduates continued to be sent to Europe or the USA to undertake specialty training. When many doctors failed to return from such training, specialty training programmes were introduced at COM in 2004 (Zijlstra and Broadhead 2007). For clinical specialties, these consist of four-year training programmes leading to a Master's of Medicine degree (MMed). For public health, a Master's of Public Health (MPH) programme is available, as well as doctorates in public health-related fields (Muula 2010). Given the limited pool of trainers and specialist equipment, registrars (trainee specialists) in some specialties undertake two or more years of training at other postgraduate institutions. Table 4.3 shows the MMed specialties currently offered at COM and their location of training. On completion of training, specialists who remain in the public sector are posted to central hospitals.

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[39] Presumably this is request of certificates rather than actual emigration, although this is not specified in the report.

Table 4.3 COM MMed training by specialty and location

Specialty	Training location(s)
Public health	2 years in Malawi
Internal Medicine	4 years in Malawi
Orthopaedic surgery	4 years in Malawi
General surgery	4 years in Malawi
Ophthalmology	4 years in Malawi, with short periods in Germany
Paediatrics and Child Health	2 years in Malawi, 2 years in South Africa
Renal medicine/Nephrology	2 years in Malawi, 2 years in South Africa
Anaesthetics	2 years Malawi, 2 years South Africa
Emergency Medicine	4 years in South Africa
Obstetrics & Gynaecology	4 years in South Africa

South Africa is the main collaborating centre for specialties offered at COM. Visas are granted only for the training period, encouraging return to Malawi after completion of training (Zijlstra and Broadhead 2007). For other specialties, government-funded training is undertaken at other postgraduate institutions in other Southern or East African countries. Other funders have sponsored doctors to undertake training outside of Africa. Doctors are eligible for entry to specialty training from completion of internship. While experience at district-level is nominally required for entry to specialty training, with longer durations of service preferred, this is rarely the case in practice.

The number of specialty training places available is heavily dependent on funding from development partners, research organisations or NGOs, and private donors (Zijlstra and

Broadhead 2007, Schulze Schwering, Spitzer et al. 2014). The most substantial funding in recent years has come from the National AIDS Commission (financed mostly by development partners) which funded 34 doctors in three cohorts to undertake training across 12 specialties. This was an initial three-year grant with the possibility of repeat funding, but was not renewed after 2011. Training sponsored by research organisations or private donors is usually one-off or very short-term. The Ministry of Health has drawn up 12- and 15-year forecasts of the specialists needed to replace those retiring from central hospitals, however as there is no associated budget allocation the number actually trained is dependent on the *ad hoc* funding available each year. Overall, access to "scholarships" - as funded training places are known among doctors – appears to be unpredictable, untransparent and uninstitutionalised.

At this juncture, it is important to recognise the extremely small size of the specialist workforce in Malawi. Table 4.4 shows data from the Ministry of Health and the Malawi Medical Council describing the stock of specialists. In 2012, the total number of registered specialists in Malawi was 132 for nearly 16 million people (Medical Council of Malawi 2011, World Bank 2015). Less than one third of these specialists were Malawian (37/132, 28.0%), with most trained in high-income countries (55/132, 41.7%) followed by other LMIC (40/132, 30.3%). These figures are likely to be overestimates, as doctors are not required to deregister if they stop working or leave Malawi[40]. In some areas such as dermatology, anaesthetics, and orthopaedics, specialised clinical officers make up the shortfall (Mkandawire, Ngulube et al. 2008).

[40] There would also be generalist doctors working in these clinical areas that did not have a specialist qualification.

Table 4.4 Specialists in Malawi by specialty and year of estimate

	2004§	2012§§
	Total specialists working in public sector (total budgeted posts)	**Malawian specialists (total registered specialists)**
Anaesthetist	4 (14)	0 (10)
Cardiothoracic surgeon		0 (1)
Ear, nose and throat surgeon		1 (1)
Family physician/GP		2 (6)
General surgeon	17 (115)	4 (27)
Haematologist		0 (1)
Head and neck surgeon		0 (1)
Internal physician	3 (65)	5 (21)
Maxillofacial surgeon		0 (1)
Neurologist		0 (2)
Obstetrician & gynaecologist	11 (126)	10 (17)
Ophthalmologist		3 (5)
Orthopaedic surgeon		1 (5)
Paediatrician	5 (60)	4 (18)
Pathologist	0 (22)	3 (5)
Psychiatrist		1 (2)
Public health physician		2 (2)
Radiation oncologist		1 (1)
Radiologist		0 (4)
Urological surgeon		0 (2)
Total		**37 (132)**

Source: *§Ministry of Health (2004); §§Medical Council of Malawi (2011).* ***Notes:*** *Empty cells indicate no data available.*

There is also evidence of a lack of workforce planning for medical graduates despite the expansion of undergraduate training. Table 4.5 compares the number of specialists that would be trained under the MOH 15-year forecast if fully funded to the number of medical officers that would be eligible for training each year based on current enrolment at COM. While initially the plan covers around a third of eligible graduates, this drops to one tenth by 2020. This analysis is necessarily simplistic, ignoring the other sources of funding for specialty training and also the cumulative stock of eligible doctors each year. Yet it shows that the most long-term funding in recent years, the NAC grant, was not sufficient for replacement purposes and only covered around a third of eligible graduates.

4.6 CONCLUSIONS AND RESEARCH GAPS

As a response to low doctor-to-population ratios constraining effective health service delivery, the stock of Malawian doctors has expanded substantially in recent years. In order to encourage the retention of new and existing doctors in the public sector, a salary top-up has been provided with considerable budget impact without evidence for its effectiveness. There has not been equivalent planning or funding for specialty training, despite indications from both stated intentions and actual career choices that specialty training is highly valued by current and future Malawian doctors. A thorough analysis of the trade-offs that Malawian doctors make between financial incentives and specialty training would be valuable in order to inform future health workforce policies. The next chapter will describe the design and methods of the research undertaken to investigate this issue.

Table 4.5 Speciality training places and future medical officer numbers

Year	Predicted number of medical officers*	MOH 15-year replacement plan			NAC grant	
		Number of specialists required	Specialty training places required**	Training places as proportion of medical officers	Number of NAC training places§	Training places as proportion of medical officers
2009	48	20	17	0.35	11	0.23
2010	38	18	17	0.45	11	0.29
2011	55	18	17	0.31	12	0.22
2012	53	17	15	0.28	-	-
2013	62	17	15	0.24	-	-
2014	53	17	14	0.26	-	-
2015	61	15	14	0.23	-	-
2016	80	15	14	0.18	-	-
2017	98	14	14	0.14	-	-
2018	104	14	13	0.13	-	-
2019	86	14	11	0.13	-	-
2020	99	14	11	0.11	-	-
2021	-	13	-	-	-	-
2022	-	11	-	-	-	-
2023	-	11	-	-	-	-

Source: *MOH and COM data* ***Notes:*** **Based on number of graduates from previous academic year or medical students enrolled in relevant year, under assumption that all enrolled students graduate, complete internship and stay in the public sector; **based on a lag of four years from the number of specialists required assuming a four-year training programme; §divided equally between years as planned rather than actual annual intake which was affected by implementation delays*

5 STUDY DESIGN AND METHODS

This chapter sets out the aims and objectives of this thesis, along with the conceptual framework underpinning the research. The components of the research programme are then described in turn. The chapter concludes with a consideration of sample size and ethical issues.

5.1 AIMS AND OBJECTIVES

The aim of this thesis is to determine the importance of specialty training for the retention of junior doctors in the Malawian public sector. Although "junior doctor" can refer to any doctor who is not a certified specialist or general practitioner, we defined the term for these purposes as within seven years of graduation.

There are several reasons to focus on Malawian junior doctors rather than the entire doctor population. First, as highlighted by the literature review, studies of medical emigration show that junior doctors contribute substantially to more recent emigration (see section 2.3). Second, specialty training is usually undertaken relatively early in a doctor's career. Junior doctors may thus place higher value on such training than generalist doctors well established in their careers, thus increasing its potency as a policy lever. Third, the development of medical education in Malawi over the last 25 years has led to a wide variation in training experiences across the medical workforce. The focus on a cohort with more homogeneous experiences avoids confounding heterogeneity in preferences with these period effects. Finally, the scaling up of undergraduate training under EHRP has led to a glut of new graduates, who now outnumber the original medical workforce. This creates a policy urgency to retaining these new doctors, who represent a considerable investment of public funds.

In order to determine the importance of specialty training for the retention of Malawian junior doctors, there are four main objectives of this research:

(i) To identify the key factors influencing Malawian junior doctors to leave the public sector:

   a. What is the perception of current incentives?
   b. What role do opportunities for specialty training play?

(ii) To investigate the retention of Malawian junior doctors:

   a. What proportion of doctors have moved outside of Malawi?
   b. What proportion of doctors have moved outside the public sector?
   c. What proportion of doctors are in specialty training?
   d. How do these proportions compare to historical trends?

(iii) To quantify the preferences of Malawian junior doctors for specialty training:

   a. What are junior doctors willing to trade for specialty training opportunities?
   b. Are different types of training valued equally?
   c. Do these preferences vary between different subgroups?

(iv) To determine the cost-effectiveness of specialty training for retaining doctors in the Malawian public sector:

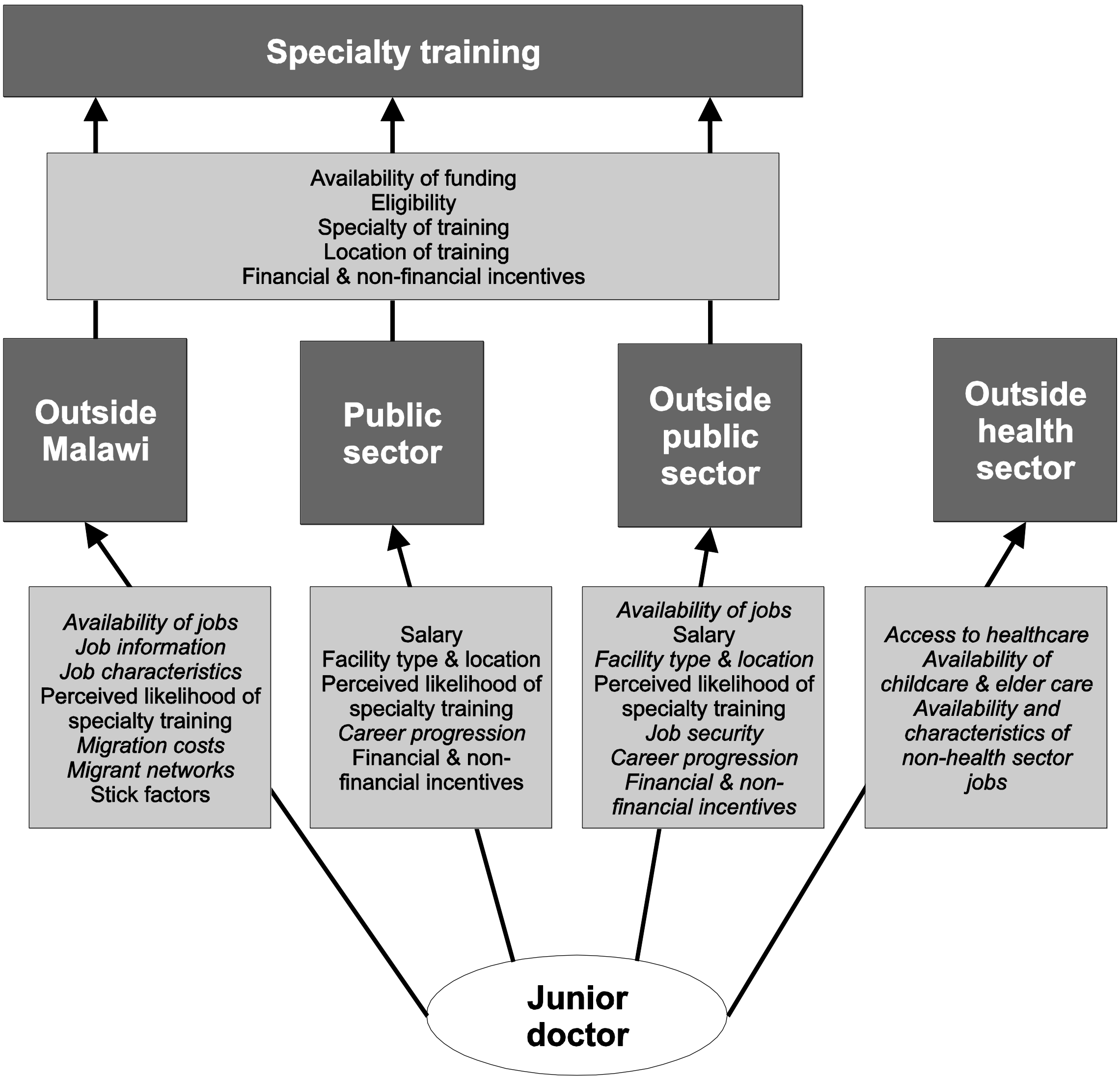
a. Is expansion of specialty training cost-effective in the long-term?
b. How does the cost-effectiveness of alternative policy options compare?
c. What is the impact of heterogeneity in the study population?

5.2 CONCEPTUAL FRAMEWORK

The key ideas encompassed by the previous chapters can be drawn together in a conceptual framework (Figure 5.1). This presents the labour market options available to a Malawian junior doctor. There are four choices: remaining in the public sector, taking up a job outside the public sector, leaving Malawi, or leaving the health sector altogether (for example due to illness, provision of child- or elder-care, or uptake of a non-health sector job). Factors that are likely to influence the choice of labour market option are shown, which include both the availability and characteristics of jobs. For the three health sector options, this includes the perceived likelihood of undertaking specialty training in these jobs. Actual entry to specialty training, however, is influenced by the availability of funded training places, eligibility for that training and the type of training on offer. Finally, the framework distinguishes between those factors examined as part of this research and those that lie outside its scope. Due to resource limitations, it was not possible to examine all factors fully for all labour market options. Priority was given to those factors that were considered to be most closely associated with the research objectives and also most amenable to policy interventions by the Malawian government. The next section outlines the study design used to investigate these job choices and influential factors.

Figure 5.1 Conceptual framework

Notes: *The labour market options available to a Malawian junior doctor are shown in dark grey, with factors influencing this choice shown in light grey. Factors investigated as part of this research programme are indicated in normal font, with those not measured shown in italics.*



5.3 STUDY DESIGN

The first step in the research programme was to construct a sampling frame of the target population. Due to limitations with administrative data, it was necessary to trace the location of all COM graduates between 2006 and 2012. This provided a partial update for the last such study undertaken in 2006, but with a focus on the early career period when the risk of emigration has been shown to be higher. It also enabled investigation of the retention rates of Malawian graduates, as well as eligibility for the DCE survey.

The findings of the tracing study, along with the literature reviews contained in Chapters 2 and 3, provided a foundation for the design of the DCE. As per best practice, semi-structured interviews were then undertaken with members of the target population, other doctors and a range of key informants in order to gain more nuanced insights into the job choices of Malawian junior doctors (Bridges, Hauber et al. 2011). Information from all these elements were combined with experimental design techniques in an iterative design process, described separately in this thesis (Johnson, Lancsar et al. 2013). The design of a cross-sectional survey to be administered alongside the DCE in order to gather background information on participants was undertaken concurrently following standard survey design principles. Extensive piloting of both parts of the survey was undertaken on the target population.

The DCE survey was administered to all eligible junior doctors over a six-month period. In order to protect against model estimation problems due to insufficient information, data were collected for choice tasks both with and without an opt-out option. An exploratory analysis of the results was first undertaken, followed by more sophisticated modelling in order to explore heterogeneity of preferences. The relative impact of different attributes was assessed using welfare estimates and probability analysis, with the latter used to simulate the uptake of public sector posts under different policies.

The final research component combined the DCE results and local cost data in an economic evaluation of the costs and consequences of different specialty training policies. The outcome in this analysis was retention in the public sector measured in doctor- and specialist-years. The effectiveness measures were predicted job uptake rates from the DCE results. Costs were estimated through collection of local expenditure data on the training and employment of doctors. As outlined in chapter 3, several studies have combined DCE results with cost data to investigate the cost-effectiveness of different policy options (Chomitz, Setiadi et al. 1998, Vujicic, Alfano et al. 2010a, Rao, Shroff et al. 2012), although only one to my knowledge has done so as part of a formal decision analytical modelling framework (Lagarde, Blaauw et al. 2012). The CEA here follows the approach taken in this study.

Table 5.1 describes the study population, type of data and main analytic approach for each research component, as well as the objective(s) to which each component contributes and the associated thesis chapter.

5.4 TARGET POPULATION AND SAMPLE SIZE CONSIDERATIONS

The target population for this research was Malawian junior doctors, i.e. those within seven years of graduation. At the time of data collection, this comprised all COM graduates between 2006 and 2012. We excluded those doctors who had completed any part of their undergraduate training outside Malawi, as their preferences may be systematically different to those who had undertaken exclusively domestic training.

Table 5.1 Description of research components

COMPONENT	STUDY POPULATION	DATA	ANALYSIS	OBJECTIVE & CHAPTER
Tracing study	All Malawian medical graduates between 2006 and 2012	→Current location, job, and sector of graduates →Proportion in specialty training and funder	→ Descriptive analysis of graduate locations →Comparison with previous studies →Regression analysis of location and available personal characteristics	(i), (ii), (iv) Chapter 6
Semi-structured interviews	→ Target population → Emigrant doctors → Doctors in other sectors → Key informants	→Views on current incentives and specialty training →Reasons for emigration	→Directed thematic analysis to select attributes and levels for DCE →Assessment of heterogeneity in target population	(i), (iii) Chapter 7
DCE	All Malawian medical graduates between 2006 and 2012 in Malawi and not in specialty training	→ Unforced choice data → Forced choice data	→Attribute preferences and subgroup analysis →Welfare estimates →Policy simulations	(iii), (iv) Chapter 8
Cross-sectional survey	All Malawian junior doctors within seven years of graduation who are in Malawi and not in specialty training	→ Personal characteristics →Attitudes towards specialty training →Employment history	→Descriptive analysis of junior doctor population →Descriptive analysis of specialty training preferences → Heterogeneity variables for DCE analysis	(i), (iii) Chapter 8
CEA	Malawian medical graduates over a 40 year time horizon	→Predicted probabilities of job uptake from DCE →Local cost data	→ Distributions over time horizon → Incremental cost-effectiveness ratios → Cost-effectiveness acceptability curves →Cost-effectiveness acceptability frontiers → Subgroup analysis	(iv) Chapter 9

At the time of the planned administration of the DCE (September 2012 – March 2013), COM registry data showed a total of 256 graduates who met these criteria (Table 5.2). This was a relatively small pool of potential participants, although in line with previous DCEs in LMIC (Mandeville, Lagarde et al. 2014). Given that Malawi is a small country with a limited number of health facilities, it seemed feasible to aim for a complete census of eligible participants, thus rendering the use of any sampling strategy unnecessary.

Table 5.2 Number of Malawian COM medical graduates by year, 2006 – 2012

Year	**Number of COM medical graduates**
2006	24
2007	35
2008	44
2009	33
2010	42
2011	31
2012	47
Total	**256**

Source: *COM registry data*

Small numbers of participants can lead to difficulty in model estimation. Although sample size calculations have been developed for choice-based models (Ben-Akiva and Lerman 1985, Louviere, Hensher et al. 2000), these are rarely employed in place of 'rules of thumb' based on modelling experience (Hensher, Rose et al. 2005). These suggest a minimum of 20 participants per version (Lancsar and Louviere 2008), 30 per subgroup (Ryan, Kolstad et al. 2012), or 50 per subgroup (Hensher, Rose et al. 2005). Simulations of sample sizes of 25 to 1000 from the same dataset show that the precision of estimates increases rapidly up to 150 participants, with little marginal value above 300 (Johnson, Lancsar et al. 2013). The advent of efficient designs, however, has decreased the sample size required to reliably estimate model parameters for a particular design and made these minima less relevant (Choicemetrics Pty Ltd 2014). Therefore, although the small population was a concern, it was unlikely to prevent basic model estimation. More recent guidance, however, does point out the risk of under-powered studies leading to Type II error for small effects (de Bekker-Grob, Donkers et al. 2015). The DCE design process was therefore embarked upon with an awareness of the constrained study population (described in Chapter 7).

5.5 COUNTRY CHOICE AND RESEARCH TEAM

The choice of Malawi for this research topic was based on my personal and professional connections to the country. I was born in a mission hospital in Nkhoma when my father was working for the Malawian government in the 1980s. Returning later to the country after training as a doctor, I established contacts within COM as part of an initiative to support disadvantaged students there. This became Medic to Medic, a UK-based charity, that sponsors healthcare students at greatest risk of dropping out (such as those from rural areas). As these students started to graduate, there were repeated calls to fund specialty training due to reported difficulty in accessing government training places. This apparent discrepancy between demand and supply, against a history of high emigration of doctors and considerable investment in training, led me to select this area for the focus of my thesis. As the research question took shape, I approached Professor Adamson Muula at COM to be my Malawian-based supervisor due to his research record in this area. Other key members of the Malawi team were my survey assistants, Drs Godwin Ulaya and Lyson Gwesele. Both were COM graduates and their connections proved particularly useful to access participants. Finally, in order to ensure that the research was informed by the current and future policy environment in Malawi, I also asked the Deputy Director of Clinical Services in the Ministry of Health at that time, Dr Titha Dzowela, to be part of my advisory committee.

5.6 ETHICAL CONSIDERATIONS

Ethics approval for this programme of work was obtained from the research ethics committees of LSHTM (6042 – Appendix E) and COM (P.09/11/1129 – Appendix F). Appendix G includes the information sheet and consent form used for the survey, both in English and Chichewa (the dominant local language in Malawi). To compensate for their time and inconvenience, participants were offered a small medical textbook.

5.7 CONCLUSIONS

This chapter has outlined the conceptual framework and study design underpinning this thesis. The next chapter describes the first stage of this research programme: identifying the study population.

6 SAMPLING FRAME

6.1 OVERVIEW

The first stage of the research programme was to construct a comprehensive sampling frame of the target population. Initial attempts to do so using routine data held by COM and MOH were unsuccessful. It quickly became apparent that the administrative data available were incomplete, out of date and often contradictory. Moreover, neither institution had a record of graduates that had left Malawi outside of a government-funded training programme. In order to accurately identify the target population, a *de novo* tracing study would need to be carried out.

A retrospective cohort study was therefore undertaken to ascertain the current location of all 2006 – 2012 graduates and any eligibility restrictions. Official records were triangulated against information gleaned through the alumni network, accessed through my Malawi-based research team. Where necessary, graduates were contacted directly using a combination of telephone, email and also social networking sites. Although facilitated by the small number of graduates in Malawi, this innovative approach enabled tracing of nearly all doctors in the target population and could be applied in other contexts with similarly weak monitoring systems (Mullan, Frehywot et al. 2011).

The comprehensiveness of the data gained through this process enabled an examination of the retention rates of junior doctors, both in Malawi and in the public sector. It also permitted a partial assessment of the effectiveness of policy measures implemented in the last decade to retain medical graduates, including the establishment of specialty training at COM (Zijlstra and Broadhead 2007) and, for the first time, the financial incentives introduced under EHRP (Management Sciences for Health 2010). In this way, this chapter contributes to the first research objective of identifying the key factors influencing Malawian junior doctors to leave the public sector and fulfils the second objective of investigating the retention of Malawian junior doctors between 2006 and 2012. As will be seen in Chapter 9, these data also helped to populate the Markov model in the cost-effectiveness analysis, thus contributing to the final objective.

This study has been published in Tropical Medicine and International Health (Mandeville, Ulaya et al. 2014), and is presented in this format here.

6.2 RESEARCH PAPER

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Principal Supervisor	Kara Hanson
Thesis Title	Train to retain: the role of specialty training in stemming Malawi's medical brain drain

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Early career retention of Malawian medical graduates: a retrospective cohort study

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Abstract OBJECTIVE There have been longstanding concerns over Malawian doctors migrating to high-income countries. Early career is a particularly vulnerable period. After significant policy changes, we examined the retention of recent medical graduates within Malawi and the public sector.

METHODS We obtained data on graduates between 2006 and 2012 from the University of Malawi College of Medicine and Malawi Ministry of Health. We utilised the alumni network to triangulate official data and contacted graduates directly for missing or uncertain data. Odds ratios and chi-squared tests were employed to investigate relationships by graduation year and gender.

RESULTS We traced 256 graduates, with complete information for more than 90%. Nearly 80% of registered doctors were in Malawi (141/178, 79.2%), although the odds of emigration doubled with each year after graduation (odds ratio = 1.98, 95% CI = 1.54–2.56, $P < 0.0001$). Of the 37 graduates outside Malawi (14.5%), 23 (62.2%) were training in South Africa under a College of Medicine sandwich programme. More than 80% of graduates were working in the public sector (185/218, 82.6%), with the odds declining by 27% for each year after graduation (odds ratio = 0.73, 95% CI = 0.61–0.86, $P < 0.0001$).

CONCLUSIONS While most doctors remain in Malawi and the public sector during their early careers, the odds of leaving both increase with time. The majority of graduates outside Malawi are training in South Africa under visa restrictions, reflecting the positive impact of postgraduate training in Malawi. Concerns over attrition from the public sector are valid and require further exploratory work.

keywords human resources for health, retention, medical education, Malawi, doctors, health policy

Introduction

There have been longstanding concerns over the migration of Malawian medical doctors to high-income countries (Muula & Broadhead 2001; Broadhead & Muula 2002; Joint Learning Initiative 2004; Record & Mohiddin 2006; Muula & Panulo 2007; Mills *et al.* 2011). In the past, medical students were sent abroad for training, most commonly to the United Kingdom, South Africa and Australia (Muula & Broadhead 2001; Broadhead & Muula 2002). The finding that a large majority were remaining outside Malawi after completion of training combined with continuing reliance on Western doctors to staff key clinical services led to the establishment of the first medical school in Malawi in 1991 (Muula & Broadhead 2001; Broadhead & Muula 2002; Zijlstra & Broadhead 2007). The curriculum at the University of Malawi College of Medicine (COM) had an emphasis on community health, aiming to sensitise students to conditions facing the majority of Malawi's population (Muula & Broadhead 2001; Broadhead & Muula 2002; Zijlstra & Broadhead 2007; Mullan *et al.* 2010). Since then, the number of graduates has increased gradually from 12 in 1992 to 47 in 2012 (Zijlstra & Broadhead 2007). However, the retention of Malawi-trained graduates in Malawi has not been a resounding success. A tracing study in 2006 found that 40% of all graduates since 1991 were working or training abroad, with nearly half in the United Kingdom (Zijlstra & Broadhead 2007). This echoes findings from other sub-Saharan countries (Hagopian *et al.* 2004; Mullan 2005; Clemens & Pettersson 2008), with a 2013 study finding emigration of doctors to the United States from a number of sub-Saharan African countries had risen over the last decade (Tankwanchi *et al.* 2013).

In 2004, the assessment from Malawi's Ministry of Health (MoH) that the health worker situation was 'critical [and] dangerously close to collapse' led to a 6 year Emergency Human Resources Programme with major support from development partners (McCoy *et al.* 2008; Management Sciences for Health 2010). The ratios of health workers to population at that time were some of the worst in the world, with only 1.1 doctors per 100 000 people. Of the then 27 districts in Malawi (now 28), ten were without a MoH doctor and four without any doctor at all (Ministry of Health 2004). The goal of the programme was to increase levels of key health professionals to those of neighbouring Tanzania. Implemented measures included a 52% salary top-up (nearer 30–35% after tax), other financial incentives such as continuation of free accommodation and transport to work (although a planned rural bonus was never implemented) and tripling the number of medical students at COM (Palmer 2006; Manafa *et al.* 2009; Management Sciences for Health 2010). These incentives were offered to all doctors employed in the public sector, and the entire programme costs approximately USD 30 million for all targeted health workers (Management Sciences for Health 2010). A final evaluation of the programme in 2010 determined that if all doctors trained had remained in the country, the doctor-to-population ratio should now be just below that of Tanzania at 2.03 per 100 000. No data were available at that time, however, to assess emigration of doctors (Management Sciences for Health 2010).

Another major policy change in 2004 was the introduction of postgraduate training at the now well-established COM, again with support from development partners (Zijlstra & Broadhead 2007). This is a 4-year Master of Medicine (MMed) degree that qualifies the candidate for registration as a specialist with the Medical Council of Malawi. In 2013, there were 27 specialist trainees enrolled across six specialties. For most specialties, this training is undertaken as a two-part 'sandwich' programme: candidates initially work in Malawi for at least 2 years and then spend 18–24 months in South Africa to broaden trainees' experience (Zijlstra & Broadhead 2007; Sawatsky *et al.* 2014). Moreover, visa restrictions negotiated with the South African authorities impede overstay of specialist trainees after their period of training, thus encouraging the return of trainees to Malawi (Zijlstra & Broadhead 2007). Other sub-Saharan African countries such as Kenya and Tanzania also receive trainees, who complete all training in these countries without any bilateral agreements.

In the light of these significant changes in the educational and working environment of Malawian doctors, it is a pertinent time to update the 2006 tracing study by investigating the location of recent graduates (Zijlstra & Broadhead 2007) by investigating the location of recent graduates. Early career has been shown to be one of the most vulnerable times for migration of health professionals, with older graduates more effectively retained by 'stick' factors such as career establishment, assets acquirement and marriage that overcome strong push or pull factors for migration (Padarath *et al.* 2003; Mandeville *et al.* 2012; Tjadens *et al.* 2012). We examined the retention rate of Malawian doctors who graduated between 2006 and 2012.

Overview of the health and medical education systems in Malawi

The provision of public health services is split two to one between the MoH and the Christian Health Association of Malawi (CHAM) a coalition of church organisations (Management Sciences for Health 2010). The Ministry of Health pays all staff salaries for Malawian nationals in CHAM facilities to facilitate the provision of health services in rural areas, where 84.0% of the population reside (2012 data, Global Health Observatory 2011). There are two major hospitals (Queen Elizabeth Central Hospital in Blantyre and Kamuzu Central Hospital in Lilongwe), two other tertiary hospitals (Mzuzu and Zomba Central Hospitals), 27 district hospitals and 23 CHAM hospitals.

After 5 years of medical education, graduate doctors must complete an 18-month internship at either of the two major hospitals to be eligible for registration with the Malawi Medical Council. They are then allocated to a district as a district medical officer (DMO, supervising clinical care at district hospitals) or the more senior district health officer (DHO, responsible for district health programmes). Alternatively, they remain in tertiary hospitals as medical officers attached to a specialty department (Zijlstra & Broadhead 2007). After registration, doctors are able to work outside MoH facilities, for example for CHAM, non-governmental organizations (NGO), private companies or research organizations.

Methods

Data collection

Data were collected as part of a research programme on the effectiveness of incentives to retain doctors in

Malawi. For the purposes of this study, we sought information on four variables: (i) current job; (ii) location; (iii) currently in postgraduate training; and (iv) if so, funder of training. For a fifth variable, sector of work, we categorised participants based on their current job or postgraduate funder from the following: government, CHAM, research or teaching institutions, private organisations or NGO.

The COM Registry provided the names of those who graduated between academic years 2006 and 2012. As our primary interest was retention of Malawian graduates within Malawi, we excluded those graduates who were not Malawian citizens. We also excluded those who completed some or all of their undergraduate training outside Malawi as their career choices after graduation might differ systematically from those training in Malawi.

We reviewed three sources of secondary data to build up information on graduates: current location of all doctors in government jobs (provided by MoH), doctors in postgraduate training funded by government scholarships (MoH) and doctors registered for a COM postgraduate degree (COM).

As the first two data sets were found to be affected by time lags in updating official information, we triangulated these sources with information known to the research team through the alumni network. The alumni network for this cohort is very small, with an average of 37 graduates per year, and includes two members of the research team.

Finally, for those variables where there was a level of uncertainty or no information available, we contacted graduates directly through a combination of telephone, email and social networking sites using contact details obtained through the alumni network. For those graduates who did not reply, we collected data by proxy by questioning peers in the same year and triangulating amongst responses.

Participants

There were 276 Malawian graduates from COM between 2006 and 2012, with a mean of 36.6 per year. We excluded 15 graduates (5.4%) as non-Malawian citizens and five (1.8%) who completed some undergraduate training outside Malawi (Figure 1). Of the 256 remaining graduates, of whom 36.3% were female (93/256), we directly contacted 54 (21.1%) to verify uncertain variables or obtain missing data. Complete information (data on all five variables) was obtained for more 91.0% (233/256) and at least partial (four or fewer variables) for all graduates. Missing data largely pertained to funder of postgraduate training and associated sector of work (Table 1). Data on graduates were obtained directly for 93% (237/256) and by proxy for 7.1% (18/256). There were no deaths reported in this cohort.

Data analysis

Data were entered and cleaned in Microsoft Excel 2010. Due to the small numbers involved, some results have been aggregated into larger categories or not specified if less than five to preserve participant anonymity. For the purposes of this analysis, we aggregated government and CHAM into 'public sector'. Pre-specified statistical tests were carried out in Stata version 12.0, including logistic regressions to analyse trends by year of graduation and chi-squared tests to examine outcomes by gender.

Ethics approval

Ethics approval was obtained from the COM Research and Ethics Committee of the University of Malawi and the London School of Hygiene and Tropical Medicine.

Results

Eight-five percentage of recent graduates (218/256, 85.2%) were still in Malawi (Figure 1). If we exclude interns due to the mandatory period within Malawi to register with the Malawi Medical Council, then nearly 80% (141/178, 79.2%) of registered medical practitioners are still in Malawi. Only seven graduates (7/256, 2.7%) were outside Africa, with fewer than five in the UK/USA. Overall, fewer than five graduates were working outside of Malawi and not in postgraduate training (<5/256, <2.0%).

Of the 30 graduates in other sub-Saharan African countries (30/256, 11.7%), three quarters (23/30, 76.7%) were undertaking the South African component of their MMed postgraduate training. Fewer than five graduates (<5/30, <16.7%) were training in sub-Saharan African countries without visa restrictions. The odds of a doctor being outside Malawi doubled for each year after graduation (odds ratio (OR) = 1.98, 95% confidence intervals (CI) = 1.54–2.56, $P < 0.0001$, Table 1); however, these odds fell if those training in South Africa are excluded (OR = 1.45, 95% CI = 1.06–2.00, $P = 0.021$).

Nearly 85% of recent graduates were working or training in the public sector in Malawi (185/218, 84.9%). The odds of a doctor working in the public sector declined by 27% for each year after graduation (OR = 0.73, 95% CI = 0.61–0.86, $P < 0.0001$, Table 1). The largest attrition from the public sector (MoH or CHAM) within

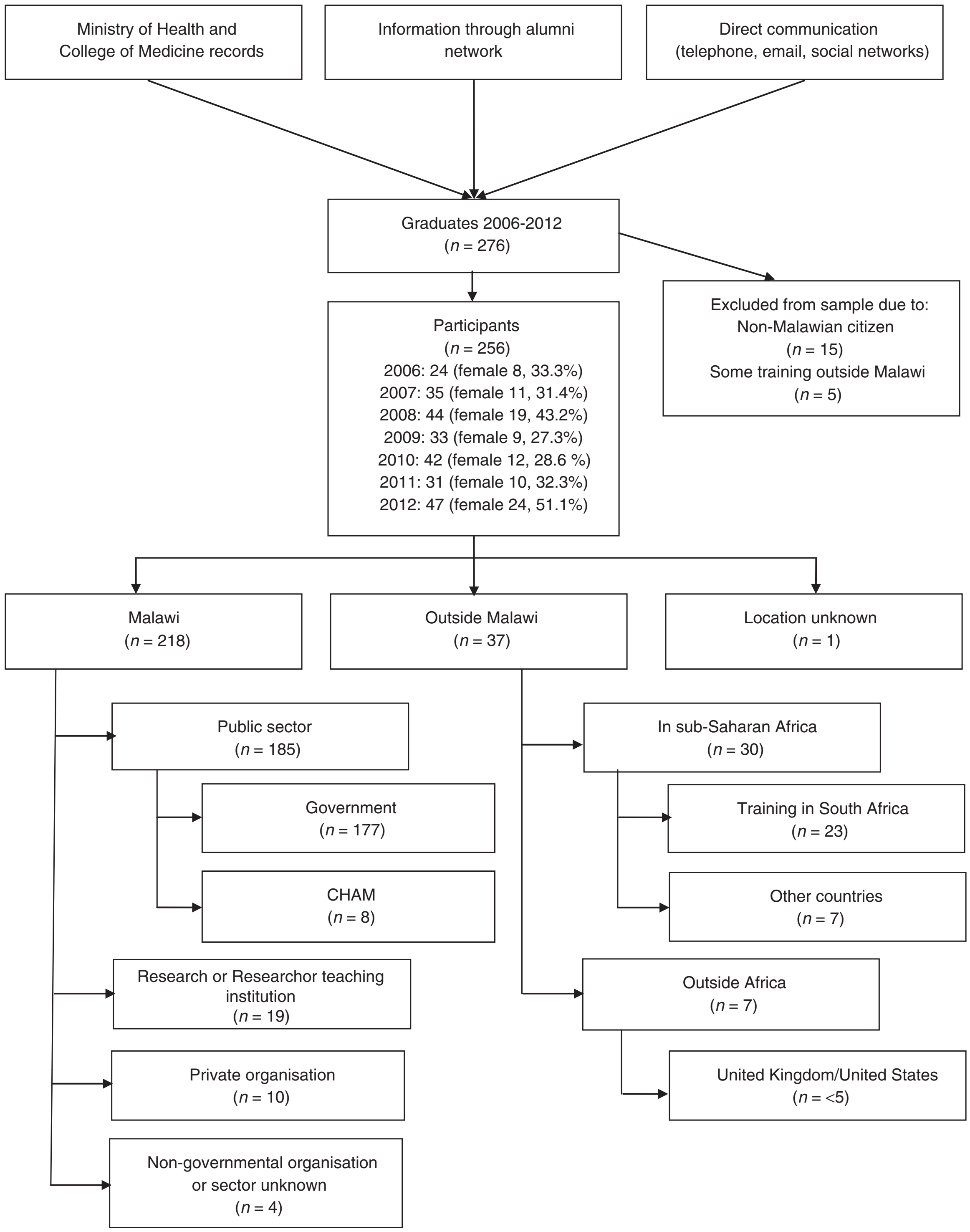

Figure 1 Flow of participants through study and overall distribution of graduates.

Table 1 Distribution of graduates by year

Year	Graduates (n)	In Malawi		Outside Malawi (%)	In postgraduate training (%)	Training in South Africa (%)
		Public sector (%)	Rural areas (%)			
2006	24	13 (54.2)	5 (20.8)	9 (37.5)	14 (58.3)	7 (29.2)
2007	35	15 (42.9)	<5 (<14.3)	12 (34.3)	22 (62.9)	9 (25.7)
2008	44	28 (63.6)	12 (27.3)	8 (18.2)	27 (61.4)	6 (13.6)
2009	33	24 (72.7)	11 (33.3)	6 (18.2)	15 (45.5)	1 (3.0)
2010	42	30 (71.4)	17 (40.5)	<5 (<11.9)	5 (11.9)	0
2011	31	28 (90.3)	10 (32.3)	0	0	0
2012	47	47 (100)	0	0	0	0
Total	256	185 (84.9)	<60 (<23.4)	<40 (<15.6)	83 (32.4)	23 (9.0)
Missing data*		5 (2.0)		1 (0.4)	1 (0.4)	

Categories are not mutually exclusive. Row percentages refer to number of graduates for that year, except for missing data which is out of total number of graduates. *Other missing data: Current job = 4 (1.6%); Funder of postgraduate training = 18 (7.0%).

Malawi was to research organisations, with one in 12 graduates working as research officers (18/218, 8.3%). Ten graduates (4.6%) were working for private facilities or commercial organizations and fewer than five (<5/218, 2.3%) for non-governmental organisations (Figure 1). Men were no more likely to be working outside the public sector than women (16.6% *vs.* 12.3%, OR 1.41, 95% CI 0.67–3.02, $P = 0.374$).

Figure 2 maps the distribution of 2006–2012 graduates working at district level. While pre-2006 graduates would also be working at district level, 21 doctors from this cohort were working as DHOs and 30 as DMOs, with seven district hospitals benefitting from two graduates as DMOs. If we define an urban location as any of the four major cities in Malawi (Lilongwe, Blantyre, Mzuzu or Zomba) and a rural location as elsewhere, as well as exclude interns due to their mandatory training at the two urban teaching hospitals, then nearly a third of recent graduates (27.5%, 57/207) in Malawi are based in rural areas (Table 1). Men were significantly more likely to be based in rural areas compared to women (34.3% *vs.* 12.5%, OR= 3.67, 95% CI 1.73–7.74, $P = 0.0002$).

Overall, one third of graduates were in postgraduate training (83/256, 32.4%), with doctors twice as likely to be in training for every year after graduation (OR = 2.18, 95% CI = 1.78–2.68, $P < 0.000$, Table 1). Over half of graduates in training (55.4%, 46/83) were on government scholarships, either funded directly by the Malawian government or by development partners. One in 10 trainees (9/83, 10.8%) were self-funding or had procured private scholarships, including all graduates training outside Africa. Eight trainees (9.6%, 8/83) were being sponsored by CHAM or research organisations, with no trainees funded by private organisations. The odds of being in training were not significantly different between graduates in the public or other sectors (30.6% *vs.* 29.6%, OR = 1.05, 95% CI 0.49–2.26, $P = 0.904$). Those on government scholarships were less likely to be from.

Discussion

We traced 256 doctors from a seven-year cohort of graduates at Malawi's only medical school, finding that nearly 80% of registered doctors were located in Malawi. The odds of emigrating, however, doubled for each year after graduation. Of the graduates outside Malawi, over four fifths were in postgraduate training with over 60% in South Africa. Over 10% of postgraduate trainees were self- or privately funded, including all those training outside Africa. Within Malawi, 85% of graduates were working in the public sector. The odds of leaving the public sector increased with time, with the largest attrition to research organisations. Graduates were well distributed at district level, with all districts being served by at least one recent graduate.

There is a high retention of medical graduates in Malawi during the early part of their career. This study refutes findings from a survey of medical students at COM in 2008 that found nearly 40% of medical students intended to work or train outside Malawi soon after graduation (Mandeville *et al.* 2012) and corroborates a general perception of fewer doctors emigrating identified through qualitative work (Bailey *et al.* 2012). It also contrasts with findings from other sub-Saharan countries, where graduates between 2005 and 2008 stayed on average just 1.3 years in their country of training before emigrating to the USA (Tankwanchi *et al.* 2013).

While retention soon after graduation was high, the odds of emigration increased with time. This may reflect

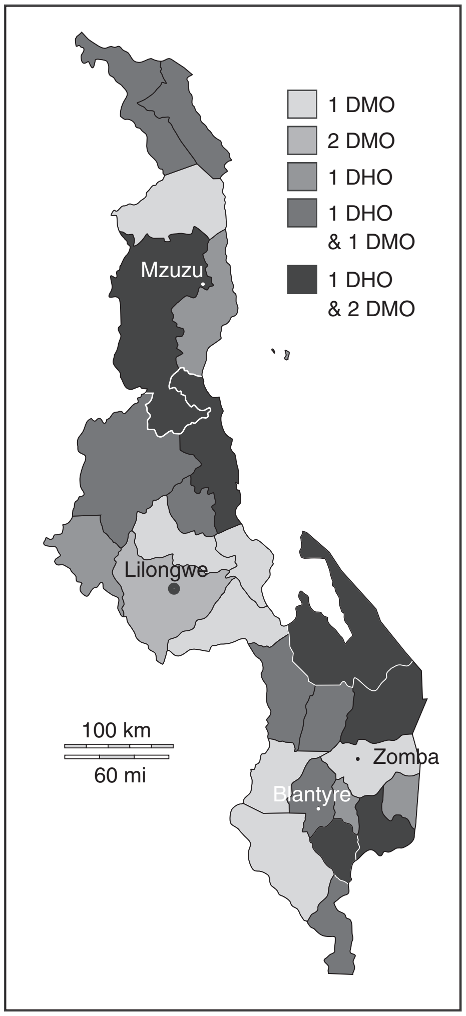

Figure 2 Distribution of graduates working at district level. Map denotes districts of Malawi. DMO, District Medical Officer; DHO, District Health Officer.

growing disillusionment as work experience increases or the time required to identify opportunities outside of Malawi. There is reason to believe, however, that the current trend is less pessimistic than first appears. The largest group of graduates outside Malawi were those training in South Africa as part of the COM sandwich programme, with bilateral agreements in place to encourage return to Malawi, and fewer than five graduates were in the United Kingdom or United States. This is a more positive situation than previously and provides support for the positive impact of the COM postgraduate training programme. In comparison, the study by Zijlstra and Broadhead (Zijlstra & Broadhead 2007) traced all graduates from 1991 to 2006. While retention rates by year of graduation were not available, they found 59.7% of registered doctors (123/206) in Malawi, with a third of emigrants unlikely to return (28.9%, 24/83) and nearly half in the United Kingdom (40/83, 48.2%). Further follow-up of the cohort studied here is required to ascertain whether emigration continues to rise with age and whether training in Malawi or sub-Saharan Africa decreases the likelihood of emigration after completion of specialist training.

The importance of postgraduate training is underlined by one third of early graduates being in training, with doctors twice as likely to be in training for every year after graduation. Specialisation is seen as integral to career progression by medical students and early graduates both in Malawi (Bailey *et al.* 2012; Mandeville *et al.* 2012) and other sub-Saharan African countries (Burch *et al.* 2011), with the quality and availability of postgraduate training a primary concern (Burch *et al.* 2011; Bailey *et al.* 2012; Sawatsky *et al.* 2014). There has been some increase in the number of government scholarships: one pooled funding scheme (the National AIDS Commission) provided 5 years of continuous scholarships, and new funding has been obtained for obstetrics and gynaecology and surgery training. Yet postgraduate training has not kept pace with the expansion in medical student numbers under the Emergency Human Resource Programme (Management Sciences for Health 2010). In a vacuum of training opportunities in the public sector, graduates are likely to look elsewhere for funding (Bailey *et al.* 2012). One in 10 postgraduate trainees was self-funding or on private scholarships, including all those who were training outside Africa. Some may have deliberately sought to train outside Africa, with ambiguous feelings held towards the COM postgraduate programme by medical students (Sawatsky *et al.* 2014) and nearly 90% intending to specialise abroad (Yeganeh-Arani *et al.* 2012). Yet it is likely that some graduates, who would have preferred to have trained within Malawi, were unable to do so due to difficulty in obtaining government scholarships. A whole-career approach should be taken to medical training with postgraduate training increased proportionally to pre-service training (Mullan *et al.* 2010; Greysen *et al.* 2011), in order to maximise the return on government investment into medical education (previously estimated at USD57 000 per doctor) (Muula & Panulo 2007).

Concerns over graduates leaving the public sector have some basis, however, with the odds of attrition increasing with time after graduation. Possible reasons include differences in remuneration, prospects of postgraduate training scholarships, working conditions or career progression. Salaries are certainly higher in other sectors (Muula & Maseko 2005; McCoy *et al.* 2008), and those working for research or private organisations in this cohort earned three times the salary of graduates in the public sector with a mean of MK344 000 per month [USD869] *vs.* MK114 000 [USD288] (unpublished data Mandeville, KL). This takes into account the salary top-up under the Emergency Human Resources Programme, but not free housing/transport or supplements such as *per diems* for meeting attendance. Yet previous qualitative work found little interest in working for non-governmental or private sector organisations amongst Malawian medical students and interns, with a perception of 'being better looked after' in the public sector (Bailey *et al.* 2012). For example, private sector employees are not eligible for government training scholarships: making the public sector attractive as a route towards professional development (Muula & Maseko 2005; Sawatsky *et al.* 2014). Although no private organisations were funding trainees in this cohort, we actually found that graduates in other sectors were no less likely to be in training than those in the public sector. Further qualitative work is required to delineate the reasons behind this movement out of the public sector.

Research organisations were the largest absorber of graduates leaving the public sector, compared to private or non-governmental organisations. While such jobs may be time limited and confer important additional skills, graduates may be 'poached' during a period where the government is still recouping their investment into training through public sector service. There may, of course, be later re-entry into the public sector, although it has been reported that there are barriers to such re-employment in Malawi (Muula & Maseko 2005). Furthermore, while more graduates leave the public sector with time, attrition may tend towards a steady state: Zijstra and Broadhead also found 79.6% (98/123) of graduates working for the public sector over a 15-year period (Zijlstra & Broadhead 2007).

Nearly a third of recent graduates are based in rural areas, compared to 18.3% of all registered doctors in Malawi in 2009 (Africa Health Workforce Observatory 2009). While previously doctors at district level were few and usually working in isolation (Muula & Maseko 2005), now six districts have a team of one DHO and two DMOs from recent graduates alone. It appears that the policy of posting newly registered doctors to districts has achieved good coverage of rural areas by recent graduates, despite the lack of rural allowances (Management Sciences for Health 2010). Yet the majority of recent graduates are still concentrated in the two major hospitals, where most specialists and training capacity reside. As the number of specialists increases, an active policy of building up the training capacity of the smaller central hospitals to continue redistribution of graduates outside the two major cities will be important. Women were significantly less likely to be working in rural areas than men, which is corroborated by findings from rural practice in other countries (Laven & Wilkinson 2003; Matsumoto *et al.* 2008). This may reflect demand or supply side gender bias, with women less likely to be allocated to rural areas, more likely to petition to remain in urban areas or more likely to leave rural jobs than men.

These results strengthen a field characterised by a paucity of research, with 47 of 58 sub-Saharan African medical schools reporting no formal tracking of graduates (Mullan *et al.* 2010). While some sub-Saharan countries utilise medical registration and licensing requirements as a tracking mechanism, these systems suffer from a lack of enforcement, impeding accurate follow-up (Chen *et al.* 2014). To overcome the fragmented health workforce records found in many low-resource settings (Riley *et al.* 2012; Chen *et al.* 2014), we cross-validated official records with more current information obtained through the alumni network. This enabled us to build up a comprehensive database on recent graduates, with complete information for over nine in 10 graduates and at least partial information on all graduates. There is a risk that the alumni data could be less accurate than official records; however, these were triangulated between two researchers who interact with the alumni community daily and graduates were contacted directly if there was any uncertainty. Moreover, it would be short-sighted to favour official records in a weak institutional environment over the real-time information based on natural social groupings provided by networking sites such as Facebook. Indeed, the power of social media is being harnessed for information gathering and dissemination in many areas of health policy (Merchant *et al.* 2011; Thackeray *et al.* 2012; Mandeville *et al.* 2014), and five sub-Saharan African medical schools are now using social media to maintain contact with graduates (Chen *et al.* 2014). We report here a low-cost yet effective method for tracking graduates that leverages the strengths of a small alumni community, which could be considered in similar settings in order to obtain timely data to inform health workforce policy.

Limitations of our design include the lack of data collected on sociodemographic variables, which may influence later career choices. For example, a study following up the first 22 years of graduates over 22 years from Nepal's public medical school found that a rural birthplace was associated with work in rural areas and paramedical training before medical school was significantly associated with lower migration outside Nepal (Zimmerman *et al.* 2012). We also could have followed up a larger cohort of graduates in order to capture more graduates undertaking and completing specialist training. However, this would have lost the homogeneity of experience in terms of training and working environment that allows us to draw tentative conclusions on migration decisions in the absence of period effects. While obtaining data through proxies may be criticised for possible inaccuracy, this was required for less than one in 10 graduates and is a pragmatic approach employed by other studies in low-resource settings (Zimmerman *et al.* 2012). Finally, this study reflects just one point in time, whereas the job choices of graduates are likely to be dynamic, particularly during early career. Further follow-up of this cohort would enable investigation of movement between sectors, including the rate of return after completion of training.

Conclusions

While most doctors remain in Malawi and the public sector during their early career, the odds of leaving both increase over time. The majority of those outside Malawi are training as part of a sandwich programme, reflecting the positive impact of postgraduate training in Malawi. Postgraduate training capacity should be increased proportionally to undergraduate training. Concerns over attrition from the public sector are valid, requiring further exploratory work.

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Corrigendum

Please note two corrections in Mandeville *et al.* (2014). Early career retention of Malawian medical graduates: a retrospective cohort study. *Tropical Medicine and International Health* 20(1), 106–114.

A label in the Figure 1 flowchart was incorrect. It should read “Research or teaching institution (n = 19)”.

On Page 5, at the end of the first paragraph in the second column of text the sentence “Those on government scholarships were less likely to be from.” should have been removed.

6.3 CONCLUSIONS

The findings reported in this chapter had several implications for this thesis. Of note, fewer junior doctors than anticipated were outside Malawi, with most emigrants in specialty training. However, this proportion increased with time after graduation and an identical follow-up period for all graduates is likely to have identified higher emigration. Second, there was some basis for anecdotal reports that junior doctors are leaving the public sector, with the proportion of doctors in other sectors increasing with time after graduation. Third, a substantial minority of doctors in specialty training were self or privately funded, indicating a paucity of government-funded training places. The next chapter describes how these findings contributed to the design of the DCE survey.

7 DISCRETE CHOICE EXPERIMENT SURVEY DESIGN

7.1 OVERVIEW

As demonstrated by the systematic review reported in Chapter 3, the design stage in undertaking a DCE is crucially important. When assessed for quality, most DCEs in HRH to date have fallen down in this aspect rather than conduct or analysis. Bearing this in mind, a careful design process was embarked upon for this thesis. A narrative literature review focused on HRH issues in Malawi was conducted in order to build up specific contextual knowledge (incorporated into Chapter 4). Detailed qualitative interviews were carried out with members of the target population, doctors outside Malawi and the public sector, and a range of key informants. The initial topic guide for these interviews forms Appendix H. Recent developments in experimental design were employed to ensure high statistical efficiency in a small target population (ChoiceMetrics Pty Ltd 2012). Lastly, a two-stage pilot was conducted, first to finalise design features and then to obtain preliminary (prior) results to feed back into the design.

The design was also informed by a MSc student project that I designed and supervised during my first year of research, using a qualitative approach to explore the postgraduate career intentions of senior medical students and interns in Malawi. These results were subsequently published in BMC Medical Education (Bailey, Mandeville et al. 2012).

The design of the DCE followed best practice at that time, yet I quickly came up against limitations in the available guidance (Coast and Horrocks 2007, Lancsar and Louviere 2008, Ryan, Gerard et al. 2008, Bridges, Hauber et al. 2011, Coast, Al-Janabi et al. 2012, Ryan, Kolstad et al. 2012, Johnson, Lancsar et al. 2013). For example, a linear process with discrete stages is commonly described in the literature, yet the reality is actually highly iterative with overlapping stages. A mixed-methods approach to DCE design is advocated by many researchers (Ryan and Gerard 2003, Lancsar and Louviere 2008, Bridges, Hauber et al. 2011), however existing guidance continues to assert the primacy of particular aspects or approaches (Louviere and Lancsar 2009, Coast, Al-Janabi et al. 2012). This results in the lack of a cross-disciplinary framework to guide new researchers in the resolution of competing design demands. For example, to what extent should respondent efficiency (the extent to which choices made by participants reflect their actual preferences) be balanced against model identification (the ability to obtain unbiased estimates for all parameters) or statistical efficiency (the precision of these estimates).

In order to both justify the design decisions taken for this DCE and critique the prevailing model exemplified by this guidance, the design process is described in detail in this chapter. This contributes to the first research objective of identifying the key factors influencing Malawian junior doctors to leave the public sector and also forms the preliminary work for the third objective of quantifying the preferences of junior doctors for specialty training. This work has been written up as a paper, but is not currently submitted to a journal. References are included as part of the final bibliography.

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Student	Kate Mandeville
Principal Supervisor	Kara Hanson
Thesis Title	Train to retain: the role of specialty training in stemming Malawi's medical brain drain

If the Research Paper has previously been published please complete Section B, if not please move to Section C

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Where is the work intended to be published?	Health Economics
Please list the paper's authors in the intended authorship order:	Kate L. Mandeville, Adamson S. Muula, Titha Dzowela, Godwin Ulaya, Kara Hanson, Mylène Lagarde
Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I undertook the design, data collection and analysis for this work. I also wrote the first draft of the manuscript.

Student Signature: K. L. Mandeville **Date:** 10.3.2016

Supervisor Signature: K Hanson **Date:** 11/3/16

7.2 RESEARCH PAPER

From optimise to compromise: designing a discrete choice experiment to investigate the job preferences of Malawian junior doctors

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Keywords: discrete choice experiment; stated preference; scientific reporting; Research Design; Malawi; doctors

ABSTRACT

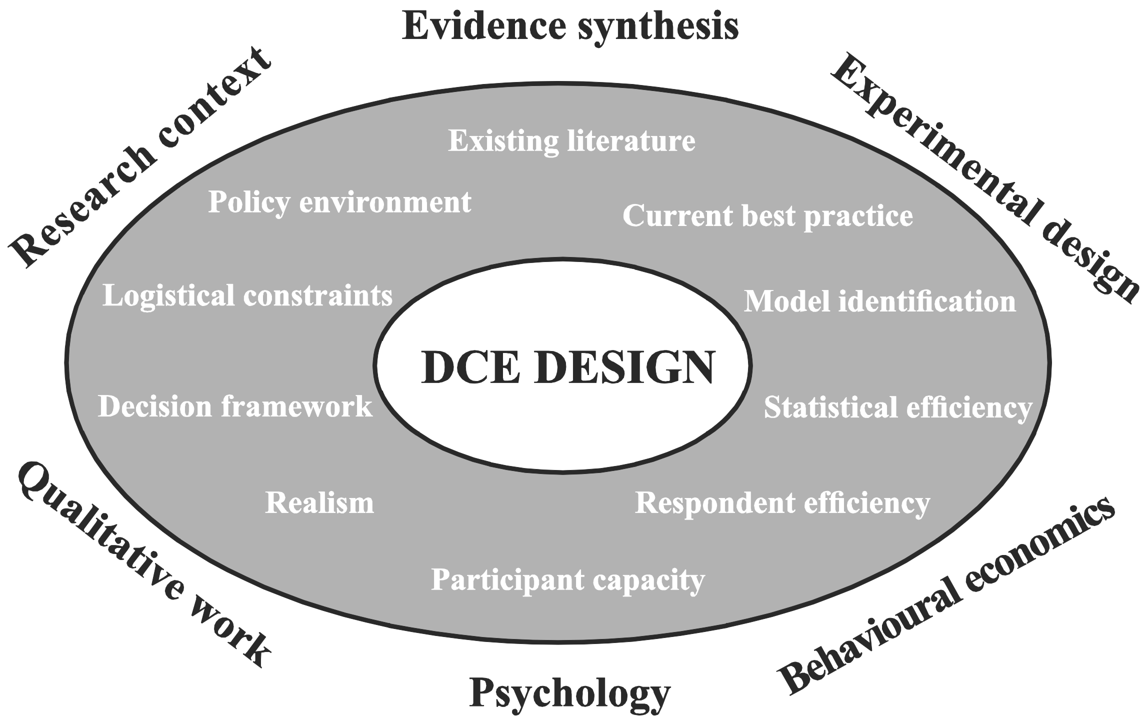
The design of discrete choice experiments is integral to the validity of their results, yet researchers have to balance a number of competing demands arising from different disciplinary influences. Existing guidance tends to represent the design process as a linear sequence of distinct steps, yet experienced researchers will be familiar with a less tidy and iterative process that seeks to reconcile these different demands. We designed a discrete choice experiment to investigate the postgraduate job preferences of junior doctors in Malawi using a combination of literature review, qualitative interviews, experimental design and piloting. A transparent description is given of the iterations and compromises necessary for the best design possible within real-life constraints. We call for fuller reporting of design processes and guidance that better reflects the compromises inherent in discrete choice experiment design.

1. INTRODUCTION

The design of a discrete choice experiment (DCE) is integral to the validity of its results. Yet this process is a complex undertaking that employs both mathematical and social sciences. In order to generate the best design possible, a researcher is likely to combine elements of experimental design, qualitative work, evidence synthesis, psychology and behavioural economics, supported by a deep understanding of the study context and policy environment (Coast and Horrocks 2007, Lancsar and Louviere 2008, Rose and Bliemer 2010, Bridges, Hauber et al. 2011, Coast, Al-Janabi et al. 2012, Kløjgaard, Bech et al. 2012, Johnson, Lancsar et al. 2013, Michaels-Igbokwe, Lagarde et al. 2014).

This multi-disciplinary input gives rise to a number of competing demands on the design process (Figure 1). In health, for example, researchers are advised to respond to policymakers' concerns by including levels implementable by policy, while retaining realism and relevance to participants (Lancsar and Louviere 2008, Ryan, Kolstad et al. 2012). DCEs should also reflect current best practice in discrete choice design, but must take into account any logistical constraints such as available resources, time or country infrastructure. They should be informed by the existing literature and consider unanswered research questions, but remain anchored in the decision framework of participants (Lancsar and Louviere 2008, Coast, Al-Janabi et al. 2012). In order to more accurately reflect this framework, researchers may decide to construct more complex designs, yet this can constrain model identification and statistical efficiency. The latter must be considered alongside respondent efficiency, whereby poor quality responses leads to measurement error through, for example, participant disengagement due to unrealistic choice tasks, low participant capacity, or decision heuristics employed due to lack of time (Louviere and Lancsar 2009, Johnson, Lancsar et al. 2013). In light of

Figure 1 Competing demands during DCE design



all these demands, it is unsurprising that the process of designing a DCE has been described as "*as much an art as science*" (Ryan, Kolstad et al. 2012).

For most researchers, the result of these tensions is an iterative process that relies on triangulation between complementary sources of information to guide a series of pragmatic compromises (Rothbauer 2008, Green and Thorogood 2009). Yet this reality is rarely acknowledged in the literature, where the design process is usually represented as a sequence of distinct stages without overlap. For example, a practical guide to conducting DCEs to inform healthcare decision making leads the reader through conceptualising the choice process, defining attributes and levels, using experimental design techniques to create choice tasks, and piloting of the resulting design (Lancsar and Louviere 2008). Similar sequences are described elsewhere (Amaya-Amaya, Gerard et al. 2008, Ryan, Kolstad et al. 2012). Even where the interconnectedness between DCE stages is recognised, little guidance is given on how to resolve conflicts between them (Bridges, Hauber et al. 2011). As a consequence, empirical studies - conscious of best practice - rarely make the iterations and compromises necessary to reconcile these competing demands explicit. The entire design process is typically relayed in a few terse paragraphs, outlining several tidy linear steps that bear little resemblance to the experience of most researchers.

This embedded disconnect between reporting and reality in DCE design has several consequences. First, it undermines the ability of the reader to evaluate the design decisions taken and the extent to which these may have influenced the validity of the results. Second, it misleads those researchers new to the field who are relying on the literature for guidance. And lastly, it prevents recognition of the burgeoning research agenda at the junctions of these disciplines that has been largely neglected up to now.

In order to illustrate a possible alternative format that transparently documents the necessary iterations and compromises, we describe the design of a DCE to investigate postgraduate job preferences of junior doctors in Malawi.

2. CONTEXT

Malawi is a low-income country with historically high emigration of doctors to high-income countries, notably the United Kingdom (UK) (Broadhead and Muula 2002, Record and Mohiddin 2006). This led to a severe shortage of medical staff, particularly in rural areas, with an estimated 2 doctors per 100,000 people in 2009 compared to 279 per 100,000 in the UK (World Health Organization 2015). To aid retention, the first medical school in Malawi was established in 1991 (Muula and Broadhead 2001, Broadhead and Muula 2002, Zijlstra and Broadhead 2007). Postgraduate (specialist) training was introduced in 2004, with training for different specialties provided all in Malawi, split between Malawi and South Africa, or entirely in South Africa (Zijlstra and Broadhead 2007, Mandeville, Bartley et al. 2012, Mandeville, Ulaya et al. 2014). Continued attrition from the public sector led to the implementation of an Emergency Human Resources Programme (EHRP) over 2004 – 2010, with funding from development partners, which tripled the number of medical students in training and doubled doctors' salaries among other incentives (Management Sciences for Health 2010). Yet junior doctors continue to emigrate, with the odds of emigrating doubling with each year after graduation (Mandeville, Ulaya et al. 2014). In light of the considerable investment into medical education in Malawi (Muula and Panulo 2007), we decided to investigate postgraduate job choices made by junior doctors in order to inform sustainable health workforce policies.

3. METHODS

In this section, we describe the mixed-method approach taken to design the DCE, with a description of the results obtained and their iterative effect on DCE design in the following section. Throughout the design process, there was discussion of the emerging results within the research team, comprising a Malawian policymaker (TD); a medical educationalist (AM); a Malawian junior doctor (GU); a British doctor in postgraduate training (KM); and two health economists experienced in DCE design (ML and KH). Ethics approval was obtained from the research ethics committees of the University of Malawi, College of Medicine and the London School of Hygiene and Tropical Medicine, with informed consent obtained from all participants.

3.1 Target population

Our target population was doctors in Malawi who had recently finished medical training (within the last seven years), but who had not yet started (i.e. made a choice over) postgraduate training. As our focus was on national retention policies, we excluded non-Malawian citizens and those who had completed any of their undergraduate training abroad (n = 20). Due to emigration, uptake of postgraduate training, and the low number of medical graduates in Malawi (mean of 37 per year in this cohort), this population was extremely constrained with only 153 doctors eligible to take part out of a total 276 graduates.

3.2 Literature review

A literature review is often conducted as part of DCE design in order to obtain contextual information and identify potential attributes and levels. To this end, we conducted a systematic review of DCEs informing health workforce policy (fully reported elsewhere) and a narrative review of literature investigating the health workforce crisis in Malawi (Mandeville, Lagarde et al. 2014).

3.3 Qualitative interviews

Qualitative work is often conducted to gain insight on the decision framework of the target population, including possible attributes and levels. We undertook semi-structured interviews over January to April 2012, purposively sampling key informants (n = 18) and members of the target population (n = 19). Key informants were identified by snowball sampling and included policymakers from the Malawi Ministry of Health (MOH), medical educationalists from the College of Medicine-University of Malawi (COM), specialist clinicians, hospital directors, and representatives of professional and hospital associations (Patton 1990). For members of the target population, initial sampling was for maximum variation in time after graduation, job role, location and gender (Patton 1990, Coast, McDonald et al. 2004). As hypotheses emerged on the main factors influencing postgraduate job choices, we sought out confirming and disconfirming cases both within and outside of the target population. These included doctors working outside the public sector (n = 4) and several doctors that had left Malawi (n = 3) (Patton 1990). Only selected personal details of participants have been reported to protect anonymity.

While the initial topic guide focused on exploring attributes/themes identified in the systematic review, this quickly evolved to questions on the specific training and working environment in Malawi. As the amount of new information began to lessen, later interviews became more structured and sought affirmation of key attributes, levels and wording (Coast and Horrocks 2007). Interviews took between one and two hours depending on type of interviewee, conducted in English by the lead author in private offices or homes, tape recorded, fully transcribed and supplemented by written notes. Data were analysed in NVivo version 10 (QSR International Pty Ltd, Doncaster).

Thematic analysis was carried out by one author, aided by discussion within the research team.

3.4 Design of choice tasks

We used a ternary generic design including an opt-out option. Five attributes, each with four levels, were included, giving 1024 possible choice profiles (4^5) and 523, 776 choice tasks (1024*1023/2) (Ryan, Kolstad et al. 2012). A D-efficient approach using the Ngene version 1.1.1 (ChoiceMetrics Pty Ltd, Sydney) was used to select 16 choice tasks. As we were uncertain what type of econometric model would be used for analysis, a basic multinominal logit model was specified in the design (ChoiceMetrics Pty Ltd 2012).

3.5 Pre-testing

Pre-testing was carried out over June 2012 in order to (i) confirm validity of the design, attributes and level range of the choice tasks, and (ii) assess usability of the accompanying questionnaire. Participants were 15 doctors who had also taken part in the interviews, so were familiar with the research objective. A concurrent think-aloud process was used, whereby participants described their thoughts as they completed the DCE and questionnaire, with prompt questions for key areas (Ericsson and Simon 1993, Kuusela and Paul 2000, Ryan, Watson et al. 2009). Wording and layout were changed iteratively between each participant. Face validity was also assessed with selected key informants and the Malawi-based research team.

3.6 Piloting

Piloting was carried out with 16 participants over three sessions in July 2012 in order to (i) confirm timing and instructions for the main survey, and (ii) obtain priors (Carlsson and Martinsson 2003, ChoiceMetrics Pty Ltd 2012). Data obtained from the pilot were dummy coded and analysed in a multinomial logit model in NLOGIT 4.0 (Econometric Software, Inc, Plainview).

4. RESULTS

4.1 Iteration 1: Refining the choice problem

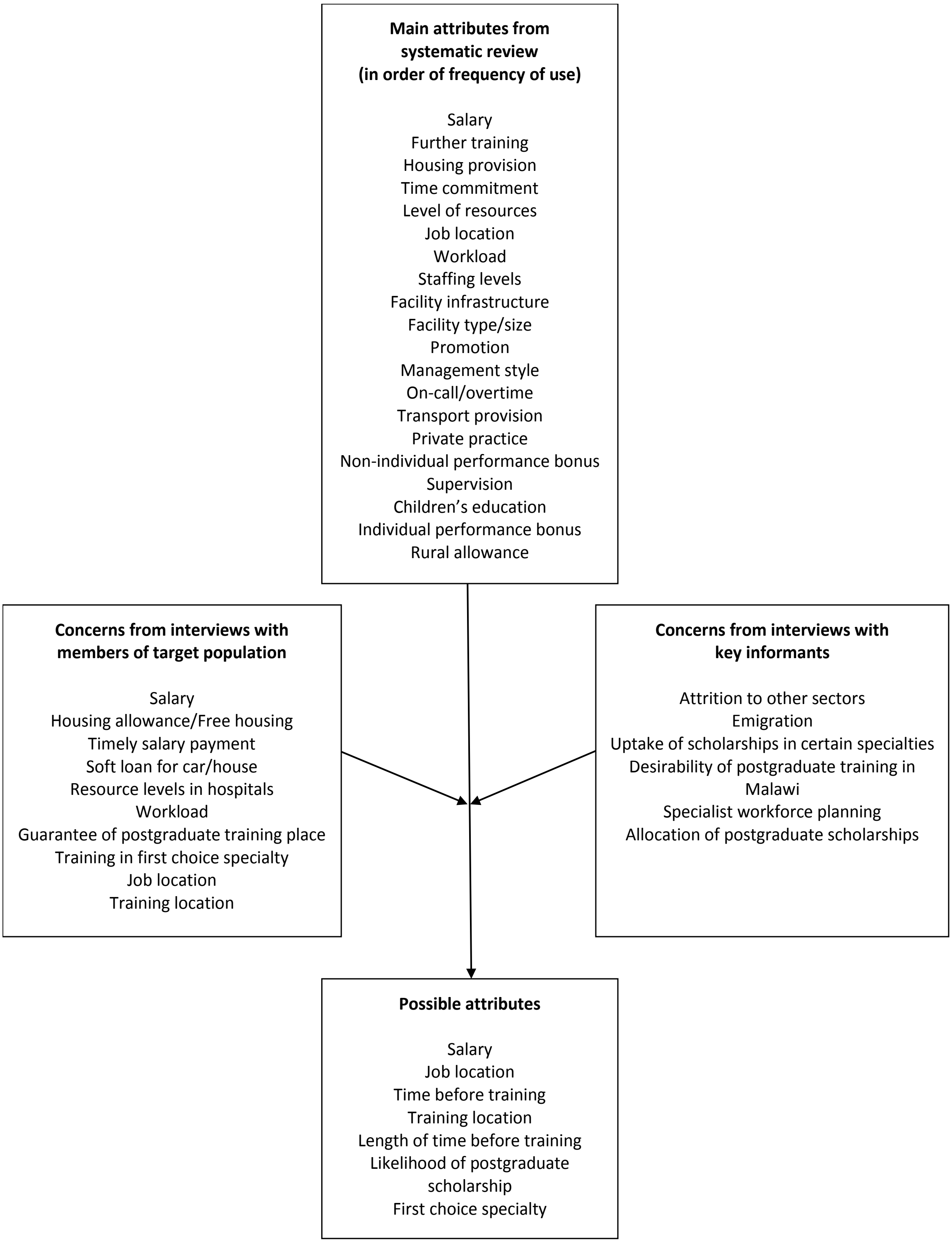
The first steps in conducting a DCE should be to confirm that the method is appropriate and then to clearly define the research question so that it is answerable by a DCE (Michaels-Igbokwe, Lagarde et al. 2014). To this end, our systematic review verified that the majority of DCEs in this area had focused on postgraduate job choices, particularly how to attract health workers to or retain them in underserved areas of the health service (Mandeville, Lagarde et al. 2014). These included rural or remote areas, primary care, the public sector or undersubscribed specialties. Attributes included in these studies therefore usually reflected negative aspects of these jobs (e.g. poor infrastructure) and possible incentives to counter them (e.g. free housing). The review of the Malawi-specific literature gave us insight into the causes of the health workforce crisis (including poor working environments, low remuneration and little access to postgraduate training) and the strategies health workers employed to get by in such conditions (such as attending workshops to obtain *per diems*) (Muula and Maseko 2005, Palmer 2006, McCoy, McPake et al. 2008, Manafa, McAuliffe et al. 2009, McAuliffe, Bowie et al. 2009, Bailey, Mandeville et al. 2012, Mandeville, Bartley et al. 2012). A DCE therefore seemed an appropriate method to investigate what aspects of postgraduate jobs are most influential on the retention of doctors in Malawi. We drew up a list of attributes included in previous health workforce DCEs to explore in the qualitative work (Figure 2). Initial interviews with members of the target population seemed to support this focus on the working environment and possible incentives: *People are working outrageous hours and for the extra hours they are working, their pay comes in late…* (Medical officer, female, Lilongwe). *They are starting to tax [salaries], the houses they are going to remove, the transport is not very consistent.* (Intern, male, Blantyre, discussing incentives under EHRP)

Yet discussions with key informants also identified quite specific concerns regarding postgraduate training and its role in the retention of junior doctors. For example, training in Malawi appeared to be valued less highly than training in other countries: *I think our own registrars feel a sort of inferiority and they do want to get the South African exams as well. They somehow feel that that validates them. And I think it's a shame.* (Specialist clinician). The *ad hoc* nature of access to training was also highlighted, with no clear pathway or minimum service requirement to enter training. This hampered workforce planning and the continuity of medical expertise in district hospitals: *Also the career strategy, it's there but it's still quite loose. A junior doctor who finishes now doesn't have a clear path which says "Okay… if I want to be in government service I will work for three years at Ntcheu. They will support me to come back and do post graduate."* (Academic clinician). Finally, some specialties seemed to enjoy lower status among junior doctors, with low rates of application to funded training places:*...I can tell you for a fact that we are still failing to fill a lot of the posts. So, there are some posts that, or places, that are fully funded and I can cite anaesthesia, we haven't had anybody for I* *think the past two years…another area is ophthalmology. Right now we have four scholarships...and they have not been filled since last year. The donors are just like get somebody and we are failing to fill them. (*Medical educationalist)

While these early interviews confirmed the importance of postgraduate training to junior doctors, it was evident that not all training was valued equally. In this case, offering more postgraduate training indiscriminately would be unlikely to be effective for retention. Policymakers required more information on how to best leverage postgraduate training to optimise workforce planning, particularly given the ongoing evolution of medical education in Malawi. For example, what would induce a doctor to train in a specialty that is a national priority but not their first choice? For how long would doctors be willing to work before training? And what would it take to make national postgraduate training as attractive as training in other countries? Due to this gap in the evidence base, it was decided to reorient the DCE design towards the influence of postgraduate training on job preferences and the value of different types of training. Figure 2 shows the attributes and concerns collated through the systematic review and initial qualitative work, and possible attributes at the end of iteration 1.

4.1.1 Tensions and compromises in this iteration: In the face of contrasting information gained from the existing literature, the target population and key informants, we decided to prioritise policy questions over immediate concerns about working conditions as the focus of the DCE.

Figure 2 Possible attributes and levels at the end of iteration 1



4.2 Iteration 2: Deepening knowledge of the decision context

The focus of interviews was now exploring aspects of postgraduate training and identifying levels for likely attributes. One key theme was the desirability of different specialties. The objective of this DCE was not to find out the attractiveness of any particular specialty or the generic aspects that make a specialty attractive to junior doctors, but the extent to which junior doctors in Malawi would compromise on their favoured specialty: *If, if, I mean, I can't get scholarships for number one choice, I will go to number two. But if there's a scholarship for something, but I don't, I surely don't want to do that, I wouldn't.* (Intern, male, Blantyre).

It emerged that medical students and interns in Malawi are primarily exposed to four "core" specialties (internal medicine, general surgery, paediatrics, obstetrics & gynaecology), with significant time spent training in each and highly visible role models. *So, you can imagine here's somebody who has gone through medical training, they have done their clinical specialities, their four main departments here…and all they think about when they're coming out is those four…*(Medical educationalist). In contrast, certain clinical areas that are well established as medical specialties in other countries, such as dermatology and anaesthetics, are often undertaken in Malawi by clinical officers (a mid-level cadre with lower entry requirements), resulting in a loss of legitimacy and status among junior doctors. *You know dermatology, I know it is useful but you have lots of people who do that things, the clinical officers, they do such things, so do you need a specialist to do [it]?* (Intern, male, Lilongwe).

Thus setting the levels of a specialty attribute as the four "core" specialties would provide little useful information, as all four are priority specialties in Malawi with sufficient demand for training places. Moreover, the considerable exposure to these specialties is likely to have constructed strong preferences that may dominate other attributes: a doctor set on surgery may not be able to countenance becoming a paediatrician and vice versa. Instead, we formulated the levels as "1st choice core specialty" and "2nd choice core specialty" in order to explore whether participants would be willing to give up their first-choice specialty in exchange for other aspects of a job (Table 1). Although this meant that the interpretation of these levels would vary for each participant, it enabled investigation of the generic disutility associated with accepting a less favoured specialty: a more important barometer for workforce planning. In order to minimise misunderstandings around the terms, clear descriptions and instructions were included in the questionnaire. We also included three very different specialties as additional levels to further inform workforce planning: (i) *family medicine:* recently introduced in Malawi, with uncertainty over the attractiveness of generalist training; (ii) *public health:* traditionally popular in Malawi, yet a non-clinical specialty; (iii) *ophthalmology:* a priority specialty due to the high burden of eye disease, but with a low uptake of training places.

Further interviews also confirmed the ambiguous feelings towards training programmes in Malawi, which were felt to be "limiting": *So they would like us to be here, understand our situation and then be able to practise within our own resources. It's a good idea on the government side. But on the clinician it's actually not a good one, it's actually the reverse. People don't want to be doctors that are limited... (*Intern, male, Blantyre). *What is the point of studying things which will only apply to Malawi?...it is not international so then why would you want to do something less like, substandard?* (Intern, male, Lilongwe). The training in South Africa as part of a sandwich programme was viewed as a better option, with all training outside Malawi of the highest value: *If I have to compromise, it's better I do two years here, two years outside. However, the ideal is go there, see there and come back. But staying here all four years, if I have no money and I have no way, I would do it, but it's because I haven't had options.* (Intern, male, Lilongwe). Training location was therefore included as a likely attribute, with four levels: all in Malawi, split between Malawi and South Africa, all in South Africa and all outside Africa.

As training for some specialties was provided all in Malawi, e.g. general surgery and ophthalmology, and others in Malawi and South Africa, e.g. paediatrics and internal medicine, this raised concerns that participants may be presented with implausible combinations of specialty and training location. It is advised to apply constraints between these levels during experimental design or to replace these choice profiles with more plausible combinations, although both sacrifice statistical efficiency for increased realism (Lancsar and Louviere 2008). From the continuing qualitative work, however, it was clear that junior doctors were not familiar with the structure of the specific training programmes, probably because these had been evolving over the past few years. We were also aware that with a finite population, it would not be possible to overcome any loss of statistical efficiency with an increase in sample size. We therefore decided that the small increase in realism was not worth any associated loss in statistical efficiency and retained these combinations.

While initially we were considering a labelled or generic design, the focus was becoming clearer as the trade-off between these different attributes in a hypothetical post in the public sector rather than their value in different sectors or Malawi versus overseas (Mandeville, Lagarde et al. 2014). We therefore decided to frame the DCE as two generic job descriptions in which postgraduate training is guaranteed, but this training differs in the aspects described above. There would also be a requirement to work for some time before starting training, and these posts would vary in salary, length and location (district versus central hospital). We also decided to include an opt-out option to reflect the many possible options for this population in the labour market (e.g. staying in their current job, leaving Malawi, or leaving the health sector) (Bridges, Hauber et al. 2011, Mandeville, Lagarde et al. 2014). To minimise the risk of insufficient data in the case of substantial use of the opt-out option, we also included a follow-up question, with participants "forced" to choose between the two alternatives (Bridges, Hauber et al. 2011, Mandeville, Lagarde et al. 2014).

To develop levels for the salary attribute, we asked participants for their current salary and also what they would consider a living wage, following the approach taken by a DCE on Malawian nurses (Mangham, Hanson et al. 2009). Current salaries were most commonly described as the "take-home" monthly amount, i.e. after income tax but inclusive of the EHRP top-up. The base level was set a little above the monthly intern salary at 100,000 Malawian Kwacha (MK), approximately USD372 at exchange rates prevailing at the time. Living wages were set as MK300,000 (USD 1115) in order to encompass the higher earnings of district doctors and also consistent voicing of this amount by interviewees: *But to be fair enough I think not less than 300,000…We know money, even if you have a million it won't be enough. But to be reasonable to be fitting* *yourself and do some other little things outside that.* (Intern, male, Blantyre). *I think at least 300,000 kwacha. Because I need to be able to say buy a car and put fuel in the car.* (District medical officer, female). We also included a level of MK200,000 (USD 743) evenly spaced between the two endpoints (Lancsar and Louviere 2008). A similar approach was taken for the time variable, with participants asked the maximum time they would be willing to work before starting postgraduate training. Table 1 shows the attributes and levels under consideration at end of iteration 2.

4.2.1 Tensions and compromises in this iteration: We went beyond current best practice in defining levels for the specialty attribute for the sake of enhanced policy relevance. While maintaining statistical efficiency was judged to be more important than increased realism when considering less plausible combinations, the opposite was true for inclusion of an opt-out option.

4.3 Iteration 3: Reconciling the decision context with experimental design

The design was now $2^1 \times 3^2 \times 4^1 \times 5^1$, meaning a minimum of 60 choice tasks would be needed for level balance. (Huber and Zwerina 1996, Hensher, Rose et al. 2005, Rose, Bain et al. 2011, Johnson, Lancsar et al. 2013). While blocking into smaller sets would have been possible, this would also reduce the information gained from each participant. In light of the small target population, it was important for each participant to complete as many choice tasks as possible in order to maximise the number of observations for analysis. It was therefore necessary to revisit the number of levels, taking into account the continuing qualitative work.

Table 1 Likely attributes and levels at end of iteration 2

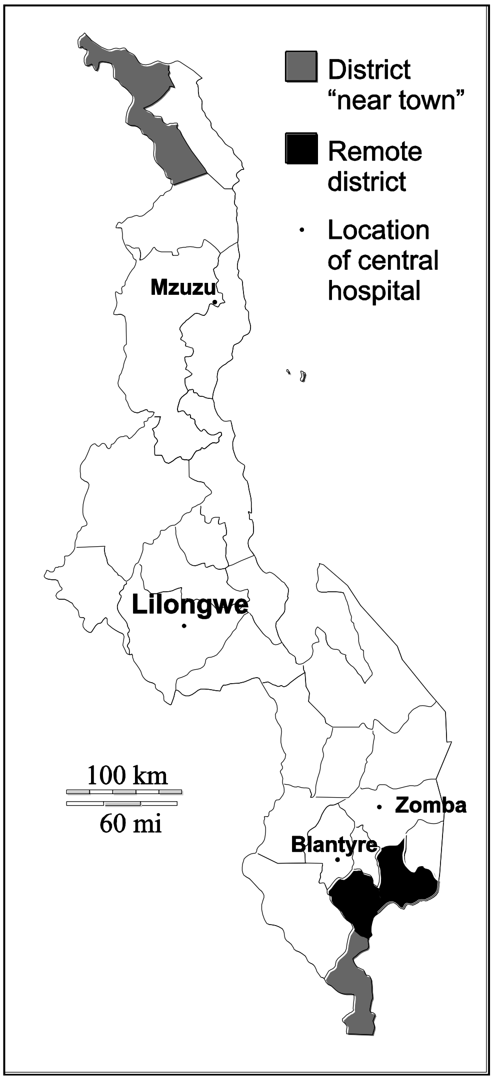
ATTRIBUTE	LEVELS*
Salary	100,000 200,000 300,000
Time spent working before training	1 year 3 years 5 years
Job location	District hospital Central hospital
Training location	All in Malawi Malawi and South Africa All in South Africa All outside Malawi
Specialty	~~Internal medicine~~ ~~General surgery~~ ~~Paediatrics~~ ~~Obstetrics & Gynaecology~~ 1st choice core specialty 2nd choice core specialty Public health Family medicine Ophthalmology

Notes: **Discarded levels denoted by strike-through text*

To this end, it was becoming clear from further interviews and analysis that family medicine was poorly recognised as a specialty in Malawi. A postgraduate training programme was still at planning stage and only current undergraduates had had exposure to the specialty: *We don't know family doctors in Malawi. The system is kind of, different* *from the other countries.* (Intern, male, Lilongwe)*. …During my training I didn't do it but the new guys are doing family medicine. I don't know what it involves yet. But I don't know how it can be helpful in our setting*. (Intern, male, Blantyre). Although its inclusion would have been interesting from a research and policy perspective, the risk of non-engagement from our target population was too great and it was discarded as a level.

Distinctions were also emerging with regard to district and central hospitals. District hospitals near major cities were considered by some participants as a positive experience, at least for a limited period, due to opportunities to earn extra income through *per diems* for district workshops while retaining proximity to urban amenities. In contrast, district hospitals in remote areas were generally unpopular, with several interviewees having requested reposting when allocated to such districts. To accommodate this heterogeneity in preferences, we decided to split the district hospital level into two: "peri-urban" and "remote". In addition, discussions with key informants alerted us a distinction between the two major teaching hospitals in Lilongwe and Blantyre, where specialists and resources were concentrated, and the smaller central hospitals in Mzuzu and Zomba (Figure 3). The latter were the focus of a government initiative to build up the number of junior doctors and specialists outside of the major hospitals, with some medical officers and recently trained specialists posted there. In order to inform this strategy, we also split this level into two - "major" and "minor" central hospital. While the district levels did not adhere to the best practice of uni-dimensional attributes (Mandeville, Lagarde et al. 2014) as they combined both location and type of facility, this was felt to be more pragmatic than nesting these levels with an associated loss of statistical efficiency, as no new central hospitals would be built in the short-term.

Figure 3 Map of Malawi showing district boundaries, location of central hospitals and district classification examples



The design was now 3^2 x 4^3, making 12 choice tasks possible. Yet feedback from policymakers indicated that the proposed upper levels for the salary and time attributes would be difficult to implement in the short-term. Wider level ranges, however, protect against participants ignoring attributes due to little differences in levels and are associated with more precise estimates (Lancsar and Louviere 2008, Rose, Bain et al. 2011). We therefore decided to retain the current endpoints established with the target population, but include an additional level for each attribute representing a realistic extension of current policy. This had the disadvantage of removing the even spacing between these levels at a cost to statistical efficiency. We now had 4^5, with 16 choice tasks leading to level balance.

At this point, we discussed incorporating two-way interactions into the design (Amaya-Amaya, Gerard et al. 2008, Mandeville, Lagarde et al. 2014). As each interaction requires an additional degree of freedom, this constrains statistical efficiency, yet excluding interactions from the model means that the main effects may be confounded by them (Johnson, Lancsar et al. 2013). Here, the most probable two-way interaction was between '1st choice specialty' and 'training location', with the marginal utility of this specialty dependent on whether training took place in Malawi or abroad. Although this interaction term was included in the pilot experimental design, it was dropped for the main survey design due to concerns over the restricted population and the additional design space required to estimate each interaction (Rose, Bain et al. 2011). The likelihood of the main effects being confounded by this interaction (i.e. poor model identification) was felt to be less than the risk of Type II error (i.e. failing to detect an effect even when it is present) with a finite population and a more complex model. Table 2 shows the design at the end of this iteration, which was used for pre-testing.

4.3.1 Tensions and compromises in this iteration: Best practice in level definition was compromised for enhanced realism and policy relevance. In addition, the restricted population size led us to drop the interaction term, balancing the risk of Type II error against the likelihood of confounded main effects.

Table 2 Attributes and levels at end of iteration 3

ATTRIBUTE	LEVELS*
Salary	100,000 120,000 200,000 300,000
Time spent working before training	1 year 2 year 3 years 5 years
Job location	Peri-urban district hospital Remote district hospital Major central hospital Minor central hospital
Training location	All in Malawi Malawi and South Africa All in South Africa All outside Africa
Specialty	1st choice core specialty 2nd choice core specialty Public health ~~Family medicine~~ Ophthalmology

**Added levels denoted by bold text, discarded levels denoted by strike-through text*

4.4 Iteration 4: Changes emerging from pre-testing and pilot

During pre-testing, we verified that the task and opt-out option were well understood, the design was a realistic representation of the decision context and no major attributes had been omitted. In order to explore the level of consensus on the distinction between district hospitals, we asked participants to categorise Malawi's districts into "peri-urban", "remote" or "neither". Five districts enjoyed perfect agreement among all raters and these were therefore used as examples of each category in the DCE introductory text (Figure 3). Peri-urban was also changed to "near town" based on participant feedback and the names of all four central hospitals included to aid clarity.

There was good understanding of the terms first- and second-choice core specialties, although the instructions preceding the choice tasks were reworded extensively for clarification. Implausible combinations of specialty and training location levels were not raised as an issue. It was noted that public sector salaries had just been raised, so the base level for the salary attribute was changed to 110,000 MK so as to maintain realism. The upper level on the time variable (time spent working before training) provoked discussion, as several participants indicated that they would work for longer than five years for a guaranteed training scholarship. We concluded, however, that a longer timeframe would diminish the realism of any trade-offs made by participants, particularly in the low-trust environment described in several interviews: *So there isn't that and trust is a good word, there isn't that element of trust saying "If I do this, if I serve my time I will be supported* [in postgraduate training]*."* (Academic clinician, Blantyre).

During the pilot, the full survey took around 45 minutes. In contrast to other DCEs (Kløjgaard, Bech et al. 2012), there was high participant capacity with little difficulty understanding the concept or instructions. This was, however, a population selected for their ability to complete a university degree characterised by frequent and rigorous testing (Lancsar and Louviere 2008, Kløjgaard, Bech et al. 2012). Moreover, participants at this career stage were likely to have already spent considerable time reflecting on their job preferences (Ryan, Kolstad et al. 2012), We therefore considered increasing the number of choice tasks to counter the impact of the small population, however decided against this as the survey was likely to be administered during busy clinical hours. When examining the parameter estimates obtained from the pilot (Table 3), we noted a strong preference for a MK300, 000 salary, raising concerns that this upper level had been set too high. After discussion, we adjusted the salary levels to lower values that were more

Table 3 Parameter estimates obtained from pilot survey

Model statistics	Number of observations	480
	Number of parameters	16
	Log-likelihood function	-198.34
	Pseudo R-squared	0.28
Attribute	**Level**	**Coefficient§ (SE)**
Job location	Zomba or Mzuzu Central Hospital	-0.007 (0.337)
	District hospital near town	0.352 (0.380)
	Remote district hospital	0.557 (0.439)
Monthly salary	MK 120,000	0.183 (0.395)
	MK 200,000	0.905 (0.398)*
	MK 300,000	2.05 (0.389)***
Time before training	2 years	-0.376 (0.324)
	3 years	-0.244 (-0.357)
	5 years	-1.709 (0.388)***
Training location	All in Malawi	-0.737 (0.348)*
	In Malawi & South Africa	-0.184 (0.304)
	All in South Africa	-0.259 (0.362)
Specialty	1st choice core specialty	2.346 (0.400)***
	2nd choice core specialty	1.464 (0.347)***
	Ophthalmology	-1.030 (0.413)*
Alternative-specific constant (opt-out option)		0.598 (0.501)

Notes: *Multinominal logit model using dummy coding; MK = Malawian Kwacha; SE = Standard error; §Reference levels = Major central hospital, MK 110,000 monthly salary, 1 year before training, All training outside of Africa, Public health; *Statistically significant at 5% level, **Statistically significant at 1% level, ***Statistically significant at 0.1% level* sensitive to the public sector wage bill, but still reflective of remuneration in more senior posts and other sectors. These were finalised as increases of approximately 20% (MK 130,000), 45% (MK 160,000) and 80% (MK 200,000) on the base level (MK110, 000). Further piloting to obtain priors using these revised levels would have been preferable, yet the limited naive population available for piloting along with logistical constraints prevented another round. We therefore used the priors obtained in this round, recognising their limited ability to improve statistical efficiency given the revised upper salary levels. Five years of training was associated with significant disutility, therefore we were reassured that this level range was sufficiently wide, and a strong preference for 1st choice specialty was seen as expected. A design incorporating these estimates with normal random distributions was run in Ngene using 1000 Sobol draws for 250,000 iterations to obtain the final survey design. Figure 4 is the participant instruction sheet and Figure 5 is an example choice task from the main survey.

4.4.1 Tensions and compromises in this iteration: Judgements were made on level ranges for two attributes, balancing realism, best design practice, and feasibility for policy implementation. Logistical considerations prevented an increase in the number of choice tasks and a further round of piloting, which may have decreased statistical efficiency.

Figure 4 Information sheet given to participants in main survey

DESCRIPTION OF JOB CHARACTERISTICS AND LEVELS			
	CHARACTERISTICS	**DESCRIPTION**	**LEVELS**
WORK BEFORE TRAINING	**JOB LOCATION**	This is the hospital where you will be working before you start training.	• **QECH or KCH** • **Zomba or Mzuzu Central Hospital** • **District hospital near town** • **Remote district hospital**
	SALARY	This is the monthly salary which you will be earning before you start training. This is after tax but includes SWAP.	• **MK 110,000** • **MK 130,000** • **MK 160,000** • **MK 200,000**
	TIME BEFORE TRAINING	This is the time you will have to work in this job before you start training. You will be rotating between departments at central or overseeing services at district.	• **1 year** • **2 years** • **3 years** • **5 years**
SPECIALTY TRAINING	**TRAINING LOCATION**	This is the location where you will undertake your specialist training.	• **All in Malawi** • **Malawi and South Africa** • **All in South Africa** • **All outside Africa**
	SPECIALTY	This is the specialty that you will be training in. All are four year training programmes that will lead to you being a consultant. **Core** = Medicine, Paediatrics, Surgery or Obstetrics & Gynaecology	• **1st choice core** • **2nd choice core** • **Ophthalmology** • **Public Health**

Notes: *SWAP refers to the salary top-up paid under EHRP; QECH = Queen Elizabeth Central Hospital; KCH = Kamuzu Central Hospital*

Figure 5 Example of choice task from main survey

You have seen two jobs advertised in the newspaper.

Postgraduate training is guaranteed if you accept one of these posts, but your **future training differs in location and specialty.**

You will also need to **work for some time before training**, and this job differs in **location, salary and duration.**

Please compare the following two job descriptions:

JOB A	WORK BEFORE TRAINING	JOB B
Remote district hospital	JOB LOCATION	District hospital near town
MWK 200,000	MONTHLY SALARY	MWK 120,000
2 years	TIME BEFORE TRAINING	5 years
	SPECIALIST TRAINING	
All in Malawi	TRAINING LOCATION	Malawi & South Africa
Ophthalmology	SPECIALTY	Public Health

→ Considering the job as a whole, would you choose A, B or neither?

A **Neither** **B**

→ If you chose neither, do you lean towards Job A or Job B?

A **B**

Notes: *QECH = Queen Elizabeth Central Hospital; KCH = Kamuzu Central Hospital; see text for explanation of 1st and 2nd choice core specialty.*

5. DISCUSSION

This paper describes the process of designing a DCE to inform health workforce policy using a combination of literature review, qualitative interviews, experimental design and piloting. Numerous iterations were required to resolve competing design demands, challenging the perception of distinct stages without overlap. The contribution of this study is three-fold. First, it transparently acknowledges the tensions inherent in designing a DCE and makes explicit the compromises necessary to reconcile these demands. Second, it adds to the limited literature detailing the qualitative aspects of DCE design. Lastly, it provides a rich description of the entire design process, laying bare the iterative nature at the heart of most DCE design.

Our account will be encouraging to other researchers facing similar tensions, particularly in health where reporting of design features has been noted to be poor (Coast and Horrocks 2007, Louviere and Lancsar 2009, Coast, Al-Janabi et al. 2012, de Bekker-Grob, Ryan et al. 2012, Clark, Determann et al. 2014). Strengths of this design process include the complementary information gained from the mixed-method approach, which enabled triangulation throughout the entire design process. We would agree with the conclusions of Kløjgaard et al. that the important knowledge gained through numerous – and sometimes contradictory – sources increases understanding of the decision context, guiding necessary compromises in a more rounded manner than could be achieved through a mono-method lens (Kløjgaard, Bech et al. 2012). This process of familiarisation with the decision context also enhances the analysis and interpretation of the main results. In addition, our qualitative work was rigorous and comprehensive, with a subsequent study identifying similar concerns in the same population (Sawatsky, Parekh et al. 2014).

Our judgements to resolve the emerging design issues are intentionally open to criticism and others may have reached different conclusions. This specific context with a very small target population was unusual and restricted the design solutions available to us, leading to some divergence from best practice. However, these decisions were based on an intimate knowledge of the research problem and context, both from the work undertaken here and the experience of the research team. It should be acknowledged that the composition of this team – all with professional investment into medical education, policy or research – may have influenced the interpretation of the early qualitative work and subsequent direction of the DCE (Green and Thorogood 2009, Coast, Al-Janabi et al. 2012). However, our wide sampling strategy and continuous triangulation with interviewees is likely to have protected against any significant distortion based on prior constructs.

In order to narrow the gulf between reporting and reality, we call for three actions. First, guidance should better reflect the reality of DCE design, with a move away from the predominant model of sequential steps to a more cyclical and interconnected process. While the former is certainly diagrammatically attractive, it misrepresents the iterative nature of DCE design and risks confusing researchers new to the field. Second, we encourage more researchers to report their full design process, including a transparent account and justification of any compromises. Indeed, regularly reporting the design process separately to results may be a superior format for DCEs. It is difficult to do justice to the complexity involved in DCE design as well as thoughtful interpretation of results within the confines of one paper, and the brevity criticised in previous studies may be more due to space limitations than lack of robustness (Coast, McDonald et al. 2004, Coast and Horrocks 2007, Louviere and Lancsar 2009, Coast, Al-Janabi et al. 2012). Lastly, we call for more research that seeks to bridge disciplinary divides in DCE design, such as the impact of trade-offs between statistical and respondent efficiency. In this way, areas of current ambiguity will be illuminated, supporting better design decisions and helping to improve the quality of empirical studies.

6. CONCLUSIONS

In conclusion, designing a DCE is an iterative process that involves a series of compromises between conflicting demands. Transparent reporting and grounded guidance that better reflects this reality would help to improve quality in this area.

8 DISCRETE CHOICE EXPERIMENT SURVEY RESULTS

8.1 INTRODUCTION

Having designed and piloted the DCE survey, the next step was to administer the survey. The final survey tool is reproduced in Appendix I[41]. Data collection was carried out over September 2012 to March 2013 by my Malawian-based research team. An initial exploratory analysis of the results was undertaken with a multinomial logit model, the results of which can be found in Appendix J. The multinomial logit model has several major limitations, however, including the assumption of independent error terms across participants leading to the independence of irrelevant alternatives property and the inability to account for heterogeneity of preferences between participants (Amaya-Amaya, Gerard et al. 2008). Given the preceding work and results from other DCEs focused on doctors, considerable heterogeneity in preferences for specialty training was anticipated in this target population (Vujicic, Alfano et al. 2010b, Lagarde, Pagaiya et al. 2013). Therefore, a more advanced model capable of exploring this heterogeneity would be required for the full analysis.

The latent class model is a semi-parametric model that assumes preference heterogeneity among participants has a discrete rather than continuous distribution, i.e. a number of underlying groups (classes) of participants with similar preferences (Greene and Hensher 2003, Amaya-Amaya, Gerard et al. 2008, Greene 2012). Class membership is characterised by unobserved (latent) variables, the nature of which may be inferred

[41] This includes the DCE framing text and practice exercises, however excludes the actual choice tasks that were presented in a separate pack.

through measured variables such as attitudes or sociodemographic characteristics (Amaya-Amaya, Gerard et al. 2008). The analyst must make a decision regarding the optimal number of classes, based on a comparison of several model fit measures, and also the selection of variables to include in the model (Greene 2012). Within each class, choice probabilities are modelled by a multinomial logit model. While becoming increasingly popular in general health DCEs (Clark, Determann et al. 2014), no DCE focused on HRH had used this model at the time of my review (Mandeville, Lagarde et al. 2014).

The chapter presents the results of an analysis using a latent class model that has been submitted as a paper to Social Science and Medicine, along with a supplementary file providing additional details on study design and results. Further analyses undertaken as part of this thesis comprise the remainder of this chapter, including alternative models considered for analysis such as the mixed logit, generalised mixed logit and the latent class random parameters models (Amaya-Amaya, Gerard et al. 2008, Greene 2012, Sivey, Scott et al. 2012). These combined results fulfil the third research objective of quantifying the preferences of Malawian junior doctors for specialty training and contribute to the first objective of identifying the key factors influencing junior doctors to leave the Malawian public sector. The results are also used in the cost-effectiveness analysis, described in the next chapter, and so contribute to the fourth objective as well.

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SECTION A – Student Details

Student	Kate Mandeville
Principal Supervisor	Kara Hanson
Thesis Title	Train to retain: the role of specialty training in stemming Malawi's medical brain drain

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	Social Science and Medicine
Please list the paper's authors in the intended authorship order:	Kate L. Mandeville, Godwin Ulaya, Mylène Lagarde, Adamson S. Muula, Titha Dzowela, Kara Hanson
Stage of publication	**Submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I led the design of the study, collected the pilot data, undertook the analysis, and wrote the first draft of the manuscript.

Student Signature: K.L. Mandeville **Date:** 10.3.2016

Supervisor Signature: K Hanson **Date:** 11/3/16

8.2 RESEARCH PAPER

The use of specialty training to retain doctors in Malawi: a discrete choice experiment

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Keywords: discrete choice experiment; stated preferences; human resources for health; Malawi; Physician; Specialization

ABSTRACT

Emigration has contributed to a shortage of doctors in many sub-Saharan African countries. Specialty training is highly valued by doctors and a potential tool for retention. Yet not all types of training may be valued equally. We carried out a discrete choice experiment as part of a cross-sectional survey in order to ascertain the preferences of all Malawian doctors within five years of graduation and not yet in specialty training. 140 doctors took part out of 153 eligible in Malawi. Despite evidence that specialty training is highly sought after, Malawian junior doctors would not accept all types of training. Doctors preferred timely training outside of Malawi in core specialties (general medicine, general surgery, paediatrics, obstetrics & gynaecology). A doctor would work for an additional 1.3 to 8.5 years if guaranteed training in their 1st choice core specialty, but just two to five months for an extra 10% in basic salary. Training undertaken in Malawi would require a 36% to 79% increase in basic salary and training in ophthalmology, representing a bundle of unpopular but priority specialties, would require a 200% to 350% increase. Using a latent class model, we identified four subgroups of junior doctors with distinct preferences. Policy simulations showed that these preferences could be leveraged by policymakers to improve retention in exchange for guaranteed specialty training.

1. INTRODUCTION

Of the 30 countries with the fewest doctors per population worldwide, 27 are in sub-Saharan Africa (World Health Organization 2015). This paucity of doctors constrains the delivery of essential services and responses to new health threats, such as the rollout of antiretroviral treatment or the recent Ebola epidemic in West Africa (World Health Organization 2006, Sidibé and Campbell 2015). Factors contributing to the current situation include both low production and high emigration of doctors (World Health Organization 2006, Mullan, Frehywot et al. 2011). Out of 105 medical schools surveyed in the Sub-Saharan African Medical Schools Study, half produced less than one hundred graduates in 2008 (Mullan, Frehywot et al. 2011). Of the doctors trained in sub-Saharan African medical schools, those who are now registered in the USA are equivalent to 22.7%, 26.2%, and 52.3% of the medical workforce in Ethiopia, Ghana, and Liberia respectively (Tankwanchi, Özden et al. 2013).

In response, there has been an unprecedented investment in undergraduate medical education in sub-Saharan Africa, with 58 new medical schools established since 1990 and many existing schools mandated to expand enrolment (Mullan, Frehywot et al. 2011). In contrast, there has been less focus on specialty training, the period of postgraduate training leading to accreditation as a specialist or general practitioner (World Federation for Medical Education 2003, World Organization of Family Doctors 2013). This is despite evidence that such training is highly valued by doctors and a strong driver for emigration (Willis-Shattuck, Bidwell et al. 2008). For example, a survey of 1,619 non-European Union doctors working in the United Kingdom (UK) found that three out of four identified postgraduate training opportunities as their main reason for emigration (George, Rozario et al. 2007). The desire to pursue specialty training increased the intention to emigrate within five years of qualification for medical students in eight low- and middle-income countries (LMIC), including five in sub-Saharan Africa (Silvestri, Blevins et al. 2014). And nearly 90% of those doctors trained in sub-Saharan Africa but registered in the United States had completed their specialty training there rather than in their country of training (Tankwanchi, Özden et al. 2013). Yet only a third of sub-Saharan African medical schools offer such programmes, with a total of 1,909 specialty training places for the 7,861 graduates every year (Mullan, Frehywot et al. 2011). Offering more specialty training, therefore, is an attractive option for policymakers in sub-Saharan Africa seeking to maximise retention of their new medical graduates.

Retaining doctors is particularly important in Malawi, which has the second lowest ratio of doctors to people in the world (World Health Organization 2015). Malawian doctors used to be trained in the UK, with the result that many never returned (Broadhead and Muula 2002, World Health Organization 2015). In response, the national medical school (College of Medicine-University of Malawi, COM) was established in 1991, with enrolment of first-year students reaching 105 in 2014 (Broadhead and Muula 2002, University of Malawi 2014). Yet concerns over health worker emigration led to the implementation of a six-year emergency programme in 2005 that included a 52% salary increase for doctors (Management Sciences for Health 2010). Despite this, a study tracing COM graduates from 2006 to 2012 found that the odds of junior doctors being outside Malawi and the public sector increased with time after graduation (Mandeville, Ulaya et al. 2014). Given that most medical students and junior doctors in Malawi intend to specialise, specialty training may prove a more effective tool for retention in the short-term than financial incentives (Bailey, Mandeville et al. 2012, Mandeville, Bartley et al. 2012, Sawatsky, Parekh et al. 2014). What is uncertain, however, is whether all kinds of specialty training would be equally effective. Depending on the availability of trainers for different specialties, Malawian doctors receive specialty training all in Malawi, all in South Africa (or other African countries), or split between the two (Zijlstra and Broadhead 2007). Qualitative research has shown that junior doctors hold ambivalent views about specialty training undertaken entirely in Malawi (Bailey, Mandeville et al. 2012, Sawatsky, Parekh et al. 2014). In addition, scholarships available in certain specialties - such as ophthalmology, anaesthetics or dermatology - have suffered from poor uptake from junior doctors. These specialties are a priority for training in terms of disease burden and available expertise in Malawi, yet are less established than the *"core"* specialties that dominate undergraduate training and internship: internal medicine, general surgery, paediatrics, and obstetrics & gynaecology (Bailey, Mandeville et al. 2012, Palmer, Chinanayi et al. 2014, Schulze Schwering, Spitzer et al. 2014). Collectively, this evidence suggests that while junior doctors desire specialty training, not all training may be valued equally. Before specialty training can be used effectively to improve retention in Malawi, more information is needed on junior doctors' preferences towards different kinds of training. In order to inform health workforce policy, we used a discrete choice experiment to investigate specialty training preferences of Malawian junior doctors.

2. METHODS

2.1 Design of discrete choice experiment

In order to identify potential attributes and levels and obtain contextual information, a literature review and qualitative interviews with members of the target population and key informants were carried out (Mandeville, Lagarde et al. 2014). Five attributes were included that were both important to junior doctors and potential policy levers. Two generic job descriptions were presented to participants, along with an option to opt out of the choice if neither job was attractive to participants. In both jobs, a specialty training place would be guaranteed, but only after some time working in the public sector. This work would differ in:

- *Salary*. The monthly net salary paid before training: MWK110,000 ($411 at exchange rates prevailing at the time, obtained from www.xe.com); 130,000 ($484); 160,000 ($596) or 200,000 ($746).
- *Job location.* The location of the hospital where this work would be undertaken: a major central hospital (located in the two main cities of Malawi), a minor central hospital (located in smaller cities with poorer facilities and less supervision), a district hospital near a major town or a remote district hospital (Bailey, Mandeville et al. 2012).
- *Time before training.* The amount of time required in the job before starting specialty training: 1, 2, 3 or 5 years.

The specialty training places would also differ in two aspects:

- *Training location.* The most common options for Malawian doctors: training all in Malawi, split between Malawi and South Africa, all in South Africa, or all outside Africa.
- *Specialty*. Here, we wanted to investigate the trade-offs participants would be willing to make between different types of specialties and other aspects of a job. Employing named specialties as levels would provide little information other than their relative popularity. Instead, we formulated two levels as "1st choice" core specialty and "2nd choice" core specialty in order to explore the willingness of junior doctors in Malawi to compromise on future specialty. Only the core specialties were included here due to their familiarity to participants. The third level was ophthalmology in order to investigate the incentives required to increase the uptake of less favoured but priority specialties. Finally, the fourth level was public health, a non-clinical specialty traditionally popular in Malawi.

We used an efficient design in Ngene version 1.1.1 (ChoiceMetrics Pty Ltd, Sydney) to create 16 choice tasks, with an example shown in Figure 1. An accompanying questionnaire noted sociodemographic characteristics, current job and employment history, and attitudes towards specialty training. To avoid primacy effects, two versions of choice tasks were produced with a reversed order and participants allocated to versions using a computer-generated random sequence. Extensive piloting of the choice tasks and accompanying questionnaire was carried out before data collection.

Figure 1 An example choice task

You have seen two jobs advertised in the newspaper.

Postgraduate training is guaranteed if you accept one of these posts, but your **future training differs in location and specialty.**

You will also need to **work for some time before training**, and this job differs in **location, salary and duration.**

Please compare the following two job descriptions:

JOB A	WORK BEFORE TRAINING	JOB B
Remote district hospital	JOB LOCATION	District hospital near town
MWK 200,000	MONTHLY SALARY	MWK 120,000
2 years	TIME BEFORE TRAINING	5 years
	SPECIALIST TRAINING	
All in Malawi	TRAINING LOCATION	Malawi & South Africa
Ophthalmology	SPECIALTY	Public Health

→ Considering the job as a whole, would you choose A, B or neither?

A **Neither** **B**

→ If you chose neither, do you lean towards Job A or Job B?

A **B**

2.2 Participants

The target population was all junior doctors (defined as within seven years of graduation) in Malawi who had not yet started specialty training. As our focus was on national retention policies, non-Malawian citizens and those who had completed any undergraduate training outside of Malawi were excluded. 153 out of 279 recent graduates were eligible (Mandeville, Ulaya et al. 2014).

2.3 Analysis

Results were analysed using Stata 12 and NLOGIT 5.0 (Econometric Software, Inc, Plainview). Salary and time before training were coded as continuous variables, while the other three categorical attributes were effects coded (Bech and Gyrd-Hansen 2005). A latent class model was used to examine variation in preferences between respondents (Greene and Hensher 2003). This model assumes that there are underlying subgroups (classes) of participants with similar preferences, with membership of these classes characterised by unobserved (latent) variables, the nature of which may be inferred through observed variables (Amaya-Amaya, Gerard et al. 2008). The analyst must stipulate the number of classes and which observed variables to include in the model. A posterior probability of belonging to each class is produced by the model for every participant. In order to describe each subgroup, it is possible to allocate each participant to a class based on their highest probability and then compare characteristics of participants across classes (Lagarde, Eren et al. 2014).

We calculated willingness to pay using a ratio of attribute coefficients with salary as the denominator. Positive values indicate the amount of future income participants would give up in order to gain a unit increase or level change in an attribute, whereas negative values indicate the amount that a participant would want as compensation (Sivey, Scott et al. 2012). We also calculated a second novel measure, willingness to stay, using time before training as the denominator. If negative, it indicates the time doctors would give up before specialty training for a unit increase or level change in an attribute, with positive values indicating the time that a doctor would want a post shortened by in order to compensate for such a change. These values should be interpreted as indicators of relative strength of preferences, rather than taken strictly as monetary values or time commitments.

2.4 Policy scenarios

The results of discrete choice experiments can be used in simulations to predict the uptake of jobs under different policies. We constructed scenarios for two key policy objectives in Malawi and predicted the uptake in each latent class. The first was to maximise service in the public sector in exchange for training in favoured specialties. We simulated the impact on job uptake of increasing lengths of mandatory service before access to training in a preferred core specialty. The second examined strategies to increase the uptake of unpopular but priority specialties. Here, uptake of a baseline scenario representing a normal training pathway in Malawi was compared against a job training in ophthalmology with increasing incentives.

3. RESULTS

3.1 Participant characteristics

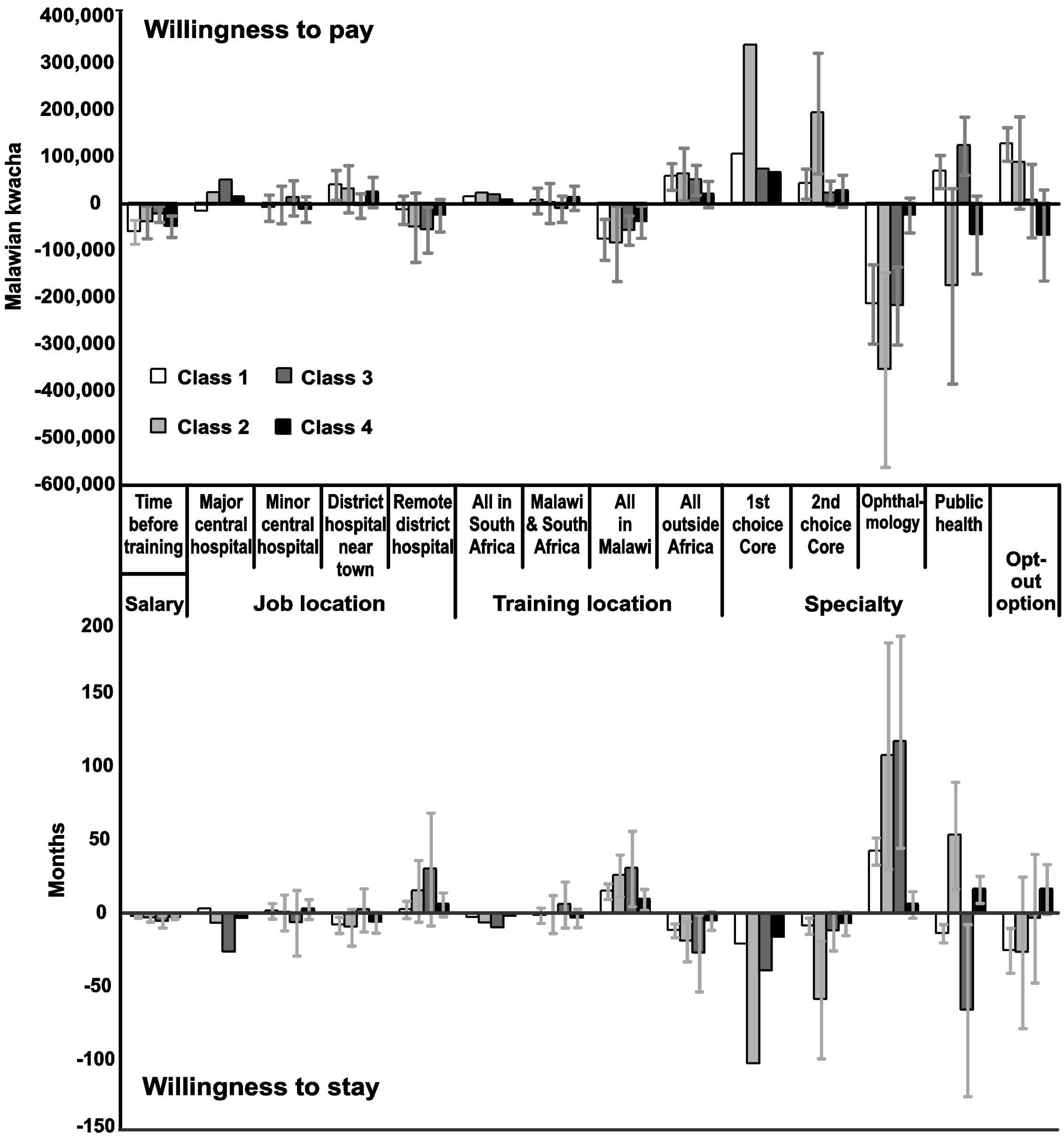
The response rate was 96.7% (149/153). There were very few graduates eligible from 2006 and 2007, as many were training or working outside Malawi (Mandeville, Ulaya et al. 2014). As it was clear that we had defined our target population too widely for this choice problem, we excluded participants who had graduated in 2006 (8.3% of total graduates, 2/24) and 2007 (17.1%, 6/35). The final sample comprised 140 doctors, with 87 (62.1%) males and a median age of 25 years (SD 2.68). The median monthly net salary was MWK 108,000 ($404), the starting salary in the public sector at that time. All doctors except one stated that they wished to specialise in the future, with three quarters currently looking for a training scholarship. When participants were asked which specialties they would consider training in, public health and epidemiology was the most popular specialty for training followed by the four core specialties, with psychiatry, dermatology and ophthalmology the least preferred (see supplementary file). These responses were used to construct a "specialty flexibility index", with higher/lower scores indicating greater/lesser flexibility in specialty choice.

3.2 Preferences

All 140 participants completed all 16 choice tasks, giving 2240 observations. The opt-out option was used 831 times (37.1%). As the two alternatives both represented public sector jobs, this relatively high usage of the opt-out option may reflect a general unattractiveness of the public sector to junior doctors that even guaranteed specialty training was unable to overcome. The best fitting model for the data comprised four latent classes and incorporated three observed variables: age, specialty flexibility index, and current salary. The model fit measures and results for each class are provided in the supplementary file.

When willingness to pay and stay values are compared across the four classes (Figure 2), the strength of preferences for specialty in comparison to other attributes is striking. Most participants would need to be paid between MWK 215,000 and 355,000 ($803 to $1,326) to undertake training in ophthalmology, whereas they would give up between MWK 42,000 and 338,000 ($157 to $1,263) to undertake training in core specialties of their choice. In terms of time, doctors were willing to work an extra 1.3 to 8.5 years for the opportunity to train in a 1st choice core specialty. The difference between the values for 1st and 2nd choice core specialties shows that all classes experience dissatisfaction with accepting their alternative choice. Training undertaken exclusively in Malawi can be seen to be universally unattractive, with most preferring training in South Africa or outside Africa. To undertake specialty training all within Malawi, doctors would require an extra MWK39,000 to 85,000 ($146 to $318) in salary, or beginning training 10 to 30 months earlier. In comparison, preferences for salary and job location were weaker. For example, an additional MWK10,000 ($37) in monthly salary would only generate between 2 and 5 months' extra work. Of note, the constant for the opt-out option was significant in class 1. This indicates that these doctors considered opting out regardless of the attributes on offer.

Figure 2 Willingness to pay and stay



Notes: *95% confidence intervals shown. See text for explanation of 1st choice and 2nd choice core specialty; Major central hospital, All in South Africa and 1st choice core specialty are reference levels, therefore only the coefficient can be calculated from other parameter coefficients in category and not the confidence intervals.*

3.3 Subgroup descriptions

Based on posterior probabilities (of which 94% were between 0.9 and 1.0), we assigned each participant to a class and compared data obtained from the accompanying questionnaire across classes (Table 1). By comparing these with doctors' job preferences obtained from the DCE (Figure 2), broad descriptions of each subgroup can be arrived at in order to highlight key differences and policy implications. We describe the four subgroups seen here as the "rich rejecters", "stubborn specialists", "money motivated" and "pliant patriots".

The "rich rejecters", comprising Class 1 and a third of participants, were the only subgroup for whom the opt-out option was consistently more attractive than the jobs on offer. They are also earning significantly more than their peers (1.5 times the sample mean salary) and showed the lowest preferences for salary increases. Although not significant, more doctors were outside the public sector in this group than the other three classes. These results suggest that public sector jobs, even with guaranteed specialty training and higher salaries, are unattractive to these doctors, who may be difficult to retain in the public sector in the long-term.

The "stubborn specialists", Class 2 and also a third of participants, displayed the strongest specialty preferences of all subgroups and the highest dissatisfaction with accepting their 2nd rather than 1st choice core specialty. They also had strong preferences on the location of this training, requiring the highest compensation if all in Malawi and giving up the

Table 1 Characteristics of latent classes

Characteristic	Class 1 N=43 (30.7%)	Class 2 N=43 (30.8%)	Class 3 N=23 (16.0%)	Class 4 N=31 (22.6%)
Sociodemographic characteristics				
Female (N, %)	18 (41.9)	19 (44.2)	5 (21.7)	11 (35.5)
Median age in years (N, SD)**	25 (2.2)	24 (2.4)	25 (3.5)	26 (2.6)
Mean net monthly salary in MWK (N, SD)**[a]	147,193 (102,973)	123,884 (79,904)	112,827 (20,242)	108,633 (2,822)
Working outside public sector (N, %)	4 (9.3)	1 (2.3)	2 (8.7)	1 (3.2)
District experience (N, %)**	12 (27.9)	4 (9.3)	9 (39.1)	10 (32.3)
Rural upbringing (N, %)	8 (18.6)	8 (18.6)	5 (21.7)	4 (12.9)
Married or relationship>1 year (N, %)	24 (55.8)	16 (37.2)	11 (47.8)	17 (54.8)
Children under 11 years old (N,%)	8 (18.6)	1 (2.3)	3 (13.0)	3 (9.7)
Six or more dependents (N, %)*	7 (16.3)	4 (9.3)	7 (30.4)	2 (6.5)
Attitudes to specialty training				
Specialty flexibility index (N,SD)***	6.0 (2.4)	6.0 (2.5)	5.0 (2.3)	7.4 (2.5)
Currently looking for specialty training funding (N, %)	32 (74.4)	33 (76.7)	15 (65.2)	21 (67.7)
Median months looking for funding (N, SD)[b]	3 (16.6)	3 (6.4)	3 (5.4)	4 (7.5)

Notes: *SD= standard deviation; MWK = Malawian Kwacha; District experience signifies current or previous job at district-level; One-way analysis of variance or chi-squared tests show significant differences across classes at the **5% or ***1% level; *Approaching significance with P-value of 0.056; [a]Bartlett's test for unequal variance significant for original and log transformed data, therefore Kruskal-Wallis test used instead; [b]Bartlett's test for unequal variance significant, therefore log transformation used instead.*

greatest income for training outside. They tended to be younger than their peers and less likely to have worked at district-level.

The “money motivated”, Class 3 and the smallest subgroup, had the largest preference for salary increases and rarely opted out of the jobs on offer. Around a third of this subgroup had six or more dependents, significantly more than other subgroups. They were the least compromising of all subgroups on the specialty flexibility index, even compared to the stubborn specialists, but would require the least compensation of all subgroups for more time working before training. Along with the rich rejecters, this subgroup had the strongest preference for public health, yet would also require the greatest compensation for working in a remote district hospital.

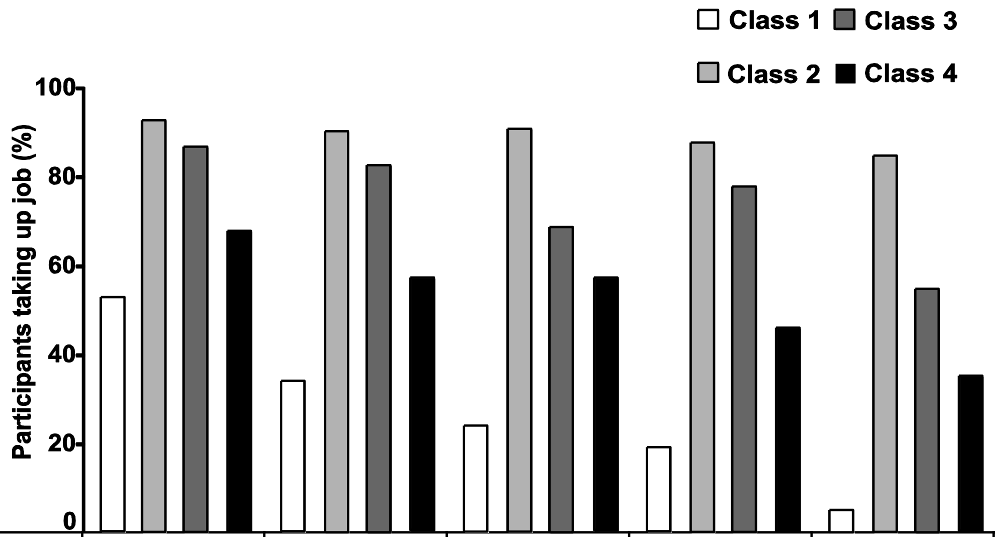
The “pliant patriots”, Class 4 and a fifth of the population, were the subgroup for whom training in Malawi was the least unattractive. They scored significantly higher on the specialty flexibility index and showed the least dissatisfaction with training in their 2nd rather than 1st choice core specialty. They were also the only subgroup for which training all outside Africa or in ophthalmology did not significantly influence their choices. They tended to be older than their peers and had the lowest mean salary, but were no more likely to have family reasons to remain in Malawi.

3.4 Policy scenarios

The first policy simulation assessed the extent to which service in the public sector could be maximised in exchange for training in popular specialties (Figure 3). Our baseline scenario represents a common pathway to specialty training in Malawi with two years working in a district hospital at a starting salary, before training in a 1st choice core specialty in Malawi and South Africa. Nine out of ten stubborn specialists and money motivated doctors would accept this job, compared to just one in two rich rejecters. As the job evolves to one with longer mandatory service before training in less favourable locations, the uptake among rich rejecters drops steeply but remains considerable for the other three subgroups. Even facing five years in a remote district hospital at basic pay, more than a third of all junior doctors in these classes would accept this job in exchange for favoured training, rising to 85% among stubborn specialists.

The second series of policy simulations examined possible incentives to improve uptake of training in priority but unpopular specialties. Here, each job is compared against a baseline scenario to estimate the proportion of doctors that could be persuaded to take up training in ophthalmology over a common training pathway. As can be seen from Figure 4, despite increasing incentives in terms of time before training, location of training, and salary, the uptake is minimal across all subgroups except the pliant patriots. In the final scenario, nearly one in two pliant patriots would choose a job training in ophthalmology with multiple incentives.

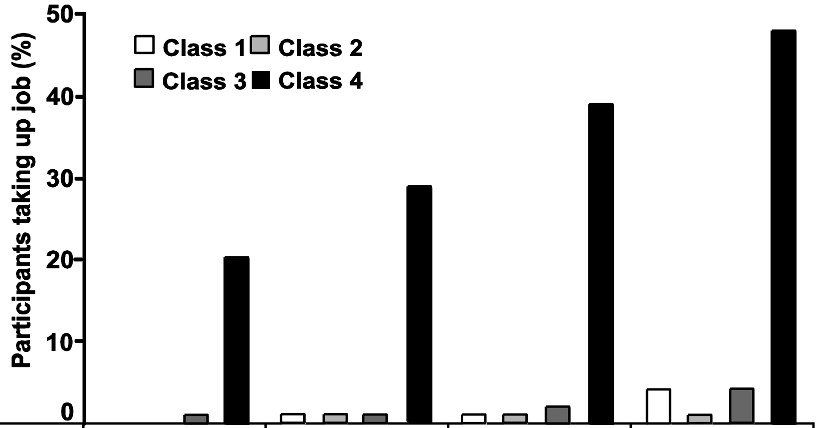
Figure 3 Maximising public sector service in exchange for preferred training



Scenario	1	2	3	4	5
Salary (MK)	110,000	110,000	110,000	110,000	110,000
Time before training	2 years	3 years	3 years	4 years	5 years
Job location	District hospital near town	District hospital near town	Remote district hospital	District hospital near town	Remote district hospital
Specialty	1st choice Core	1st choice Core	1st choice Core	1st choice Core	1st choice Core
Training location	Malawi & SA	Malawi & SA	Malawi & SA	Malawi & SA	Malawi & SA

Notes: *Figure indicates job uptake under conditions stipulated in scenarios 1 to 5. MWK = Malawian kwacha; SA = South Africa; see text for explanation of 1st choice Core*

Figure 4 Improving uptake of priority specialties



Scenario	Baseline	1	2	3	4
Salary (MWK)	110,000	110,000	110,000	160,000	160,000
Time before training	2 years	2 years	1 year	1 year	1 year
Job location	District hospital near town	District hospital near town	District hospital near town	District hospital near town	District hospital near town
Specialty	1st choice Core	Ophthalmology	Ophthalmology	Ophthalmology	Ophthalmology
Training location	Malawi & SA	All in Malawi	All in Malawi	All in Malawi	Malawi & SA

Notes: *Figure indicates job uptake in scenario 1 to 4 compared to that in baseline scenario; MWK = Malawian kwacha; SA = South Africa; see text for explanation of 1st choice Core*

DISCUSSION

Junior doctors in Malawi do not value all specialty training equally, but prefer timely training outside of Malawi in core specialties. A doctor would work in the Malawian public sector for an additional 1.3 to 8.5 years if guaranteed training in their 1st choice core specialty, but just two to five months for an extra 10% in basic salary. Training undertaken in Malawi would require a 36% to 79% increase in basic salary and training in ophthalmology, representing a bundle of unpopular but priority specialties, a 200% to 350% increase. We identified four subgroups of junior doctors with distinct preferences. Policy simulations showed that these can be leveraged by policymakers to maximise service in the public sector in exchange for guaranteed training in popular specialties, however incentivising the uptake of training in priority specialties will only be effective in those with more flexible preferences.

While previous discrete choice experiments have established the importance of postgraduate training to health workers, this is the first study to examine whether all postgraduate training is valued equally (Mandeville, Lagarde et al. 2014). Our results indicate that indiscriminate expansion of postgraduate training to slow emigration of doctors from sub-Saharan African countries may not be effective unless doctors' preferences are taken into account. Considerable divergence in these preferences was revealed through the novel use of a latent class model in this area. The study design also enabled the use of a new measure, willingness to stay, that provides a tangible indicator for retention of health professionals. Interpretation of willingness to pay and stay values, however, should be cautious given their sensitivity to the levels stipulated for the salary and time attributes (Ryan and Wordsworth 2000, Slothuus Skjoldborg and Gyrd-Hansen 2003, Sivey, Scott et al. 2012). While the number of participants is small, this is a near complete census of the eligible population in Malawi and in line with previous DCEs in LMIC (Mandeville, Lagarde et al. 2014). Indeed, as finite population corrections are not possible for these models, it is likely that the significance levels shown here are conservative. Finally, the stated preferences elicited by discrete choice experiments may be seen to be inferior to the revealed preferences gleaned from controlled or observational studies. Yet controlled experiments, while aspirational, are politically difficult to perform on workforces. Observational studies are unable to distinguish the independent effects of attributes made possible through the experimental design of discrete choice experiments. Finally, in lower-income settings, resource constraints may restrict the options that can be offered to doctors, meaning that observable choices may not reflect true preferences.

Our findings concur with other studies demonstrating the value placed on postgraduate training by doctors and medical students compared to other job attributes, although these studies focused on attraction and retention in rural areas (Vujicic, Alfano et al. 2010b, Vujicic, Shengelia et al. 2011, Rockers, Jaskiewicz et al. 2012, Lagarde, Pagaiya et al. 2013, Rao, Ryan et al. 2013). One other discrete choice experiment has explored specialty preferences, with Sivey et al. investigating the generic aspects of a specialty that increase its attractiveness to Australian junior doctors and finding a substantial effect of future earnings on specialty choice (Sivey, Scott et al. 2012). While these findings are from a high-income setting, the strong specialty preferences seen here may reflect perceived opportunities for private practice or, in the case of public health, well-paying jobs with non-government organisations (Bailey, Mandeville et al. 2012). Sivey et al. also found that doctors with higher levels of educational debt placed greater value on future earnings. Financial constraints may also have influenced the preferences of the money motivated subgroup, who supported more dependents, seldom opted out of the jobs on offer, and placed the highest value of all subgroups on public health training (despite disliking district-level work). While preferences for training location were not as strong as for the specialty itself, our results corroborate qualitative findings that most junior doctors in Malawi are reluctant to accept training all in Malawi (Bailey, Mandeville et al. 2012, Sawatsky, Parekh et al. 2014). We did, however, identify a minority who were indifferent to training in higher-income settings and this proportion may increase as domestic training becomes more established. Three other studies have identified substantial heterogeneity in preferences for specialty training, although none using a latent class model (Vujicic, Alfano et al. 2010b, Rockers, Jaskiewicz et al. 2012, Lagarde, Pagaiya et al. 2013). In particular, Vujicic et al. examined job preferences of final-year medical students and graduated doctors (mean age 42) in Vietnam, finding that the most important attribute for students was guaranteed specialty training after five years, with a six-fold difference in willingness to pay compared to that of doctors (who most valued working in an urban area) (Vujicic, Alfano et al. 2010b). We found that younger doctors had more fixed specialty preferences than older doctors, who were more willing to compromise on aspects of training. This suggests a critical window soon after graduation in which to leverage specialty training as an incentive, after which doctors place greater importance on other aspects of a job.

The broad conclusions from our results are likely to be generalisable to the many other sub-Saharan African countries at the same juncture in their domestic medical training (Mullan, Frehywot et al. 2011). For example, many countries in the region are struggling to increase their ophthalmologist workforce in line with agreed targets and a growing burden of eye disease (Palmer, Chinanayi et al. 2014). Our results suggest that any investment into scaling up training should focus on those with more flexible preferences.

These “pliant patriots” could be identified soon after graduation and targeted for fast-track training in priority specialties with an incentive package. In the same way, the firm training preferences of other junior doctors could be leveraged by stipulating several years of service in posts facing recruitment problems, e.g. remote district hospitals, as entry criteria for training in favoured specialties.

Our results provide clear evidence that postgraduate training is not a straightforward concept, and future studies would benefit from more detailed exploration of this attribute. Future research following up career choices in this cohort would shed light on the predictive validity of subgroup preferences, e.g. whether pliant patriots tend to take up training in Malawi, and the effectiveness of specialty training on retention in the long-term. Finally, no choice is without cost, and the cost-effectiveness of providing specialty training in Malawi given the preferences identified here is also a key research question.

8.3 SUPPLEMENTARY FILE

This document provides additional methodological details and results. The first section gives further details on the study population. The second section outlines the results used in the specialty flexibility index. The final section describes the latent class model results.

1. Study population

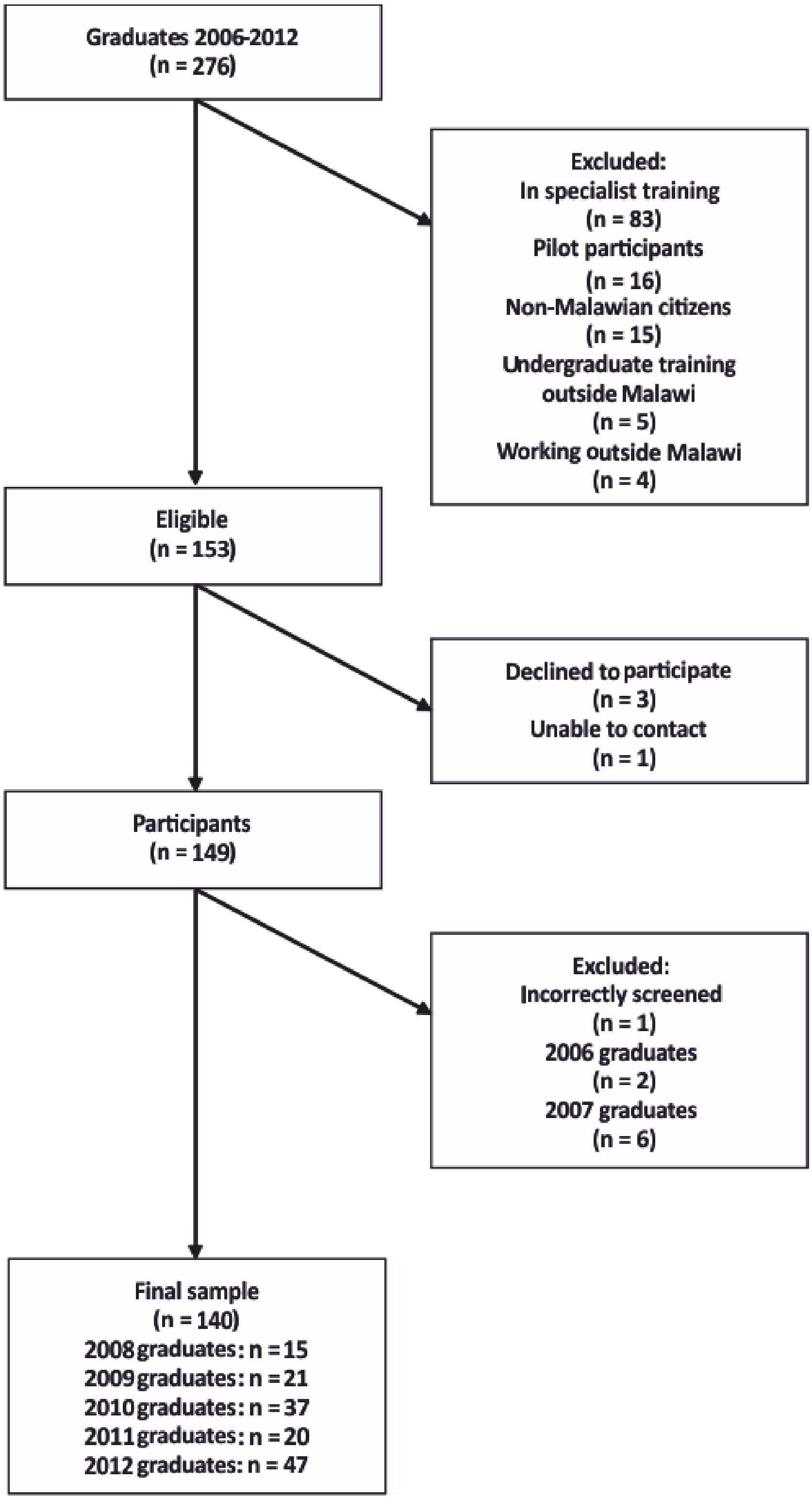
Table A1 summarises participant characteristics and Figure A1 outlines the flow of participants.

Table A1 Participant characteristics

Characteristic	**Observations**	**Number (%)**	**Mean (SD)**	**Range**
Sociodemographic				
Male	140	87 (62.1)		
Age in years	140		25 (2.68)	21 - 36
Income in MWK	137		108,000 (74,465)	100,000 – 600,000
Position	140			
Intern		78 (55.7)		
Hospital medical officer		9 (13.6)		
District medical officer		20 (14.3)		
District health officer		11 (7.9)		
Outside public sector		12 (8.6)		
Attitudes to postgraduate training				
Desire to specialise	140	139 (99.3)		
Currently looking for scholarship	139	101 (72.7)		
Months looking for scholarship	100		8.9 (10.1)	1-50

Notes: *SD = standard deviation; MWK = Malawian Kwacha*

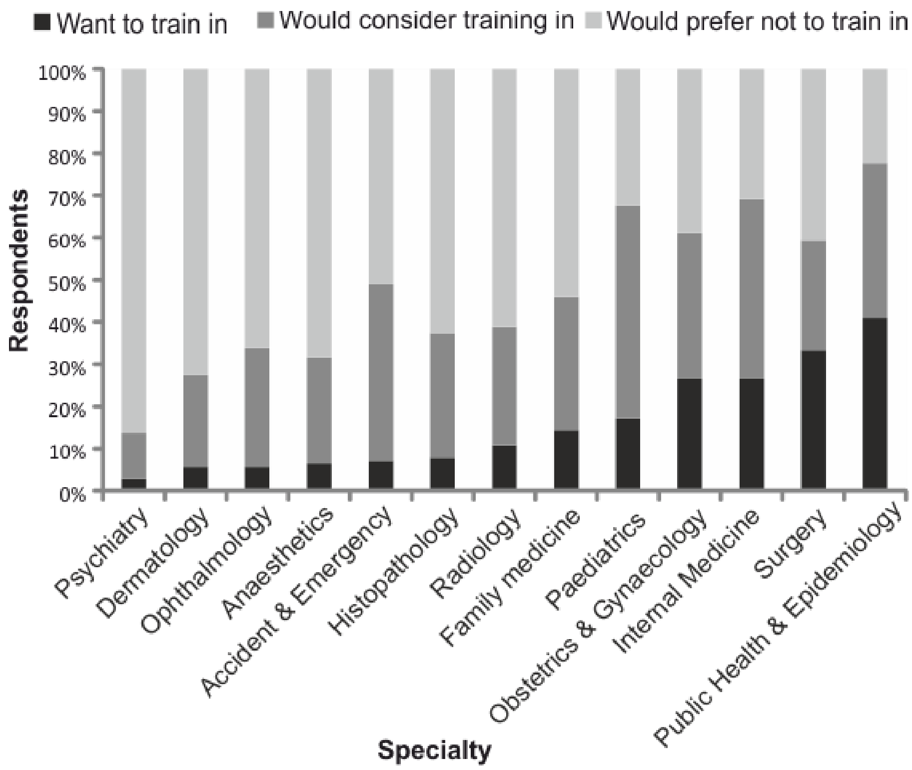
Figure A1 **Flow of participants through study**



2. Specialty preferences

As part of the accompanying questionnaire, we asked participants to indicate for 13 specialties whether: (i) they would want to train in it; (ii) they would consider training in it; or (iii) they would prefer not to train in it. Figure A2 shows these specialty preferences. Responses to these questions were used to construct a 13-point "specialty flexibility index", with a positive response to (i) or (ii) scoring one point. Higher/lower scores on the index therefore indicate greater/lesser flexibility in specialty training choices.

Figure A2 Specialty preferences of participants



3. Econometric analysis

In a latent class model, the analyst must stipulate the number of classes and which variables to include in the model. The best fitting model for the data comprised four latent classes and incorporated three observed variables: age, specialty flexibility index, and current salary. Table A2 shows the model fit measures by number of classes.

Table A2 Model fit measures by number of latent classes

	Number of classes			
Model statistics	**2**	**3**	**4**	**5**
Number of parameters	28	44	60	76
Number of observations	2240	2240	2240	2240
Log-likelihood function	-2073.9	-1972.1	-1860.1	-1845.8
Model fit measures				
Pseudo R-squared	0.16	0.20	0.24	0.25
Akaike information criterion	4203.9	4032.2	3840.1	3843.6
Bayesian information criterion	4363.9	4283.6	4183.0	4277.9

The results of the four-class latent class model are shown in Table A3. When the signs and significance of coefficients are compared for different attributes and levels, it can be seen that all doctors prefer higher salaries and less time before training. Training undertaken exclusively in Malawi is universally unattractive, with training all in South Africa or outside Africa preferred by most. The preferences for specialty are generally highly significant, indicating their importance in junior doctors' job choices, in comparison to job location that did not significantly influence doctors' choices for the most part. Most junior doctors would prefer to train in core specialties than ophthalmology, with divided preferences for training in public health. The opt-out option was only significant in class 1, with a positive value indicating the attractiveness of this alternative compared to the other attributes. The coefficients for the class membership variables indicate that, compared to the participant average, doctors in class 3 tended to be less flexible in their specialty preferences and doctors in class 2 tended to be younger (approaching significance at 0.053). The salary variable was not significant in any class, but its inclusion led to a better fit.

Table A3 Latent class model results

Notes: *MK = Malawian kwacha; *Significant at 5% level; **Significant at 1% level or less; [a]See main paper for explanation; [b]Reference level, therefore only coefficient can be calculated from other parameters in category*

Class	**1**			**2**			**3**			**4**		
Class probability	0.307			0.308			0.160			0.226		
	Coefficient	**SE**	**P-value**	**Coefficient**	**SE**	**P-value**	**Coefficient**	**SE**	**P-value**	**Coefficient**	**SE**	**P-value**
Job preferences												
Salary (MK 10,000)	0.124**	0.027	0.000	0.070**	0.027	0.003	0.137**	0.035	0.000	0.094**	0.025	0.000
Time before training (year)	-0.752**	0.076	0.000	-0.277**	0.096	0.004	-0.306**	0.109	0.005	-0.457**	0.084	0.000
Job location												
Major central hospital	-0.209	[b]	[b]	0.157	[b]	[b]	0.674	[b]	[b]	0.125	[b]	[b]
Minor central hospital	-0.113	0.172	0.509	-0.0170	0.145	0.907	0.162	0.257	0.530	-0.114	0.129	0.377
District hospital near town	0.490**	0.181	0.007	0.217	0.153	0.156	-0.064	0.186	0.733	0.225	0.134	0.093
Remote district hospital	-0.168	0.188	0.371	-0.357	-0.357	0.062	-0.772*	0.319	0.015	-0.236	0.149	0.112
Training location												
All in South Africa	0.167	[b]	[b]	0.150	[b]	[b]	0.251	[b]	[b]	0.068	[b]	[b]
Malawi & South Africa	0.073	0.167	0.663	0.010	0.153	0.950	-0.155	0.202	0.444	0.113	0.119	0.344
All in Malawi	-0.952**	0.168	0.000	-0.598**	0.193	0.002	-0.783**	0.211	0.000	-0.367*	0.148	0.013
All outside Africa	0.712**	0.145	0.000	0.438**	0.156	0.005	0.687**	0.265	0.010	0.186	0.124	0.133
Specialty												
1st choice Core,[a]	1.296	[b]	[b]	2.364	[b]	[b]	0.999	[b]	[b]	0.617	[b]	[b]
2nd choice Core[a]	0.520**	0.174	0.003	1.353**	0.131	0.000	0.303	0.189	0.108	0.243	0.148	0.085
Ophthalmology	-2.661**	0.304	0.000	-2.485**	0.410	0.000	-2.984**	0.410	0.000	-0.235	0.201	0.242
Public health	0.845**	0.175	0.000	-1.232**	0.212	0.000	1.682**	0.302	0.000	-0.625**	0.157	0.000
Opt-out option	1.571**	0.445	0.000	0.611	0.464	0.187	0.082	0.562	0.884	-0.632	0.340	0.063
Class membership variables												
Age	-0.089	0.114	0.434	-0.318	0.164	0.053	0.186	0.156	0.232	-	-	-
Specialty flexibility index	-0.199	0.164	0.225	-0.213	0.191	0.264	-0.657*	0.288	0.023	-	-	-
Current salary (MK10,000)	0.156	0.130	0.231	0.142	0.146	0.332	-0.179	0.155	0.250	-	-	-

8.4 OUTLINE OF FURTHER ANALYSIS

The following sections present the results of further analysis carried out on the DCE survey data, including participants' characteristics, salary levels and specialty choices. Other models undertaken as part of the survey analysis are described, as well as a comparison of forced and unforced choice data[42].

8.4.1 Participant characteristics

As part of the analysis, participants' characteristics were compared against available population indicators in order to build up a profile of the junior doctor population in Malawi. Key characteristics are shown in Table 8.1. Only one in five junior doctors described their upbringing as rural, compared to a rural population in Malawi of 84% in 2013 (World Bank 2015). Nearly 80% had at least one parent who had gone onto tertiary education, set against just 1.6% of the adult population in Malawi with a tertiary education qualification (National Statistical Office of Malawi 2012) and 81% of the population existing as subsistence farmers (National Statistical Office of Malawi 2012). Most of the Malawian population faces barriers to international travel, with the current fee of MWK15,100 for a new passport set at more than the national median monthly gross income of MWK13,600 (Department of Immigration (Republic of Malawi) 2010, National Statistical Office of Malawi 2014). In contrast, two in every five junior doctors had travelled outside Africa at some point.

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[42] The "unforced choice" is the first choice made which includes an opt-out option. If participants chose the opt-out option, they were then asked to indicate which job option they would lean towards as the "forced choice" (see Appendix I).

Table 8.1 Participant characteristics

Characteristic	N (%)
Upbringing	
Rural	25 (17.9)
Urban	110 (78.6)
Neither	5 (3.6)
At least one parent tertiary educated	111 (79.3)
Ever travelled outside of Africa	56 (40.0)

Overall, the profile of the current junior doctor population in Malawi suggests a selection process for medical school that is overrepresentative of a highly educated urban population and underrepresentative of the general population.

8.4.2 Salary differentials between sectors

The cross-sectional survey permitted comparison of current salary levels between participants working in the public sector and those working in other jobs (such as included research projects, private companies and NGOs). Unfortunately, some of the latter participants declined to disclose their current remuneration. From available data (Table 8.2), however, a large differential can be seen across sectors, with those outside the public

Table 8.2 Monthly net salary levels across sectors

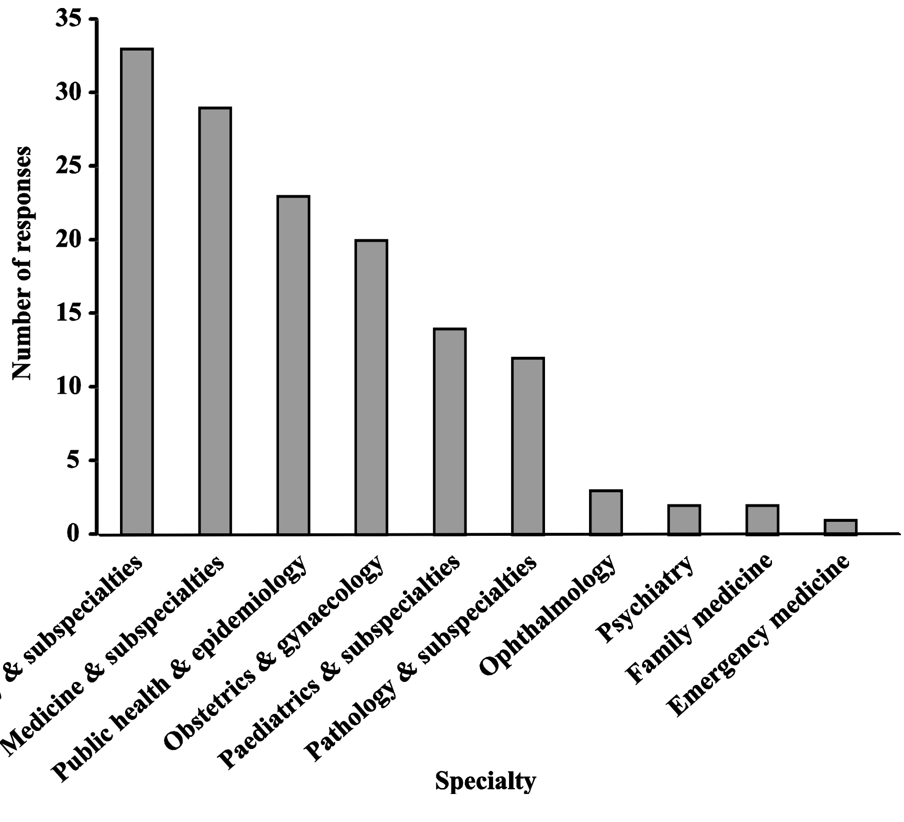
Sector	Observations (N)	Mean (MWK)	Standard deviation (MWK)	Range (MWK)
Public	132	113,426	29,584	100,000 - 315,000
Non-public	5	462,495	114,511	337,000 - 600,000

sector earning on average four times more than those in the public sector. This only takes into account official salaries, however, and does not incorporate other sources of income.

8.4.3 Specialty preferences

In addition to preferences for each specialty, the cross-sectional survey also asked participants to name one specialty they would train in if any were possible. Nearly a third of participants (31.1%) stated a specialty that was not available as a MMed programme at COM. This open-ended question also confirmed the dominance of core specialties and public health, and the unpopularity of more marginal specialties, in junior doctors' specialty intentions (Figure 8.1).

Figure 8.1 Responses for "any specialty" question



While some participants may be planning to train in an underrepresented specialty and bring these skills back to Malawi, these responses nonetheless indicate a mismatch between current training capacity in Malawi and the shaping of specialty preferences during undergraduate training and early practice.

8.4.4 Alternative models

Several other models were considered in place of the latent class model, including the mixed logit, generalised mixed logit and latent class random parameters models. These are all parametric models, requiring the analyst to specify a probability distribution for those parameters set as random rather than fixed (Greene 2012, Clark, Determann et al. 2014).

The mixed logit model has become increasingly popular, with over 20% of recent DCEs in health and over 40% of DCEs in HRH using this model (Clark, Determann et al. 2014, Mandeville, Lagarde et al. 2014). Rather than a single mean coefficient for the whole population, individual specific parameters are estimated, thus enabling an assessment of heterogeneity for each parameter (Lagarde, Pagaiya et al. 2013). For those with significant heterogeneity, the source of this heterogeneity can be explored by introducing observed variables to interact with these parameters (Hensher, Rose et al. 2005). A study comparing the performance of a mixed logit model to that of a latent class model on the same dataset showed stronger statistical support for the latent class model - although neither outperformed the other overall (Greene and Hensher 2003).

The generalised multinomial logit model has an advantage over the mixed logit in its ability to account for scale heterogeneity, or variance in the error terms between participants (Fiebig, Keane et al. 2010, Sivey, Scott et al. 2012, Lagarde 2013). Its use is gradually increasing, with 15% of HRH DCEs employing this model.

The latent class random parameters model combines elements of the latent class and mixed logit model, with intra-class choice probabilities specified by a continuous distribution using a mixed logit model (random parameters being another name for mixed logit) (Greene 2012). This model has not yet been used in DCEs in health or HRH (Clark, Determann et al. 2014, Mandeville, Lagarde et al. 2014).

In order to compare the performance of these models in the investigation of unobserved heterogeneity in this dataset, a mixed logit model was first explored alongside the latent class model.

8.4.5 Mixed logit model results

The mixed logit model was developed using effects-coded data and 10 standard Halton sequence intelligent (Halton) draws were initially used for exploratory purposes. All parameters were initially set as random with normal distributions. Although examination of a range of probability distributions (e.g. lognormal, uniform, triangular) is suggested in theory (Hensher, Rose et al. 2005), in practice virtually all applications have used normal distributions. Those with non-significant standard deviations were excluded from the model in a stepwise manner. Sources of the heterogeneity for each random parameter were then explored through the interaction of each random parameter with observed variables from the cross-sectional survey. From a list of ten possible variables, only two were found to be consistently significant as the number of draws was increased:

(i) Rural experience. This indicated whether the participant was currently working or had previously worked at a rural facility (either MOH district hospital or CHAM facility);

(ii) Specialty flexibility: this indicates a higher score on the specialty flexibility index (see research paper).

The final model specification was run with 1000 Halton draws and the results are presented in Table 8.3 below. All attributes have the expected sign. All are significant, except for those minor central hospital and training in Malawi & South Africa as seen with the latent class model. With regard to sources of heterogeneity, those junior doctors with rural experience have a positive preference for working in a remote district hospital and in public health compared to the whole population. They also have a weaker preference for their second-choice core specialty than their peers. In comparison, those with more flexible specialty preferences are slightly less adverse against training in ophthalmology. These results point again to the existence of subgroups within the junior doctor population with different preferences, although not quite as distinctly as with the latent class model.

Model fit measures showed a worse fit with the mixed logit model than all but the two-class latent class model (Table 8.4). Moreover, the mixed logit model proved very unstable. In contrast to usual modelling experience, significant parameter heterogeneity identified at low numbers of random draws frequently became non-significant with larger draws (Hensher, Rose et al. 2005). Additionally, the exploration of possible sources of heterogeneity through interactions with background characteristics or attitudes often led to failure of the model to converge. The results presented in Table 8.3 represent the most stable obtained. Possible reasons for this instability could be the modest number of

Table 8.3 Results of mixed logit model

Number of observations	2240			**Pseudo R2**		0.19	
Number of parameters	31			**AICc**		4056.90	
Log-likelihood function	-1997.01			**Bayesian information criterion**		4233.16	
Attribute and interaction term	**Coefficient**	**SE**	**SD**	**WTP in MK**	**WTP 95% CI**[e]	**WTS in months**	**WTS 95% CI**[e]
Salary (MK 10,000)	0.100**	0.011	N/A	N/A	N/A	-2.6**	-3.2 to -2.0
Time before training (year)	-0.460**	0.035	N/A	-46,108**	-56,847 to -35,369	N/A	N/A
Job location							
Major central hospital	0.245	[c]	N/A	10,620	[c]	-6.4	[c]
Minor central hospital	-0.031	0.066	N/A	-3.123	-16,041 to 9,794	0.8	-2.6 to 4.2
District hospital near town	0.201**	0.069	N/A	20,175**	5,860 to 34,490	-5.3**	-8.7 to -1.8
Remote district hospital [a]	-0.415**	0.093	0.281**	-41,572**	-63,216 to -19,928	10.8**	5.6 to 16.0
x rural experience	0.033**	0.140	N/A	2,849	N/A	0.81	N/A
Training location							
All in South Africa	0.146	[c]	N/A	14,609	[c]	-3.8	[c]
Malawi & South Africa	0.102	0.070	N/A	10,273	-3,754 to 24,301	-2.7	-6.3 to 0.9
All in Malawi [a]	-0.699**	0.076	0.302**	-70.112**	-90,777 to -49,447	18.2**	14.4 to 22.1
All outside Africa	0.451**	0.071	N/A	45,191**	29,870 to 60,511	-11.8**	-15.4 to -8.1
Specialty							
1st choice Core[b]	2.416	[c]	N/A	241,632	[c]	-63.0	[c]
2nd choice Core[a,b]	1.016**	0.105	0.771**	101,858**	72,908 to 130,809	-26.5**	-32.6 to -20.4
x rural experience	0.459**	0.166	N/A	40,099	N/A	11.4	N/A
Ophthalmology [a]	-2.778**	0.281	1.679**	-278,559**	-353,874 to -203,244	72.5**	57.1 to 87.9
x specialty flexibility	-2.680**	0.037	N/A	-234,173	N/A	-66.7	N/A
Public health	-0.654**	0.076	1.746**	-65,583**	-100,505 to -30,661	17.1**	8.8 to 25.3
x rural experience	0.747**	0.266	N/A	65,254	N/A	18.6	N/A
Opt-out option	0.732	0.185	N/A	73,365**	48,370 to 98,359	-19.1**	-29.6 to -8.6

Notes:
AICc = Akaike information criteria with a correction for finite sample sizes;
MK = Malawian kwacha;
SE = standard error;
SD = standard deviation;
WTP = willingness to pay;
WTS = willingness to stay;
CI = confidence intervals;
N/A = not applicable;
**Significant at 5% level;*
***Significant at 1% level or less;*
[a]*Parameter set as random;*
[b]*See text for explanation;*
[c]*Reference level, therefore only coefficient can be calculated from other parameter coefficients in category;*
[d]*Calculated using the delta method*

Table 8.4 Model fit measures for latent class and mixed logit models

Model	2-class latent class	Mixed logit	3-class latent class	4-class latent class	5-class latent class
Parameters	28	31	44	60	76
Observations	2240	2240	2240	2240	2240
Log-likelihood function	-2073.94	-1997.01	-1972.09	-1860.07	-1845.81
Pseudo R^2	0.16	0.19	0.20	0.24	0.25
AIC	4203.90	4056.00	4032.20	3840.10	3843.60
AICc	4204.63	4056.90	4034.00	3843.46	3849.01
AIC3	4063.89	3901.02	3812.18	3540.13	3463.62
BIC	4363.88	4233.16	4283.61	4182.99	4277.90

Notes: *AIC = Akaike information criterion; AICc = Akaike information criterion with a correction for finite sample sizes; AIC3 = Akaike information criterion with a per-parameter penalty factor of 3; BIC = Bayesian information criterion*

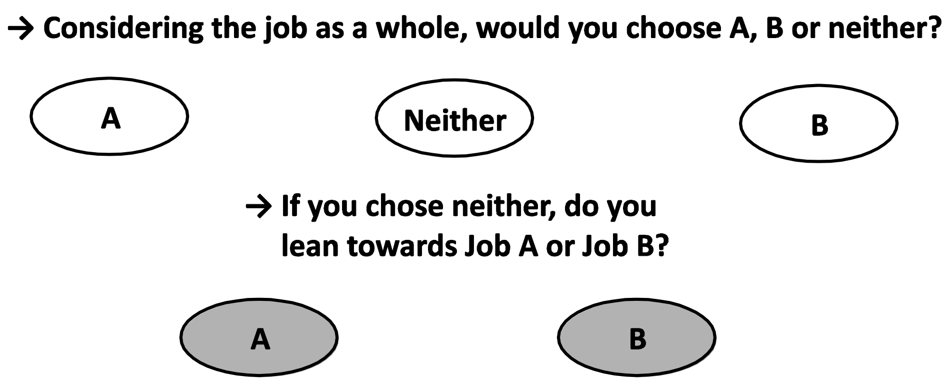
observations (although in line with other DCEs in HRH that have successfully used mixed logit models) or the relative homogeneity of most observed variables in these participants. Given this volatility, I did not attempt to estimate the more computationally demanding models under consideration.

8.4.6 Analysis of forced choice versus opt out data

All the results presented above are from a ternary choice: two generic alternatives and an opt-out option. The DCE, however, comprised a two-stage choice task: first with the option to opt out and then forcing participants to choose between the two jobs on offer

(Figure 8.2). As discussed in Chapter 3, the inclusion of an opt-out option avoids an unrealistic “forced choice” that may overestimate preferences, leading to inflated welfare estimates and overconfident predictions of job uptake rates (Carson, Louviere et al. 1994, Olsen and Swait 1997, Ryan and Skatun 2004, King, Hall et al. 2007, Louviere and Lancsar 2009, Mandeville, Lagarde et al. 2014). The risk is that participants may frequently select the opt-out option (possibly to avoid a cognitively challenging choice), leading to insufficient data for model estimation.

Figure 8.2 Opt-out option in choice task



The norm in previous health workforce DCEs has been a forced choice. Out of the 27 health workforce DCEs identified in my systematic review, only a third included an opt-out or *status quo* option (8/27, 29.6%). This may be changing, as half the studies published since this review (see Section 3.7) did include such an option (5/10, 50%) (Li, Scott et al. 2014, Pedersen and Gyrd-Hansen 2014, Yaya Bocoum, Koné et al. 2014, Robyn, Shroff et al. 2015, Scott, Witt et al. 2015). In order to investigate the impact of a forced versus unforced choice, I compared the datasets for both responses.

Table 8.5 shows the pattern of responses by choice task number. The opt-out option was used in 37% of responses in the unforced choice. Although this produced sufficient data for the latent class model, it may have contributed to the volatility of the mixed logit model. For both the forced and unforced choice, the distribution between Job A and B is nearly equal overall, as would be expected in a generic choice task with an efficient design based on utility balance (Choicemetrics Pty Ltd 2014).

Table 8.5 Distribution of responses in forced and unforced choice datasets

		Unforced choice			**Forced choice**	
		A	**B**	**Neither**	**A**	**B**
Total	**N**	689	720	831	1106	1131
	%	*30.8*	*32.1*	*37.1*	*49.4*	*50.6*

In order to examine whether those who opted out were doing so to avoid a cognitively challenging task, I compared the distribution of A and B responses for these participants in the forced choice tasks against the distribution of A and B responses in the initial unforced choice tasks (Table 8.6). In 13 out of 16 choice tasks, the pattern of A and B responses in those forced to make a choice were not significantly different compared to the pattern in those who chose A or B freely.

In the three choice tasks with a significant difference, I then investigated whether the observed pattern was different to an expected distribution if the choice had been made randomly, i.e. an equal proportion of A and B responses. Table 8.6 shows that there was a significant difference between the observed and expected pattern for one choice task,

Table 8.6 Comparison of responses in forced and unforced choice datasets

Choice Task		Unforced choice		Opt-outs only		Opt-outs compared to unforced choice		Opt-outs compared to random choice	
		A	**B**	**A**	**B**	χ^2	**p-value**	χ^2	**p-value**
1	**N**	32	29	34	45	1.23	0.268	-	-
	%	22.9	20.7	43.0	57.0	-	-	-	-
2	**N**	33	22	58	27	1.00	0.318	-	-
	%	23.6	15.7	68.2	31.8	-	-	-	-
3	**N**	46	26	39	29	0.63	0.836	-	-
	%	32.9	18.6	57.4	42.6	-	-	-	-
4	**N**	19	98	13	10	17.69	0.000	0.34	0.562
	%	13.6	70.0	56.5	43.5	-	-	-	-
5	**N**	67	67	5	1	-	*0.210	-	-
	%	47.9	47.9	83.3	16.7	-	-	-	-
6	**N**	41	54	27	18	3.47	0.063	-	-
	%	29.3	38.6	60.0	40.0	-	-	-	-
7	**N**	28	35	43	33	2.03	0.154	-	-
	%	20.0	25.0	55.8	42.9	-	-	-	-
8	**N**	14	69	29	28	18.37	0.000	0.01	0.911
	%	10.0	49.3	50.9	49.1	-	-	-	-
9	**N**	36	54	17	32	0.38	0.538	-	-
	%	25.7	38.6	34.0	64.0	-	-	-	-
10	**N**	31	15	49	45	2.94	0.087	-	-
	%	22.1	10.7	52.1	47.9	-	-	-	-
11	**N**	68	33	10	29	2.43	0.119	-	-
	%	48.6	23.6	25.6	74.4	-	-	-	-
12	**N**	60	48	17	15	0.06	0.808	-	-
	%	42.9	34.3	53.1	46.9	-	-	-	-
13	**N**	57	53	8	22	6.00	0.014	5.42	0.020
	%	40.7	37.9	26.7	73.3	-	-	-	-
14	**N**	47	46	22	25	0.17	0.677	-	-
	%	33.6	32.9	46.8	53.2	-	-	-	-
15	**N**	60	20	47	13	0.21	0.646	-	-
	%	42.9	14.3	78.3	21.7	-	-	-	-
16	**N**	50	51	25	13	2.95	0.086	-	-
	%	35.7	36.4	64.1	33.3	-	-	-	-
Total	**N**	689	720	443	385	-	-	-	-
	%	30.8	32.1	53.3	46.3	-	-	-	-

Notes: *All comparisons are χ^2 tests with one degree of freedom, except * = 2-sided Fisher's exact test. Random choice indicates an equal proportion of A and B responses.*

but for the two other tasks there was no difference compared to a randomly chosen distribution. In summary, in 14 out of 16 forced choice tasks, participants who had opted out were not choosing randomly. This suggests that participants are not opting out in order to avoid cognitive effort, but are likely to have valid reasons to do so. This supports the findings of the latent class model that identified a large subgroup of participants who opted out more often than their peers, and also the use of the unforced choice dataset.

I then analysed the forced choice dataset using a mixed logit model with the same set of random parameters and individual-level variables found to be most stable above (section 8.4.5). Table 8.7 compares the results for the unforced and forced choice models. An alternative-specific constant for Job B replaces the opt-out option and is non-significant, as expected in a generic choice. The coefficient for Malawi and South Africa, which is non-significant in the unforced choice model, becomes strongly significant in the forced choice model. Participants with rural experience do not have significantly less aversion to working in a remote district hospital in the forced choice model, as was seen with the unforced choice model. Apart from these variables, there is little difference in sign or significance of the parameter estimates. There is no significant difference in the standard deviations between models.

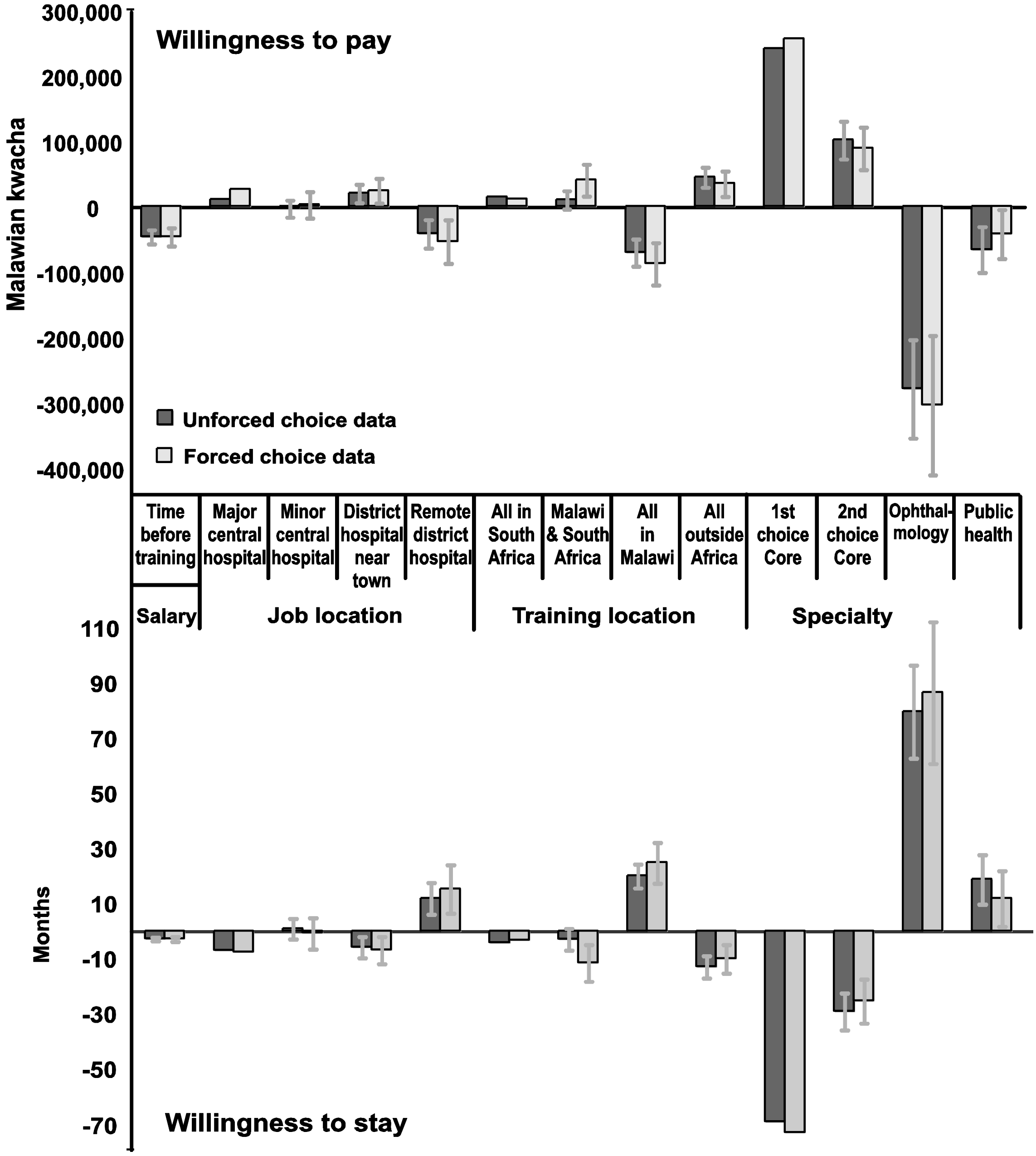
In order to compare parameter estimates between the two models, the willingness to pay and stay values are shown in Figure 8.3. In general, the confidence intervals are wider around the forced choice values. There are no significant differences between the two sets of values, and no consistent pattern of over- or under-estimation. The forced choice data

Table 8.7 Mixed logit results for forced and unforced choice data

	Unforced choice model			**Forced choice model**		
Model fit measures	**Observations**	**Parameters**	**LLF**	**Observations**	**Parameters**	**LLF**
	2240	31	-2073.94	2237§	31	-1260.01
	Pseudo R^2	**AICc**	**BIC**	**Pseudo R^2**	**AICc**	**BIC**
	0.19	4204.63	4363.88	0.19	2582.90	10,201.85
Attribute	**Coefficient**	**SE**	**SD**	**Coefficient**	**SE**	**SD**
Salary (MK 10,000)	0.100**	0.011	N/A	0.0683**	0.012	N/A
Time before training (year)	-0.460**	0.035	N/A	-0.316**	0.051	N/A
Job location						
Major central hospital	0.245	[c]	N/A	0.181	[c]	N/A
Minor central hospital	-0.031	0.066	N/A	0.190	0.069	N/A
District hospital near town	0.201**	0.069	N/A	0.166**	0.064	N/A
Remote district hospital[a]	-0.415**	0.093	0.281**	-0.365**	0.082	0.297**
x rural experience	0.033**	0.140	N/A	-0.170	0.127	N/A
Training location				0.035		
All in South Africa	0.146	[c]	N/A	0.078	[c]	N/A
Malawi & South Africa	0.102	0.070	N/A	0.277**	0.067	N/A
All in Malawi[a]	-0.699**	0.076	0.302**	-0.595**	0.076	0.249**
All outside Africa	0.451**	0.071	N/A	0.240**	0.066	N/A
Specialty						
1st choice Core[b]	2.416	[c]	N/A	1.750	[c]	N/A
2nd choice Core[a,b]	1.016**	0.105	0.771**	0.608**	0.091	0.609**
x rural experience	0.459**	0.166	N/A	0.296*	0.134	N/A
Ophthalmology[a]	-2.778**	0.281	1.679**	-2.073**	0.290	1.982**
x specialty flexibility	-2.680**	0.037	N/A	-1.975**	0.034	N/A
Public health[a]	-0.654**	0.076	1.746**	-0.285**	0.132	1.329**
x rural experience	0.747**	0.266	N/A	0.416**	0.271	N/A
Opt-out option/ASC	0.732	0.185	N/A	0.008	0.056	N/A

Notes:
Effects coded data.
LLF = log-likelihood function;
AICc = Akaike information criteria with a correction for finite sample sizes;
BIC = Bayesian information criterion;
MWK = Malawian kwacha;
ASC = alternative-specific constant;
SE = standard error;
SD = standard deviation;
N/A = not applicable;
ASC = alternative-specific constant;
§One participant refused to make a forced choice on three choice tasks, stating that both jobs were "equally bad".
**Significant at 5% level;*
***Significant at 1% level or less;*
[a]Parameter set as random
[b]See text for explanation;
[c]Reference level, therefore only coefficient can be calculated from other parameter coefficients in category

Figure 8.3 Welfare estimates in forced and unforced choice mixed logit models



Notes: *95% confidence intervals shown. Major central hospital, All in South Africa and 1st choice core specialty are reference levels, therefore only the coefficient can be calculated from other parameter coefficients in category and not confidence intervals* would have led to slightly different policy conclusions, however, such as less importance placed on the value of public health training.

Although there is no consistent difference between the welfare estimates from the forced and unforced choice datasets, the identification of a subgroup of doctors who consistently opt out of the public sector jobs offered here (the “rich rejecters”) supports the use of the unforced choice data. The target of retention policies needs to be those who are amenable to staying in the public sector. Not providing an opt-out option makes it harder to distinguish the preferences of the two groups and could lead to less effective policy.

8.5 CONCLUSIONS

The results presented in this chapter offer important information to decision-makers on potential strategies to leverage the preferences of junior doctors for specialist training to achieve several workforce objectives. However, it is necessary to go beyond these results in order to more fully inform policy. The effectiveness of these strategies cannot be considered in isolation to their costs. The next chapter presents the results of a CEA that incorporates these results to assess the impact of specialty training in the long-term.

9 COST-EFFECTIVENESS ANALYSIS

9.1 OVERVIEW

Specialist training is expensive, and employing specialists even more so. Expanding the specialist workforce, however, widens the range of diseases that can be treated in-country. It is also a potentially powerful policy lever to retain junior doctors, as seen by the results in the previous chapter. Expanding specialist training, therefore, can be viewed as an investment for a country. In order to maximise the returns on this investment, junior doctors would need to accept the training places on offer and specialists would need to remain in Malawi after training. So far this thesis has only investigated the first premise - a very short-term perspective. Furthermore, the preferences of junior doctors for different types of specialty training do not take into account the cost of providing such training. In order to fully assess the consequences of expanding specialty training, a longer-term perspective is required, as well as consideration of related costs.

The last stage of this research programme was to determine the cost-effectiveness of specialty training for retaining doctors in the Malawian public sector, thus fulfilling the final research objective. The results presented in the preceding chapters are incorporated along with purposely gathered cost data. This chapter is written in paper style, but has not yet been submitted to a journal. Due to likely word restrictions, detailed explanations of some model parameters have been separated into a supplementary online file.

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SECTION A – Student Details

Student	Kate Mandeville
Principal Supervisor	Kara Hanson
Thesis Title	Train to retain: the role of specialty training in stemming Malawi's medical brain drain

If the Research Paper has previously been published please complete Section B, if not please move to Section C

SECTION B – Paper already published

Where was the work published?			
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Where is the work intended to be published?	Social Science and Medicine
Please list the paper's authors in the intended authorship order:	Kate L. Mandeville, Adamson S. Muula, Titha Dzowela, Godwin Ulaya, Kara Hanson, Mylène Lagarde
Stage of publication	**Not yet submitted**

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	I undertook the design, data collection and analysis for this study. I also wrote the first draft of the manuscript.

Student Signature: K.L. Mandeville **Date:** 10.3.2016

Supervisor Signature: K Hanson **Date:** 11/3/16

9.2 RESEARCH PAPER

Specialty training for the retention of Malawian doctors: a cost-effectiveness analysis

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Keywords: cost-effectiveness; human resources for health; Malawi; Education, Medical; Specialization

ABSTRACT

Background

Few medical schools and high emigration have led to low numbers of doctors in many sub-Saharan African countries. The opportunity to undertake specialty training has been shown to be particularly important to retain doctors. Yet limited training capacity means that doctors are often sent to other countries to specialise, increasing the risk that they may not return after training. Expanding domestic training, however, may be constrained by the reluctance of doctors to accept training in their home country. We modelled different policy options in an example country, Malawi, in order to examine the cost-effectiveness of expanding specialty training to retain doctors in sub-Saharan Africa.

Methods

We designed a Markov model of the labour market for doctors in Malawi, incorporating data from tracing studies, doctors' preferences for specialty training and local cost data. A government perspective was taken with a time horizon of 40 years. Expanded specialty training in Malawi or South Africa with varying mandatory service requirements were compared against baseline conditions. The outcome measures were cost per doctor year and cost per specialist year in the Malawian public sector.

Results

The most cost-effective intervention was expansion of specialty training within Malawi. Longer periods of service before training were more cost-effective, with five years' mandatory service adding the most value in terms of doctor-years. At the end of 40 years

of expanded training in Malawi, the medical workforce would be over fifty percent larger and there would be over six times the number of specialists compared to current trends. These policies, however, would cost more than current government spending. The government would need to be willing to pay at least 3.5 times more per doctor-year for a five percent minimum increase in total doctor-years over baseline and at least fifty percent more per specialist-year for a maximum six-fold increase. The most optimal option differs between subgroups of doctors, with greater increases in doctor- and specialist-years possible in those with more flexible preferences.

Conclusions

Sustained funding of specialty training could lead to improved retention of doctors in sub-Saharan Africa.

INTRODUCTION

Low production and high emigration have led to few doctors in many sub-Saharan African countries, impeding the delivery of essential health services and response to new health threats (World Health Organization 2006, Sidibé and Campbell 2015, World Health Organization 2015). Retaining doctors in their country of training, therefore, has been the focus of recent policy efforts. Out of possible incentives, the opportunity to specialise has been found to be particularly important to doctors (George, Rozario et al. 2007, Willis-Shattuck, Bidwell et al. 2008, Mandeville, Lagarde et al. 2014). Yet the specialist workforce is also small in many countries, necessitating a reliance on foreign-trained specialists or none at all. This constrains domestic training capacity, forcing countries to send doctors to other countries to specialise (Mullan, Frehywot et al. 2011). The opportunity to train in more advanced health systems is often popular with doctors, but augments the risk of emigration. This presents a dilemma for policymakers: sending doctors to train in other countries is likely to increase retention of doctors in the short-term, but may produce specialists more likely to emigrate in the long-term. Stipulating a mandatory period of work before entry to specialty training would ensure better value from this investment, but delay the production of much-needed specialists. Expanding domestic training may protect against emigration of specialists, but may not be accepted by doctors. Finally, many countries will be unable to reduce their dependence on internationally trained specialists without expansion of specialty training, yet specialists are more costly to produce and employ than generalist doctors. To tease out these issues, this study models the medical workforce in Malawi in order to assess the cost-effectiveness of different specialty training policy interventions.

STUDY SETTING

In Malawi, which has one doctor for every 53,000 people, a national medical school was established in 1991 (Muula and Broadhead 2001, Broadhead and Muula 2002, World Health Organization 2015). In 2005, concerns over the continuing low numbers of doctors led to a tripling of medical students at the College of Medicine-University of Malawi (COM), but no proportionate increase in the number of specialty training places available (Management Sciences for Health 2010). The vast majority of medical students and junior doctors still intend to specialise, raising concerns that they may emigrate if training opportunities are not available in Malawi (Mandeville, Bartley et al. 2012). Indeed, more specialists are needed in Malawi, with many public sector posts vacant or filled by international volunteers. For example, in 2014, there were just ten ophthalmologists in Malawi, seven of whom were Malawian (Schulze Schwering, Spitzer et al. 2014). Limited national capacity for specialty training, however, means that some or all training for certain specialties is undertaken in South Africa and other African countries. Where training can be provided in Malawi, junior doctors have been reluctant to take this up due to concerns over transferability of the training, resource limitations and remuneration (Bailey, Mandeville et al. 2012, Sawatsky, Parekh et al. 2014). A study that investigated junior doctors’ preferences for different types of specialty training found that doctors would work for up to five years in the public sector in return for guaranteed training, but were less likely to do so if the training was only in Malawi. Yet historically those doctors who specialise outside Malawi have been far less likely to remain in Malawi (Muula and Broadhead 2001, Zijlstra and Broadhead 2007, Muula 2009).

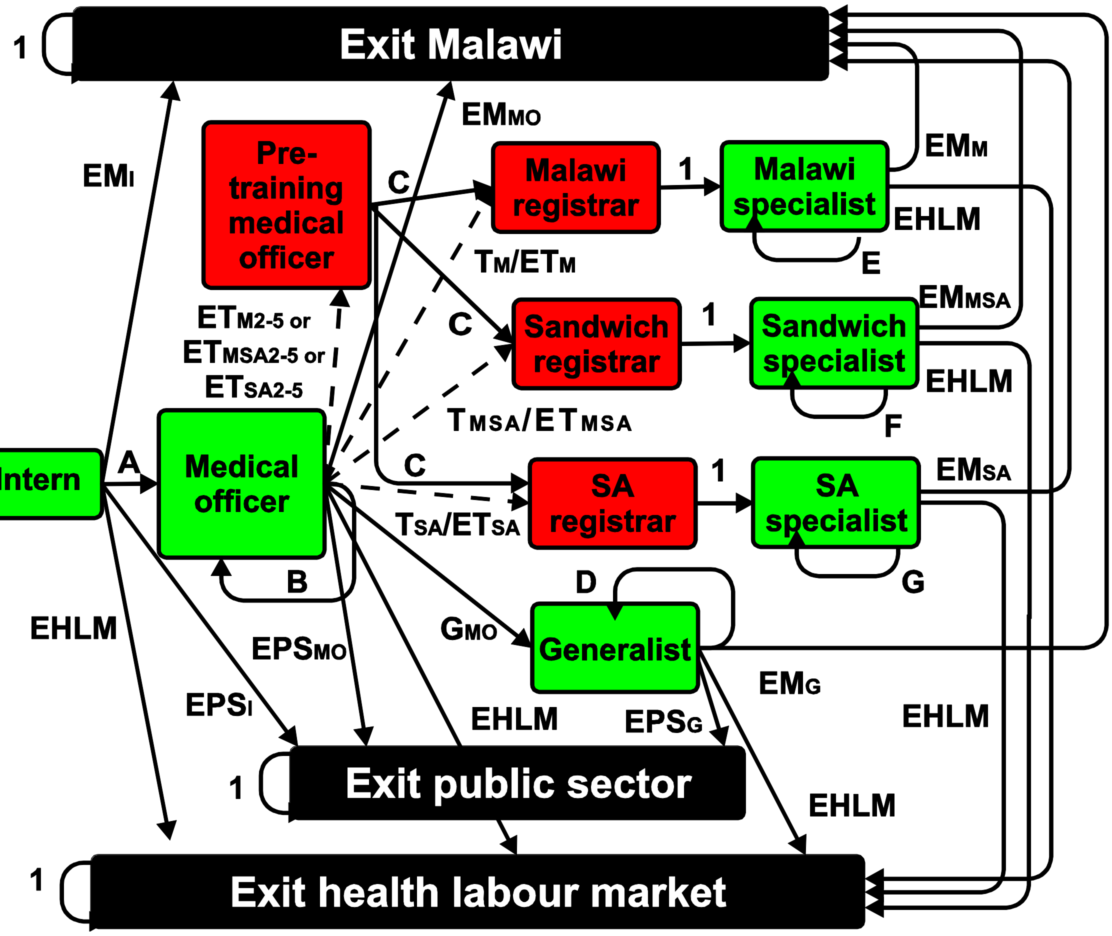
METHODS

We developed a simplified model of the prevailing labour market for Malawian doctors (Figure 1). In this model, a doctor can be in one of a limited number of mutually exclusive states, which represent jobs in the Malawian public sector or a position outside it. A discrete-time inhomogeneous Markov process was used to model the movement of doctors over their working lifetime. This is essentially a closed hierarchical system, where doctors enter at the most junior level and can only transition to more senior states. At the end of a fixed length of time, or cycle, a doctor can transition to another state. One year was chosen as the cycle length as the most natural educational and budgetary unit.

In order to identify all relevant costs and consequences, the time horizon is the working life of a doctor in Malawi. The mean age of newly graduated doctors in Malawi is 24 years and the mandatory retirement age for men and women in the public health service is 55 years (Muula and Maseko 2005, Management Sciences for Health 2010, Government of Malawi 2011). The working life of many doctors, however, has been extended past this age using repeated fixed-term contracts to boost retention (Management Sciences for Health 2010). Given this higher effective retirement age and likely increases in the mandatory retirement age over the lifetime of new graduates, the time horizon was set as 40 years.

The perspective taken is that of the Malawian government and the setting is the Malawian public health sector. As the government pays the salaries of Malawian doctors working in rural health facilities run by faith-based organisations, these doctors are considered to be working in the public health sector. We employed two outcome measures to compare

Figure 1 **Model figure**



Notes: *SA = South Africa; absorbing states are shown in in black; tunnel states are shown in red and all other temporary states in green; transition probabilities are shown and explained further in text; dashed lines indicate transition probabilities affected by policy interventions;* $A = 1 - EM_I - EPS_I - EHLM$; $B = 1 - ET - T_M - T_{MSA} - T_{SA} - EM_{MO} - EPS_{MO} - EHLM$; $C = 1 - EHLM$; $D = 1 - EM_G - EPS_G - EHLM$; $E = 1 - EM_M - EHLM$; $F = 1 - EM_{MSA} - EHLM$; $G = 1 - EM_{SA} - EHLM$

the effects of different policies over the time horizon: (i) doctor-years: the number of years worked by qualified medical doctors in the Malawian public health sector and (ii) specialist-years: the number of years worked by qualified medical specialists in the Malawian public health sector.

The baseline scenario represents the current situation in Malawi and estimates the cumulative impact on the outcome measures under current workforce policies. The alternatives examine the impact of different policy interventions that expand specialty training. Each intervention stipulates a different location for this training, which can be combined with a mandatory service period in Malawi before training.

Description of states

States can be temporary (entered but eventually left) or absorbing (entered but never left). Our model consisted of ten temporary states and three absorbing states that reflect three types of exit from the public health sector. The first, "exit Malawi", encompasses doctors who have left Malawi to work or train outside of government training programmes. In addition, all doctors who have left Malawi for specialty training not funded by the government are assumed to remain outside Malawi. The "exit health labour market" state incorporates retirement, death and doctors who have changed professions or decided not to work. For tractability, we have not modelled doctors who temporarily leave the labour market to raise children. The "exit public sector" includes all doctors working exclusively in private practice or for commercial companies, non-governmental organisations or research/teaching institutions. The transition probabilities between all model states were informed by various data sources listed in the appendix.

Doctors enter the model in the "intern" state. All medical graduates in Malawi have to complete an 18-month internship in the public sector in order to gain full registration with the Medical Council of Malawi (Muula and Maseko 2005). For simplicity, we have modelled this as a temporary state lasting one cycle.

All doctors then move to the "medical officer" state unless they enter one of the absorbing states. The probabilities of exiting the public sector and outside Malawi from the intern state were informed by a tracing study of 2006 – 2012 graduates. The probability that doctors exit the health labour market increases over the time horizon, with values informed by a 2006 tracing study of all graduates from 1991. More details of these transition probabilities can be found in the appendix.

Once in the medical officer state, doctors remain there for a maximum of six cycles. During this time, they may exit into one of the absorbing states or enter specialty training. The transition probabilities for exiting Malawi and the public sector were also informed by the 2012 tracing study, with the latter shown to be lower for medical officers than for interns. The probability of transitioning to specialty training in the baseline scenario was informed by MOH and COM administrative data (see appendix). The probability of entering specialty training under different policy interventions was based on the study of doctors' training preferences.

If a policy intervention involves a mandatory service period before training, doctors first enter a "pre-training medical officer" state for the required number of cycles before starting training. This is a tunnel state, i.e. a temporary state that can last a number of cycles but cannot be exited during this period.

Doctors undertaking specialty training are known in Malawi as registrars. There are three registrar states in the model, depending on the location of training. As most registrars training outside Malawi under government funding are sent to South Africa, this country was used in the model. Thus, a "Malawi registrar" trains fully in Malawi, a "South Africa registrar" train fully in South Africa and a "sandwich registrar" undertakes training split between Malawi and South Africa. The allocation between these states in the baseline scenario was based on current training patterns, and uptake rates for each state under different policy interventions were calculated from the doctors' training preferences study. All three states are modelled as four-cycle tunnel states, which is the standard length of specialty training programmes for clinical specialties. Only time spent in Malawi counts towards the outcome measures.

All registrars then enter one of three specialist states, depending on the location of their training: "Malawi specialist", "South Africa specialist" or "sandwich specialist". Most specialists in Malawi are employed in the public sector even if they undertake dual practice. Therefore we have assumed that no specialist exits the public sector, although they may exit Malawi or the health labour market. We used limited data on the current location of specialists trained in the last ten years to estimate retention rates for specialists trained in different locations. We anticipated this value to decline over time both within a cohort, as job mobility diminishes in later career (Padarath, Chamberlain et al. 2003, Tjadens, Weilandt et al. 2012), and also over cohorts, due a likely "magnet effect". This reflects the positive influence of a growing specialist workforce on retention of new specialists due to role modelling and greater opportunities for professional interaction (Bailey, Mandeville et al. 2012).

In order to distinguish medical officers from more senior doctors who have not specialised, we also created a “generalist” state. This represents doctors working in central and district facilities, as well as administrative positions. It also incorporates doctors working as general practitioners, as specialty training in general practice (family medicine) is rare in Malawi. All doctors still in the medical officer state at the end of seven cycles will move into the generalist state. Although doctors could still seek and enter specialty training in their later working life, it is far less common than in the early career period. Therefore, generalists only transition to one of the absorbing states. The transition probabilities for exiting Malawi and the public sector for generalists also declined over time, with the initial value equal to those for the medical officer state.

The main structural assumptions of the model are as follows. As in the norm in medical careers, doctors can only progress up the professional hierarchy and cannot return to a more junior position. For simplicity, it is assumed that doctors do not go straight into specialty training on completion of internship, although this does occur *de facto*. Transition to training occurs at the end of one cycle for a cohort rather than throughout the junior doctor period. All registrars are assumed to complete their training and all within four years. All registrars return to Malawi for at least one year of practice as a specialist after completion of training. Finally, the “exit public sector” state was modelled as an absorbing rather than temporary state. Repeated movement between sectors is uncommon in Malawi, with health workers reporting strong barriers to returning to the public sector after exit (Muula and Maseko 2005). This is compounded in a hierarchical cadre such as medicine, where re-entry risks a loss of seniority and/or status. The most flexible period is likely to be early career, yet examination of employment data collected on Malawian junior doctors showed that no doctor had returned to the public sector after a job outside it. Although data were not available to confirm this assumption for the entire medical workforce, there was sufficient justification to model an exit from the public sector as an absorbing state for these purposes. However, barriers to re-entry into the public sector – both for those outside the public sector and emigrant doctors – may lessen over the time horizon, therefore the durability of the absorbing states over the time horizon is also a strong assumption of this model.

Policy interventions

The effectiveness of each policy intervention was represented by the uptake of available training places by medical officers. These uptake rates were based on the results of a study that quantified the preferences of junior doctors for different types of specialty training. This allowed predictions of the uptake of training places that varied in two aspects:

(i) the location of the training (all in Malawi, split between Malawi and South Africa, or all in South Africa);

(ii) a mandatory period of public sector service before training, ranging from two to five years.

These predicted uptake rates form the transition probabilities between medical officer and registrar (T_M, T_{MSA}, T_{SA}) or medical officer to medical officer before training ($ET_{M2\text{-}5}$,

$ET_{MSA2\text{-}5}$, $ET_{SA2\text{-}5}$), with values given in the appendix. Those who opt out of the posts on offer remain in the medical officer state, but are subjected to the background transition probabilities to the absorbing states before transitioning to the generalist state. These uptake rates were assumed to be constant over the time horizon.

A matrix of all transition probabilities is shown in Table 1.

Model population

In order to explore the cumulative impact of different policy scenarios, the model followed 40 successive cohorts of Malawian doctors, with each cohort entering one cycle after the preceding cohort. All cohorts start in the intern state. The number of graduates at COM has increased from 13 in 1992 to 69 in 2014, with annual enrolment averaging 99 over the past five years. The size of the first cohort was therefore set as 100. As medical student numbers are likely to rise further over the time horizon, each subsequent cohort was expanded by five graduates leading to a final cohort size of 295.

The existing stock of Malawian doctors was also incorporated in the model. We used data from previous tracing studies of Malawian doctors and also the Medical Council of Malawi to inform the distribution of these doctors across model states in cycle 1 (see appendix).

Table 1 Transition matrix

Notes: *PT = pre-training; EHLM = exit health labour market; SA = South Africa; *time-dependent parameter; §time- and cohort-dependent parameter*

ORIGIN	DESTINATION												
	Intern	**Medical officer**	**PT medical officer**	**Malawi registrar**	**Sandwich registrar**	**SA registrar**	**Malawi specialist**	**Sandwich specialist**	**SA specialist**	**Generalist**	**Exit Malawi**	**Exit public sector**	**EHLM**
Intern	0	1- EM_I -EPS_I –*EHLM*	0	0	0	0	0	0	0	0	EM_I	EPS_I	*EHLM**
Medical officer	0	1- ET - T_M - T_{MSA} - T_{SA} -EM_{MO} - EPS_{MO} – *EHLM*	$ET_{M2\text{-}5}$ or $ET_{MSA2\text{-}5}$ or $ET_{SA2\text{-}5}$	T_M or ET_M	T_{MSA} or ET_{MSA}	T_{SA} or ET_{SA}	0	0	0	G_{MO}*	EM_{MO}	EPS_{MO}	*EHLM**
PT medical officer	0	0	0	1 – *EHLM*	1 – *EHLM*	1 – *EHLM*	0	0	0	0	0	0	*EHLM**
Malawi registrar	0	0	0	0	0	0	1	0	0	0	0	0	0
Sandwich registrar	0	0	0	0	0	0	0	1	0	0	0	0	0
SA registrar	0	0	0	0	0	0	0	0	1	0	0	0	0
Malawi specialist	0	0	0	0	0	0	1- EM_M - *EHLM*	0	0	0	EM_M§	0	*EHLM**
Sandwich specialist	0	0	0	0	0	0	0	1- EM_{MSA} –*EHLM*	0	0	EM_{MSA}§	0	*EHLM**
SA specialist	0	0	0	0	0	0	0	0	1- EM_{SA} – *EHLM*	0	EM_{SA}§	0	*EHLM**
Generalist	0	0	0	0	0	0	0	0	0	1- EM_G - EPS_G - *EHLM*	EM_G*	EPS_G*	*EHLM**
Exit Malawi	0	0	0	0	0	0	0	0	0	0	1	0	0
Exit public sector	0	0	0	0	0	0	0	0	0	0	0	1	0
EHLM	0	0	0	0	0	0	0	0	0	0	0	0	1

Cost estimates

There are two types of cost relevant here: in-service costs and specialty training costs. These incorporate the direct costs of training and employing more doctors and specialists and are summarised below, with further details and all values set out in the appendix. Indirect costs such as the administrative burden of policy implementation or increased service costs associated with more specialist medical activity were deemed either negligible compared to the direct costs or too difficult to attribute directly to the policy intervention rather than the general needs of the health service.

The major in-service costs comprise salaries and government pension contributions. The most recent MOH salary scales were used to estimate salaries within each state, combined with a 10% uplift to cover pension contributions. All public sector doctors are also entitled to subsidised accommodation. Data on government rental costs for doctors' housing were collected in order to estimate an average cost across states. Specialists in Malawi also receive a one-off allowance for a vehicle and monthly allowances for fuel and telephone costs. Interns and medical officers are also entitled to hospital-provided transport to and from work.

The cost of specialty training in Malawi is incurred by COM and paid by the MOH. The standard tuition fees for COM specialty training programmes were used for this cost. Tuition fees are paid to South African universities by the MOH for each year that Malawian registrars are in South Africa. Four universities have taken Malawian registrars in the past: the University of Cape Town, University of the Witwatersrand, University of Pretoria and University of KwaZulu-Natal. The mean of relevant fees for Malawian students at these universities was used to represent annual tuition fees in South Africa. We also incorporated various allowances paid to registrars in Malawi and South Africa in recent funded training places.

Modelling cost-effectiveness and sensitivity analysis

The model was constructed using Microsoft Excel 2013. A discount rate of 3% was applied to both costs and effects. A probabilistic sensitivity analysis was carried out to account for the uncertainty around the input parameters. Here, the value of each parameter is considered to be random rather than fixed, with an associated probability distribution. The distribution employed for each parameter follows standard practice in health economics (Briggs, Claxton et al. 2006). 2000 Monte Carlo simulations were used to draw values from these distributions, with the average used to examine the distribution of doctors across different states in the model, as well as the expected costs and effects for each intervention. The latter were incorporated into an incremental cost-effectiveness ratio (ICER) for each intervention compared to the baseline scenario, calculated for both doctor-years and specialist-years. This represents the difference between the average costs of the intervention compared to baseline divided by the difference in their effects.

As an intuitive intervention to confidence intervals around ICERs, cost-effectiveness acceptability curves (CEAC) graphically represent the probability of each intervention being cost-effective at different willingness to pay levels (Fenwick, Claxton et al. 2001). This probability is based on the proportion of simulations where an intervention has the highest net monetary benefits at one particular cost-effectiveness threshold (Briggs, Claxton et al. 2006). This is repeated for a range of threshold values, in this analysis from zero to MWK50 million (£60,000) in increments of MWK100,000 (£120).

If the distribution of net monetary benefit is skewed, however, the optimal option may not have the highest probability of being cost-effective (Fenwick, Claxton et al. 2001). Cost-effectiveness acceptability frontiers (CEAF) identify the optimal option (i.e. that with the highest net monetary benefit) for each willingness to pay value and then plot the probability that this option is cost-effective over all values.

Subgroup analysis

The study of doctors' training preferences identified four subgroups with substantially different preferences. These were characterised as:

(i) the "rich rejecters" (high current salary, frequently refused the hypothetical jobs in the public sector offered to them);

(ii) the "money motivated" (greatest preference for salary increases);

(iii) the "stubborn specialists" (strong training preferences with little flexibility);

(iv) the "pliant patriots" (flexible training preferences, only group without a significant preference for training outside Malawi).

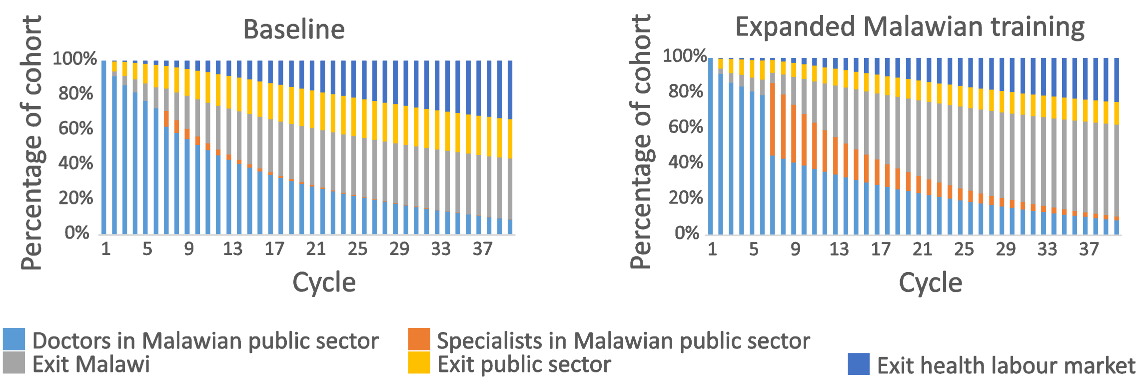
As these preferences affected the predicted uptake of training places (see appendix), we reran the analysis for each subgroup in order to assess the impact of this heterogeneity on the cost-effectiveness of the policy interventions.

RESULTS

Distributions across states

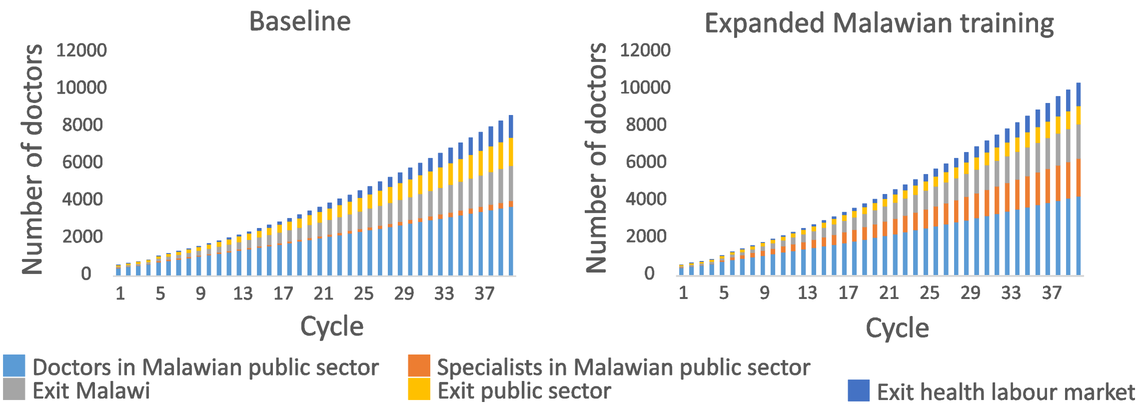
The impact of different policy interventions can be seen from the distribution of doctors across model states over the time horizon. Figure 2 illustrates the progression of the first cohort of doctors in the baseline and then with expanded Malawian training, i.e. increased access to specialty training undertaken in Malawi only. As a greater proportion of the cohort become specialists with expanded training, this substantially boosts the overall number of doctors in Malawi in the first half of the time horizon compared to the baseline. Fewer doctors exit the public sector, although more specialists leave Malawi latterly. The number of doctors exiting the health labour market rises steadily over the time horizon in both alternatives.

Figure 2 Distributions of one cohort between states over time



The distribution of all doctors in the model (existing stock and all 40 cohorts) can also be examined (Figure 3). By the end of the time horizon, the total number of doctors and specialists in Malawi with expanded Malawian training would be over 50% greater compared to current conditions. The specialist workforce would be over six times larger than with current trends. The number of doctors outside Malawi is roughly equal, however fewer doctors exit the public sector under expanded training compared to baseline. As

Figure 3 Distributions between states for all doctors



longer mandatory service is less popular with junior doctors, these policy interventions produce increasingly smaller workforce expansion. For example, five years' service before training in Malawi produces a 19% increase in doctors and specialists compared to baseline.

Impact of policy interventions on total doctor- and specialist-years

The impact of different policy interventions can also be demonstrated through the cumulative difference in doctor- and specialist-years compared to the baseline scenario (Table 2). At the end of the time horizon, the greatest difference in doctor-years is seen with expanded Malawian training, with an eight percent increase compared to baseline. Expanded training in South Africa always produces fewer doctor-years compared to baseline, whereas for sandwich training this depends on the length of mandatory service.

Expanded Malawian training is associated with a near six-fold difference in specialist-years compared to baseline, with an even greater increase under expanded sandwich training. Of course, this analysis does not take into account the cost of each intervention, which is examined next.

Table 2 Impact of policy interventions on total doctor- and specialist-years

	Total as percentage of baseline scenario	
Policy intervention	**Doctor-years**	**Specialist-years**
Expanded Malawian training	1.078	5.81
Expanded sandwich training	0.963	6.39
Expanded South African training	0.871	5.74
Expanded Malawian training + 2 years' service	1.076	3.92
Expanded sandwich training + 2 years' service	0.674	4.42
Expanded South African training + 2 years' service	0.908	3.61
Expanded Malawian training + 3 years' service	1.071	3.18
Expanded sandwich training + 3 years' service	1.025	3.60
Expanded South African training + 3 years' service	0.934	3.38
Expanded Malawian training + 4 years' service	1.063	2.58
Expanded sandwich training + 4 years' service	1.034	2.95
Expanded South African training + 4 years' service	0.965	2.79
Expanded Malawian training + 5 years' service	1.053	2.09
Expanded sandwich training + 5 years' service	1.038	2.38
Expanded South African training + 5 years' service	0.988	2.28

Notes: Total years at end of time horizon. Expanded Malawian/South African training refers to increased access to specialty training undertaken in Malawi/South Africa only.

Cost analysis

If the contribution of each cost category to baseline costs is examined separately (Table 3), salaries constitute the majority of costs. As would be expected, training costs become more prominent under expanded specialty training, however these never go above four percent of total costs in any location. A more substantial cost associated with expanded specialty training is the "perks" provided to qualified specialists, particularly the monthly fuel allowance. Combined, these consume a larger proportion of costs under expanded training than accommodation for all doctors. While these incentives play a role in the retention of current specialists, some modification is likely to be required with a larger specialist workforce.

Table 3 Cost analysis in baseline and selected interventions

Cost category as % of total costs	Baseline	Intervention		
		Expanded Malawi training	Expanded sandwich training	Expanded South African training
Salary	78.92%	72.54%	73.25%	74.74%
Accommodation	13.65%	10.02%	8.63%	7.37%
Training	1.32%	3.18%	3.57%	3.75%
Specialist perks*	5.17%	13.88%	14.22%	13.82%
Transport	0.94%	0.38%	0.33%	0.33%

Notes: *Calculated over all doctors. *Aggregates costs of communication and fuel allowances and vehicle purchase.*

Incremental cost-effectiveness ratios (ICER)

The incremental effects, costs and ICERs for all interventions are shown in Table 4 for doctor-years and Table 5 for specialist-years (exchange rates were obtained on 4 September 2015 from www.xe.com). When interventions are ranked by incremental costs, it is possible to assess dominance and extended dominance. Interventions dominate the baseline if they are more effective (i.e. produce more doctor-or specialist-years), but are dominated by other interventions that are more effective and less costly. Extended dominance occurs where an intervention is less costly than another, but has a higher ICER.

If the policy aim is to maximise years of service by doctors, then training outside Malawi is dominated by training in Malawi (Table 4). The most cost-effective policy is expansion of training in Malawi with five years of mandatory service. This provides the most value at £22,836 per doctor-year, with the next most cost-effective options conferring increasingly shorter periods of service. If the policy aim, however, is to maximise the value from specialty training, then expanding Malawian training without any prior service is the most cost-effective option at a cost of £14,717 per specialist-year (Table 5). Expanding sandwich training is also cost-effective, but at a higher cost than training all in Malawi. As there are few specialists currently in Malawi, the incremental effects of any expansion of specialty training in terms of specialist-years is much higher than for doctor-years, leading to lower ICERs in general.

ICERs, however, do not reflect well the uncertainty associated with the cost-effectiveness of an intervention, which are better displayed by CEAC and CEAF.

Table 4 **Incremental cost-effectiveness ratios for all interventions in doctor-years**

Notes: *All comparisons against baseline scenario and obtained from 2000 Monte Carlo simulations. Shading indicates dominated interventions. ICER = Incremental cost-effectiveness ratios; MWK = Malawian kwacha; GBP = pounds sterling; *Years indicate length of mandatory service*

Policy option*	Incremental effects	Incremental costs	ICER MWK	ICER GBP
Expanded Malawi training + 5 years	2,069	39,368,063,907	19,030,241	22,836
Expanded sandwich training + 5 years	1,491	54,670,726,028	36,663,098	43,996
Expanded Malawi training + 4 years	2,448	55,110,787,684	22,508,476	27,010
Expanded South Africa training + 5 years	- 464	57,029,913,187	- 122,906,856	- 147,488
Expanded sandwich training + 4 years	1,334	65,258,165,560	48,906,943	58,688
Expanded Malawi training + 3 years	2,753	73,553,168,352	26,720,869	32,065
Expanded South Africa training + 4 years	- 1,370	74,494,883,206	- 54,370,552	- 65,245
Expanded South Africa training + 2 years	- 3,569	91,165,268,655	- 25,541,532	- 30,650
Expanded South Africa training + 3 years	- 2,575	95,136,518,651	- 36,948,792	- 44,339
Expanded sandwich training + 3 years	961	95,433,888,764	99,318,282	119,182
Expanded Malawi training + 2 years	2,966	96,046,645,090	32,385,297	38,862
Expanded sandwich training + 2 years	- 12,679	121,774,947,806	- 9,604,769	- 11,526
Expanded Malawi training	3,031	152,461,243,860	50,296,772	60,356
Expanded South Africa training	- 5,024	174,543,374,508	- 34,744,116	- 41,693
Expanded sandwich training	- 1,448	183,468,998,968	- 126,709,051	- 152,051

Table 5 **Incremental cost-effectiveness ratios for all interventions in specialist-years**

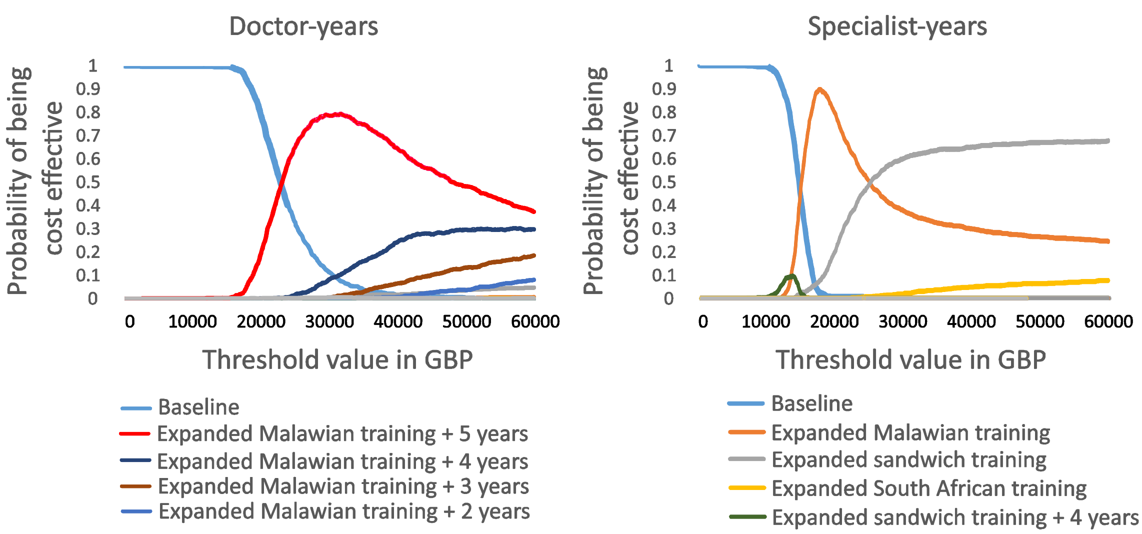
Notes: *All comparisons against baseline scenario and obtained from 2000 Monte Carlo simulations. Shading indicates dominated interventions. ICER = Incremental cost-effectiveness ratios; MWK = Malawian kwacha; GBP = pounds sterling; *Years indicate length of mandatory service*

Policy option*	Incremental effects	Incremental costs	ICER MWK	ICER GBP
Expanded Malawi training + 5 years	2,814	39,368,063,907	13,989,446	16,787
Expanded sandwich training + 5 years	3,555	54,670,726,028	15,380,432	18,457
Expanded Malawi training + 4 years	4,088	55,110,787,684	13,480,563	16,177
Expanded South Africa training + 5 years	3,315	57,029,913,187	17,203,717	20,644
Expanded sandwich training + 4 years	5,043	65,258,165,560	12,940,199	15,528
Expanded Malawi training + 3 years	5,620	73,553,168,352	13,086,736	15,704
Expanded South Africa training + 4 years	4,616	74,494,883,206	16,136,679	19,364
Expanded South Africa training + 2 years	6,751	91,165,268,655	13,503,367	16,204
Expanded South Africa training + 3 years	6,139	95,136,518,651	15,496,177	18,595
Expanded sandwich training + 3 years	6,719	95,433,888,764	14,204,505	17,045
Expanded Malawi training + 2 years	7,533	96,046,645,090	12,749,519	15,299
Expanded sandwich training + 2 years	8,832	121,774,947,806	13,787,622	16,545
Expanded Malawi training	12,432	152,461,243,860	12,263,840	14,717
Expanded South Africa training	12,243	174,543,374,508	14,256,556	17,108
Expanded sandwich training	13,913	183,468,998,968	13,186,785	15,824

Cost-effectiveness acceptability curves and frontiers

CEACs indicate the probability that each intervention is cost-effective at varying cost-effectiveness thresholds (Figure 4). If the government is willing to pay £23,040 per doctor-year, there is an 80% chance that expanding training in Malawi with five years' mandatory service is more cost-effective than current conditions, rising to 80% at £31,680 per doctor-year. Shorter mandatory service requirements only become more likely to be cost-effective at substantially higher thresholds. For example, training in Malawi with four years' mandatory service rather than five years only becomes more likely to be cost-effective at £73,920 per doctor-year (not shown in figure). In terms of specialist-years, expanding training in Malawi is more likely to be cost-effective than current conditions if the government is willing to pay at least £14,760 per specialist-year. Sandwich training only becomes more likely to be cost-effective above £25,080 per specialist-year.

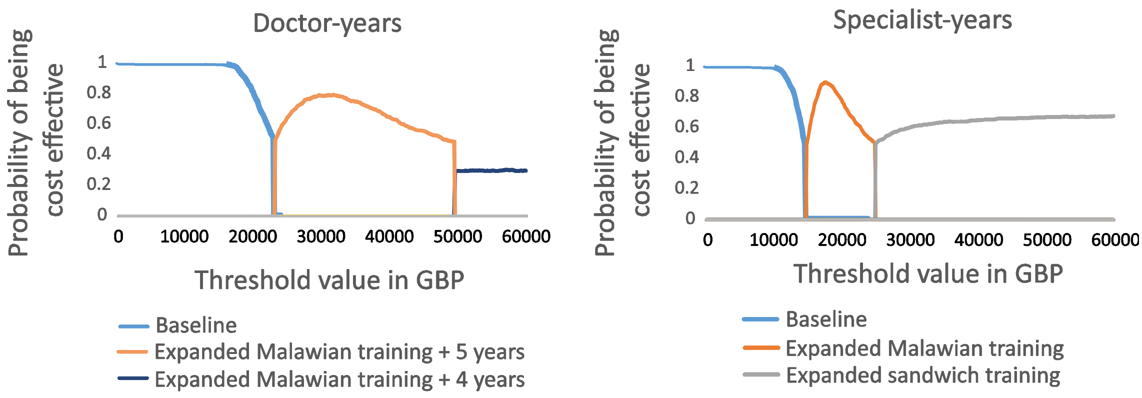
Figure 4 Cost-effectiveness acceptability curves



***Note:** Years refer to years of mandatory service before training*

Figure 5 plots the CEAFs for each outcome measure. The threshold value associated with a switch point on the CEAF (i.e. where the decision changes between two interventions) is equivalent to the base ICER between these two interventions (Fenwick, Claxton et al. 2001). If the government is willing to pay between £23,040 and £49,560 per doctor-year, then the optimal option is expanded Malawian training with five years' mandatory service and four years' service above this threshold. In terms of specialist-years, the optimal option is expanded Malawian training between £14,760 and £24,960 per specialist-year, and sandwich training above this threshold.

Figure 5 Cost-effectiveness acceptability frontiers



Note: *Years refer to years of mandatory service before training*

Threshold value by outcome measure

Suggested cost-effectiveness thresholds for LMIC include the World Health Organisation guidelines of one to three times a country's gross domestic product per capita (Tan-Torres Edejer, Baltussen et al. 2003). This threshold has been criticised, however, for neglecting allocative efficiency (Revill, Walker et al. 2014). Given the complexity of the relationship between population health and the availability of health workers, it is also difficult to compare these results with previous thresholds used for public health or clinical interventions (Speybroeck, Kinfu et al. 2006).

An alternative strategy is to identify the amount that the Malawian government is currently willing to pay for a doctor- and specialist-year (Lagarde, Blaauw et al. 2012). Using the data here, it is possible to calculate the net present value of the discounted costs of an "average" doctor working for 40 years in the public sector. This incorporates two career pathways: a "generalist path" in which a medical officer becomes a generalist after six years and a "specialist path" where specialty training is entered after one year as a medical officer. These are weighted 0.82 and 0.18 respectively according to the forecast provision of government-funded specialty training. According to these calculations, the Malawian government currently values a doctor-year at £6,536. For a specialist-year, only the costs of the specialist path were included, with weighting of costs for different training locations as per the allocations used previously (0.11 for Malawi training and 0.44 for sandwich and South African training). We estimate that the Malawian government currently values a specialist-year at £9,486.

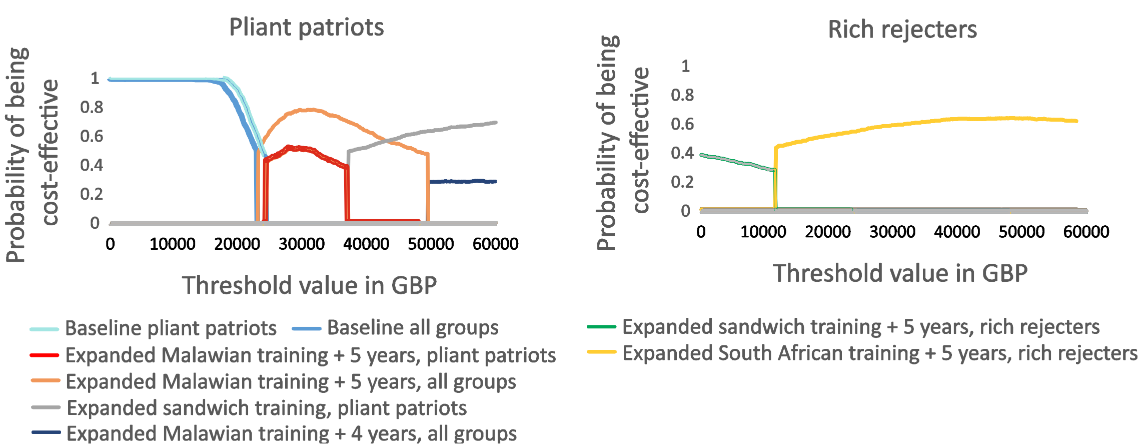
The most cost-effective policy intervention to increase doctor-years, expanding Malawian training with five years' mandatory service, would therefore require the government to be willing to pay three and a half times the current threshold for a doctor-year. To expand the specialist workforce, the government would need to be willing to pay fifty percent more per specialist-year than the current threshold.

Cost-effectiveness acceptability frontiers by subgroup

While an intervention may be the optimal option for the population as a whole, it may not be optimal for different subgroups of junior doctors. To explore this heterogeneity, CEAF were constructed for the four subgroups identified in the study of doctors' preferences.

In terms of doctor-years, the only two subgroups showing substantial differences compared to the overall CEAF were the pliant patriots and the rich rejecters (Figure 6). Expanding Malawian training with five years of service is less likely to be the optimal option for the pliant patriots, and expansion of sandwich training was the optimal option at higher willingness to pay values. This policy was associated with a 22% increase in total doctor-years over baseline. In contrast, the optimal option for the rich rejecters subgroup will never be current conditions, but rather expansion of sandwich or South African training with five years' mandatory service.

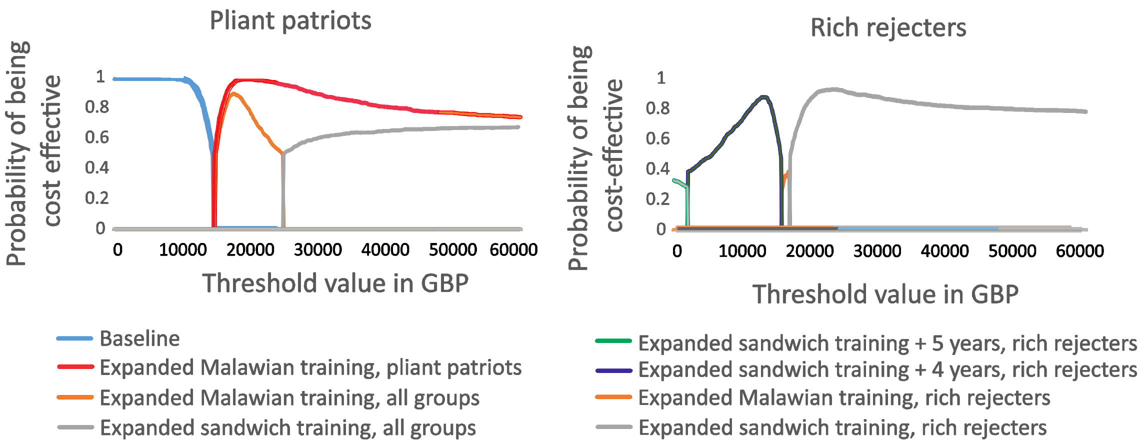
Figure 6 Heterogeneity in CEAFs for doctor-years



Note: CEAF for pliant patriots is superimposed over that for all groups.

With regard to specialist-years, again only the pliant patriots and rich rejecters showed substantial differences to the overall CEAF (Figure 7). For pliant patriots, there is very little uncertainty over all willingness to pay levels that expanding Malawian training is the optimal option, although the threshold value is the same as for the whole population. This policy would lead to an 8.5-fold increase in specialist-years compared to baseline. For the rich rejecters, expanding sandwich rather than Malawian training is more likely to be the optimal option, with better value achieved with at least four years' service.

Figure 7 Heterogeneity in CEAFs for specialist-years



Note: CEAF for pliant patriots is superimposed over that for all groups.

DISCUSSION

The findings of this economic evaluation show that the Malawian government could obtain higher returns on their investment in medical education by expanding specialty training in Malawi. Longer periods of service before training would be more cost-effective, with five years' mandatory service adding the most value. At the end of 40 years of expanded training in Malawi, the medical workforce would be over fifty percent larger and there would be over six times the number of specialists compared to current trends. These policies, however, would be more costly than current government spending for relatively modest gains in doctor-years. The government would need to be willing to pay at least 3.5 times more per doctor-year for a five percent minimum increase in total doctor-years over baseline and at least fifty percent more per specialist-year for a maximum six-fold increase. The most optimal option differs between subgroups of doctors, with greater increases in doctor- and specialist-years possible in those with more flexible preferences.

This is the first evaluation, to our knowledge, of the cost-effectiveness of specialty training for retaining doctors in LMIC. By including two outcome measures, this study recognises the often divergent objectives in health workforce policy and provides more information for stakeholders. This study demonstrates the impact of predictable financing of specialty training on Malawi's specialist workforce in comparison to the current *ad hoc* funding. It provides a realistic assessment of the costs of these policies compared to current government spending. Finally, while longer mandatory service has been considered in Malawi in light of the heavy subsidy of undergraduate medical training (Muula and Maseko 2005), this study is the first to establish its cost-effectiveness. Whilst compulsory service is often defaulted on when linked to financial incentives

(Bärnighausen and Bloom 2009), its stipulation as an entry requirement to specialty training is more feasible and common in other countries (Frehywot, Mullan et al. 2010). Despite junior doctors indicating that they would accept five years of service in exchange for guaranteed specialty training, such a period may be difficult to instigate politically and a shorter period that balances cost-effectiveness and implementation may be more pragmatic.

Only one other study, to our knowledge, has used a formal decision analytical modelling to evaluate the cost-effectiveness of different policies to retain the health workforce (Lagarde, Blaauw et al. 2012). This study used a similar preference study to establish the effectiveness of different incentive policies, but its focus was on the recruitment and retention of South African nurses to rural areas. Although the different scope limits any comparison with the results obtained here, this study did find that offering nurses study leave to specialise was more cost-effective than financial incentives alone. Overall, an "upstream" intervention of recruiting more nurses from rural areas was the most cost-effective option. This echoes our findings in the pliant patriots subgroup, who were more likely to accept specialty training in Malawi than the overall population - although this greater acceptance led to more costs to the government and thus a higher ICER overall. The flexible preferences of this subgroup may become more commonplace as training in Malawi is better established. Methodologically, our study significantly extends this study by incorporating the existing stock of Malawian doctors, exploring heterogeneity thoroughly, enabling interaction of cohorts, and distinguishing health workers with different levels of human capital through the use of two outcome measures.

There are several limitations to this analysis. First, we took a government rather than a societal perspective, thus disregarding any welfare produced by doctors working outside the public sector. The stock of doctors in Malawi is so small that clearly the labour of all doctors is of social value, yet the largest disease burden exists in rural areas with 80% of the population. As the vast majority of facilities in rural areas are public rather than private, a government perspective captures the doctor-years holding the most marginal value for Malawi's population. Although the availability of several tracing studies led to more data to inform the model than in comparable studies (Lagarde, Blaauw et al. 2012), a wider range of data sources would have enabled more accurate model parameters and investigation of assumptions. For example, we did not have information to model the effect of expanded training on exit rates from Malawi and the public sector (i.e. cross-elasticities of the demand for training places) or the likely changes in doctors' preferences for training places over a 40-year period. Probabilistic sensitivity analysis will have accounted for this uncertainty to some degree. Finally, the effectiveness measures were derived from stated preferences, rather than the revealed preferences of experimental or observational studies. Yet this type of data is especially appropriate for labour market decisions where actual market options are highly constrained.

With regard to specialty training, our reliance on tuition fees may have underestimated the true cost of providing training. Larger numbers of registrars are likely to be easily absorbed by the extensive medical educational system in South Africa, whereas more teaching staff would be required in Malawi (this would be the main associated cost as most specialties are taught via apprenticeship-style training in central hospitals). As these posts would be filled by international volunteers until sufficient Malawian specialists were trained, they were not included in the cost analysis. For these purposes, we also disregarded concerns over the quality of specialty training that can be provided in Malawi without exposure to more advanced health systems. Similar concerns were raised when the medical school in Malawi was established and shown later to be without basis (Broadhead and Muula 2002). Although we did not compare the expansion of training against purely financial interventions in this analysis, non-financial incentives are likely to be more tenable to the Malawian government in the short-term given the financial burden imposed by previous salary increases and current fiscal constraints.

Future research to refine this model would be welcomed, particularly in settings with more data available to clarify the assumptions employed here. The general conclusions of this analysis, rather than the specific ICERs, are likely to be transferable to other sub-Saharan African countries seeking to maximise the value from their investment in medical undergraduate education. Indeed, dynamic modelling and economic evaluation of different policy options are particularly well suited to medical workforce decisions in LMIC. In many cases, the lag between training investment and labour production means that costs and effects can only be fully evaluated over the long-term. Training and retaining doctors also consume considerable resources from limited budgets. For example, out of its USD125 million health budget in fiscal year 2014/2015, Malawi spent around 4% on training and 36% on salaries (Ministry of Health data). Decisions on health workforce policy are therefore high value, yet usually made in a low-information environment. More routine application of cost-effectiveness analyses to health workforce decisions is likely to be of considerable value.

In conclusion, this study has shown that expanding specialty training in Malawi is more cost-effective than training outside Malawi, despite being less valued by junior doctors. This policy direction will enlarge the specialist workforce substantially and obtain the most value from investment in undergraduate medical education, however will require increasing current spending levels.

9.3 SUPPLEMENTARY FILE

APPENDIX

This document gives further details on the estimation of model parameters. In order to populate the model, four types of parameters are required: the model population, the probability of transitioning from one state to another, the uptake of training places and cost estimates. Details are provided on each in turn. The data sources to inform these parameter values are listed in Table A1.

Model population

The existing stock of Malawian doctors was estimated from three sources: a tracing study of all graduates from the College of Medicine-University of Malawi (COM) between 1992 and 2006, another tracing study of all graduates between 2006 and 2012, and registration records for specialists from the Medical Council of Malawi for 2010/2011.

The 1992 - 2006 tracing study allowed an estimate of generalist doctors and their sector of work, along with doctors who had exited the health labour market (see below) (Zijlstra and Broadhead 2007). The 2006 - 2012 tracing study identified all graduates in specialty training and their location (Mandeville, Ulaya et al. 2014). Registrars were assumed to be in their first year of training, unless they were in South Africa as part of sandwich training in which case they were assumed to be in their third year. All interns at the time of the 2006 – 2012 study entered the model in the medical officer state in order to accommodate the first cohort of new doctors in the model (see below). The registration records allowed a broad estimate of the number of Malawian specialists and their training location (all

Table A1 Data sources for model parameter values

PARAMETER	DATA SOURCE
Model population	
Cohort size	COM registry data
Existing stock	Ziljstra and Broadhead, 2007 Mandeville et al., 2014 Medical Council of Malawi 2010/2011 registry data
Transition probabilities	
Exit health labour market (*EHLM)*	Ziljstra and Broadhead, 2007 Lagarde and Cairns, 2012
Exit public sector	
Intern (EPS_I)	Mandeville et al., 2014
Medical officer (EPS_{MO})	Mandeville et al., 2014
Generalist (EPS_G)	Ziljstra and Broadhead, 2007
Exit Malawi	
Intern (EPS_I)	Mandeville et al., 2014
Medical officer (EM_{MO})	Mandeville et al., 2014
Generalist (EM_G)	Ziljstra and Broadhead, 2007
Specialist (EM_S)	COM data
Uptake of training places	
Baseline	Ministry of Health 15-year specialist forecast, COM data
Policy interventions	Study of junior doctors' training preferences
Cost estimates	
Salary	Ministry of Health, Malawi
Pension contributions	Pension Act 2011, Malawi
Accommodation	Southern, Northern and Central Regional Offices for Housing, Malawi
Communication	Key informant interviews
Transport	
Minibus	Key informant interviews
Specialist vehicle purchase	Key informant interviews
Monthly fuel subsidy	Malawi Energy Regulatory Authority
Postgraduate training costs	COM data South African universities' websites

those who trained outside Malawi were categorised as South Africa specialists, unless recently trained in a specialty with sandwich training). Table A2 summarises these estimates across model states.

Table A2 Estimated existing Malawian doctors across model states in cycle 1

State	Number	State	Number
Intern	0	Malawi specialist	2
Medical officer	144	Sandwich specialist	2
Malawi registrar year 1	16	South Africa specialist	33
Sandwich registrar year 1	16	Generalist	107
South Africa registrar year 1	23	Exit Malawi	55

Transition probabilities

All transition probability values and their distributions are shown in Table A3. The transition probabilities from temporary to absorbing states will first be described, followed by those to specialty training.

Transition probabilities to absorbing states

The transition probabilities for the three absorbing states were constrained to be positive. For the first absorbing state, exit of the health labour market, the transition probability was assumed not to vary across states. As this state encompasses death, retirement, changing professions, and childrearing, the transition probability should increase with time, i.e.:

$$\mathrm{EHLM}(t) = 1\text{-}e^{-\gamma t} \tag{1}$$

Where t is cycle number and γ is the exit rate.

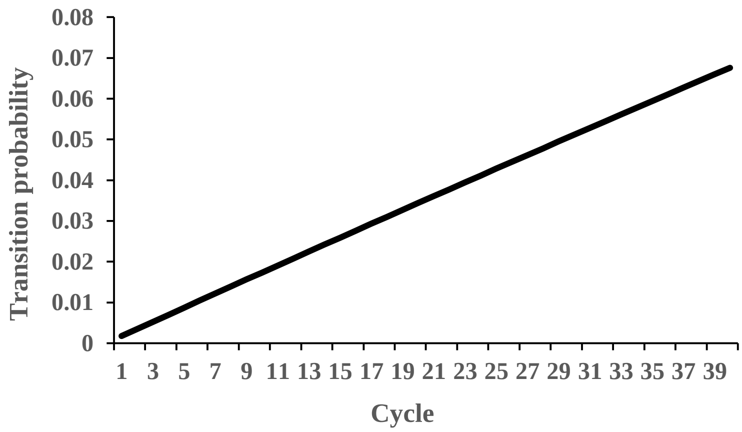
Table A3 Transition probability values

Parameter description	Mean	Distribution	SE	α	B
Medical officer to generalist *(G_{MO})*	Cycle 8 = 1, All other cycles = 0	Deterministic	-	-	-
Registrar to specialist	1	Deterministic	-	-	-
Specialty training uptake					
Training in Malawi *(T_M)*	0.02	Dirichlet	-	2	98.0
Training in Malawi and South Africa *(T_{MSA})*	0.08	Dirichlet	-	4	96.0
Training in South Africa *(T_{SA})*	0.08	Dirichlet	-	4	96.0
Medical officer to medical officer before training (*ET*)	Dependent on effectiveness measures	Dirichlet	-	-	-
Absorbing states					
Exit health labour market (*EHLM*)	γ = 0.00175*	Gamma§	0.001	0.175	99.8
Exit public sector					
Intern (EPS_I)	0.060	Dirichlet	-	6.0	97.2
Medical officer (EPS_{MO})	0.020	Dirichlet	-	2.0	97.2
Generalist (EPS_G)	0.02*, θ = 0.023	Dirichlet	-	2.0	98.0
Exit Malawi					
Intern (EM_I)	ζ = 0.027	Dirichlet	-	2.7	97.2
Medical officer (EM_{MO})	ζ = 0.027	Dirichlet	-	2.7	97.2
Generalist (EM_G)	0.027*, θ = 0.023	Dirichlet	-	2.7	97.3
Malawi-trained specialist (EM_M)	ρ = 0.1**, δ= 0.0023	Dirichlet	-	3.0	97.0
Sandwich-trained specialist (EM_{MSA})	ρ = 0.15**, δ= 0.0023	Dirichlet	-	10.0	90.0
South African-trained specialist (EM_{SA})	ρ = 0.25**, δ= 0.0023	Dirichlet	-	16.7	83.3

Notes: *SE = standard error; *time-dependent; **time- and cohort-dependent, see below for values; §gamma rather than Dirichlet distribution assigned in order to more realistically contain the range of values obtained from the exponential function*

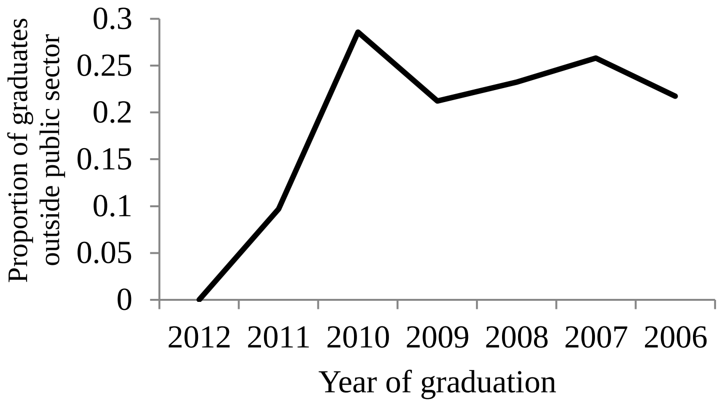
The 1992 – 2006 tracing study found that eight graduates had died and four were employed in Malawi but not in any mainstream health sector roles (Zijlstra and Broadhead 2007). As no further detail was supplied, we assumed that these four graduates had exited the health labour market. This is likely an underestimate of the population rate, however, as the study participants were from successive and progressively younger cohorts and none had attained retirement age. We therefore used this rate (12 exits at 15 years) to anchor the lower limit for γ (-0.001). We based the upper limit (-0.0025) on the value used for a similar analysis of the nursing profession in South Africa, as exit for reasons of child- or eldercare in this female-dominated profession is likely to be higher than that of medicine in Malawi (Lagarde and Cairns 2012). A mid-range value (-0.0175) between these two was used in the model, with uncertainty explored in the sensitivity analysis. Figure A1 shows the values of this parameter in each cycle.

Figure A1 Deterministic transition probabilities for "exit health labour market" parameter over time horizon



The transition probabilities for exiting the public sector for interns and medical officers was based the 2006 – 2012 tracing study (Mandeville, Ulaya et al. 2014). This allowed an examination of the proportion of doctors outside the public sector by time after graduation. This showed a polynomial rather than linear trend, with a steep rise for the first two years after graduation then a plateau (Figure A2). We used data on 2006 graduates outside the public sector to anchor transition probabilities for the intern and medical officer states.

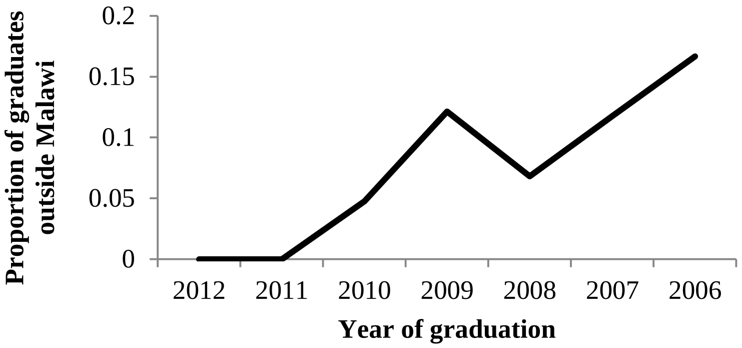
Figure A2 Proportion of graduates outside public sector by year of graduation



Source: *Mandeville, Ulaya et al. (2014)*

The probability of exiting Malawi for interns and medical officers was also based on examination of data from the 2006 – 2012 tracing study (Mandeville, Ulaya et al. 2014). In contrast, this showed a more linear trend for the proportion of doctors outside Malawi with time after graduation, even excluding those in government training programmes (Figure A3). Therefore, we used data on the proportion of 2006 graduates outside Malawi and not in government training programmes to anchor transition probabilities that reflected this trend.

Figure A3 Proportion of graduates outside public sector by year of graduation



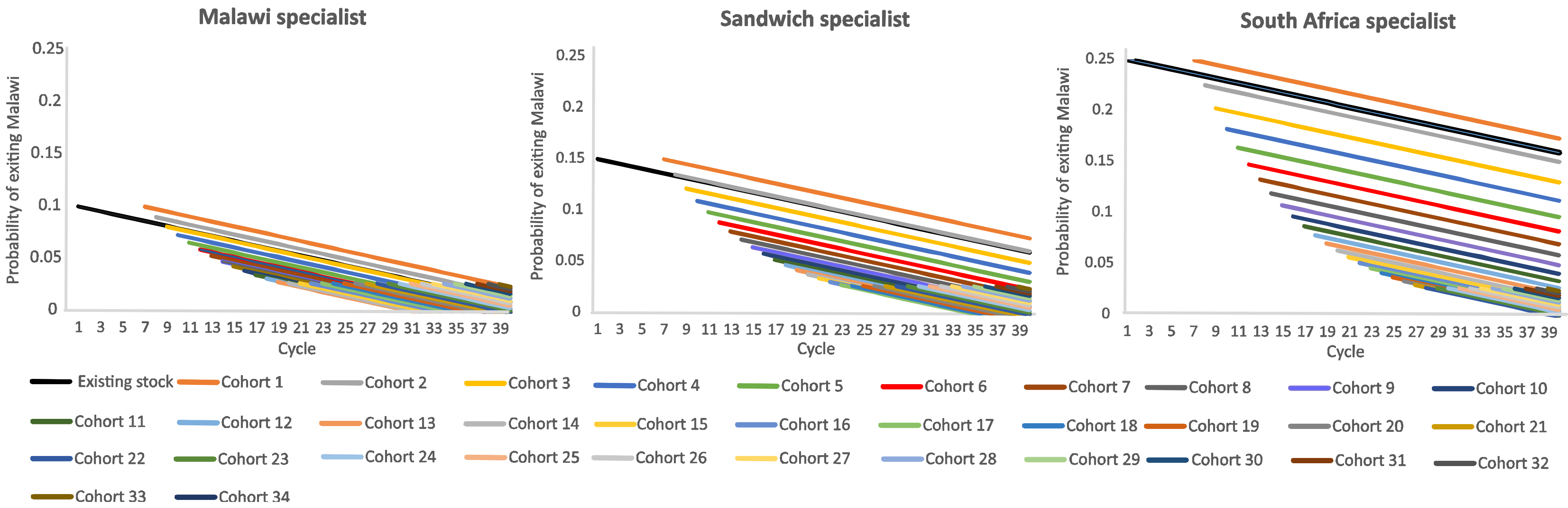
Source: *Mandeville, Ulaya et al. (2014)*

With regard to specialists, only the exit from Malawi is relevant (as it was assumed specialists did exit the public sector even if engaged in dual practice). From limited COM data on current posts of specialists trained in the last ten years, we estimated a probability, ρ, of exiting Malawi each cycle where ρ_M is for specialists who have trained all in Malawi, ρ_{SA} for specialists who have trained all in South Africa, and ρ_{MSA} for specialists with sandwich training. This value declined with time in order to reflect the likely "magnet effect" of an expanding specialist workforce (Bailey, Mandeville et al. 2012). Therefore, the functional form for exiting Malawi from each cycle in the specialist state was:

$$EM(t) = \rho + (1\text{-}e^{\delta t}) \qquad (2)$$

with δ set so that the transition probability halved after 20 years for the first cohort. As the magnet effect would be greater for subsequent cohorts, we made this parameter both cohort- and time-dependent by setting ρ to decrease by 10% for each cohort until equal to the background exit probability for generalist doctors (see below). Figure A4 provides an overview of these transition probabilities over the time horizon for each specialist state.

Figure A4 Deterministic transition probabilities over time horizon from specialist states to Exit Malawi



Note: *Cohorts 35 to 40 not shown as these cohorts do not reach specialist states by the end of the time horizon*

In the generalist state, the exit probabilities for the medical officer state were used as the basis for a declining exponential function to model exits from Malawi and the public sector, such that:

$$EM_G(t) = 0.02 + (1-e^{\theta t}) \qquad (3)$$

and:

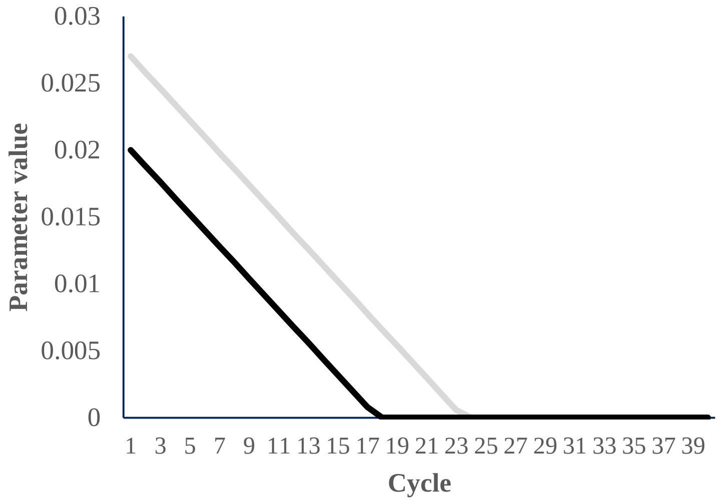
$$EPS_G(t) = 0.027 + (1-e^{\theta t}) \qquad (4)$$

Data from the earlier tracing study (Zijlstra and Broadhead 2007) were used to inform the value of θ. We defined generalists as all graduates who were not specialists or in postgraduate training programmes. Out of 186 generalists, 34 (18.3%) were outside Malawi and 21 (11.3%) outside the public sector at a maximum 14 years of follow-up for the earliest graduates. Figure A5 shows the time-dependent values for these two parameters.

Transition probability from medical officer to registrar in baseline scenario

The probability of transitioning to specialty training in the baseline is challenging to estimate for several reasons: (i) there are multiple funders of training places in Malawi (including the government, CHAM, research organisations and charities), but this analysis is focused on government funding; (ii) historically funding has been provided on an *ad hoc* basis due to budgetary constraints, therefore it is difficult to predict the annual number of available training place (whilst the MOH has forecast the minimum number of specialists required between 2009 and 2023 in order to maintain current specialist provision in central hospitals, this is not a budgetary commitment); (iii) there are important cohort effects, with a small stock of doctors in earlier years and greater

Figure A5 Time-dependent transition probabilities from generalist state



Notes: *Exit Malawi transition probability for generalists (EM_G) shown in grey and exit public sector transition probability for generalists (EPS_G) shown in black. Cycle numbers indicates the first cycle in which doctors enter generalist state.*

number of graduates more recently. Examining the tracing study dataset for the proportion of graduates in specialty training per year of graduation would be misleading for this reason. Moreover, many earlier registrars were funded by a grant from the National AIDS Commission (NAC), under which 34 registrars started between 2010 and 2012, however this funding has not been continued.

In order to inform this transition probability, we therefore constructed two forecasts for the funding of training places. In the 'replacement' scenario, the MOH 15-year forecast was compared to COM registry data on enrolled students by year in order to predict the percentage of medical officers that could start specialty training per year under the assumptions (i) the government funded training places based on this plan and (ii) all places were taken up (Table A4). This drops to 11% of interns by 2020. In the 'optimistic'

Table A4 Comparison of specialty training data and predicted medical officer numbers

Year	Predicted number of medical officers*	MOH 15-year forecast			NAC grant	
		Number of specialists Required	Specialty training places required**	Training places as percentage of interns	Number of NAC training places§	Training places as percentage of medical officers
2009	48	20	17	0.35	11	0.23
2010	38	18	17	0.45	11	0.29
2011	55	18	17	0.31	12	0.22
2012	53	17	15	0.28	-	-
2013	62	17	15	0.24	-	-
2014	53	17	14	0.26	-	-
2015	61	15	14	0.23	-	-
2016	80	15	14	0.18	-	-
2017	98	14	14	0.14	-	-
2018	104	14	13	0.13	-	-
2019	86	14	11	0.13	-	-
2020	99	14	11	0.11	-	-
2021	-	13	-	-	-	-
2022	-	11	-	-	-	-
2023	-	11	-	-	-	-

Notes: *Data from MOH and COM;*Based on number of graduates from previous academic year or medical students enrolled in relevant year, under assumption that all enrolled students graduate, complete internship and stay in the public sector; **Based on a lag of four years from the number of specialists required assuming a four-year training programme; §Places are allocated between years as planned rather than actual annual intake which was affected by implementation delays* scenario, we envisaged a similar budgetary commitment as the NAC grant. We compared the number of places offered per year under this grant compared to the number of predicted medical officers that year, finding that this represented around a quarter of new medical officers each year.

In order to elicit a more realistic forecast anchored by these best- and worst-case scenarios, we took the mean of the ratios of medical officer to training places for the three years of the NAC grant and the next five years of the replacement scenario. This gave an average of 18% of medical officers transitioning to registrars. We used the percentage of registrars in different training locations in the NAC grant to divide the transition probability between the three possible registrar states: 2% for Malawi training and 8% each for sandwich or South African training.

Transition probability from medical officer to registrar states with policy interventions

The probability of transitioning to specialty training under different policy interventions were based on a study of junior doctors' training preferences. As noted in the paper, distinct subgroups of junior doctors with different preferences for specialty training were identified by this study. The uptake rates of different policy interventions were therefore calculated across all subgroups combined (weighted by the size of the subgroup in the overall sample) and then for each subgroup in turn. These training uptake rates are shown in Table A5.

Table A5 Predicted uptake of expanded training under policy interventions

Policy intervention	PREDICTED UPTAKE (%) Weighted average	Rich rejecters	Stubborn specialists	Money motivated	Pliant patriots
Expanded training					
Malawi training	0.54	0.19	0.50	0.56	0.83
Sandwich training	0.68	0.40	0.65	0.70	0.89
South Africa training	0.70	0.42	0.68	0.78	0.88
Mandatory service before expanded training					
2 years/Malawi	0.39	0.05	0.37	0.40	0.66
2 years/Sandwich	0.52	0.13	0.52	0.56	0.76
2 years/South Africa	0.55	0.14	0.55	0.66	0.75
3 years/Malawi	0.32	0.02	0.31	0.33	0.55
3 years/Sandwich	0.44	0.06	0.45	0.48	0.67
3 years/South Africa	0.47	0.07	0.48	0.58	0.65
4 years/Malawi	0.26	0.01	0.25	0.27	0.44
4 years/Sandwich	0.37	0.03	0.38	0.41	0.56
4 years/South Africa	0.40	0.03	0.42	0.51	0.55
5 years/Malawi	0.20	0.01	0.20	0.21	0.33
5 years/Sandwich	0.30	0.01	0.32	0.34	0.44
5 years/South Africa	0.33	0.02	0.35	0.43	0.43

Cost estimates

Further details are given here on the cost estimates used in the study, with all values and distributions shown in Table A6.

Salary

The latest public sector salary scales (October 2014) were obtained from the Ministry of Health. The entry-level monthly salary for an intern is MWK 321,560, which includes a basic salary of MWK 208,855 and several allowances specific to health workers and doctors. This equates to a net annual salary of MWK 2,782,104 (£3,340)**.**

Four salary grades are relevant to this model: HH (entry level), HG, HF and HE. All have six points except HE which has four points. Doctors progress one salary point per year of service and are eligible for promotion to the next grade after four years, except for HE which is only obtained after completion of specialty training. As approval of promotions can be delayed (Muula and Maseko 2005, Chimwaza, Chipeta et al. 2014), we stipulated that doctors moved up one salary point per cycle for all six salary points before moving to the next grade. We assume that doctors in CHAM facilities are paid at the same rate as those in MOH facilities. In this model, all doctors in the generalist state are promoted to HF grade, as this is the usual level for senior district doctors (Muula and Maseko 2005). As it was only possible to distinguish specialists and generalists by year of service for the first four cycles in each state, salary costs for doctors entering these states in cycle 5 and above were set at the highest point.

While health workers in the public sector can earn extra income from overtime shifts, it is uncommon for doctors to undertake these as the remuneration is several times less than can be earned for equivalent shifts in private hospitals. Therefore no estimate for overtime was included in the costs.

Pension

The Pension Act of 2010 mandated pension contributions for all employers to a national pension scheme, set as a minimum of 10% of salary costs for employers and 5% for employees (Government of Malawi 2011, Mhango and Thejane 2012). Therefore, all salaries were uplifted by 10% to cover employer contributions.

Accommodation

All doctors are entitled to government accommodation. This may be owned by the Ministry of Health, or rented from either private landlords or the Malawi Housing Corporation (a statutory body). As data on capital investment and maintenance for government houses were not available, we used rental costs instead. Although interns are entitled to accommodation in hospital owned flats, the capacity is inadequate for the growing number of graduates and many interns are provided with rented accommodation. Data on current rents paid for doctors working in central and district hospitals were obtained from the three Regional Offices for Housing in Malawi. Although caps for government contributions to rented accommodation have been set across the public sector, the housing data showed that these caps were regularly breached in the major cities.

Accommodation continues to be subsidised while registrars are training in South Africa. Although immediate family would continue to be eligible for free accommodation whilst a registrar is in South Africa, most junior doctors were unmarried and without children in the DCE dataset. Therefore Malawian accommodation costs were not counted during training in South Africa, although residency fees for registrars were included in tuition fee estimates.

Transport

There is a one-off transport incentive associated with the transition to a specialist. This is a recent implemented policy whereby the government purchases a vehicle for each newly appointed specialist in the public sector. The vehicle is then owned by the specialist, who bears all responsibility for maintenance. The vehicle is a standard saloon car bought from Malawi-based dealers, with an estimated cost of MWK10 million. The government also provides 250 litres of fuel per month for all specialists. An average of the Malawian Energy Regulatory Authority recommended pump prices for petrol and diesel for May 2015 were used in these estimates (Malawi Energy Regulatory Authority).

The other transport subsidy is for interns and medical officers at central hospitals, who should have transport to and from work provided by the hospital. This is usually in the form of a shared minibus with other hospital staff. As the cost per doctor was therefore difficult to estimate, we instead took the market price of a journey using a public shared minibus. Junior doctors are usually accommodated relatively far from the central hospitals due to the rental caps, therefore we used an average of estimated cost of journeys to these areas in Lilongwe and Blantyre. As doctors based at district hospitals have access to hospital vehicles for personal transport, we used the same cost estimate per journey for all junior doctors.

Communication costs

All specialists in Malawi receive a standard monthly allowance to cover landline and mobile phone costs, which were included in the estimates.

Specialty training allowances

Although registrars continue to receive their MOH salary (and increments) during training, they also receive an additional stipend (higher during South African training to cover increased living costs). Registrars also receive annual conference and book allowances, along with a one-off entry cost of a laptop. Registrars in South Africa also receive allowances to cover health insurance and costs related to clinical work, e.g. transport to clinics. There is also a one-off settling-in allowance at the start of South African training, and baggage allowances on entry and exit.

Table A6 Cost estimates

Notes: *MWK = Malawian kwacha; SE = standard error (derived from sample for accommodation, 10% of point estimates for other values)*

Description	Mean cost (MWK)	Units	Annual cost	SE	Distribution	α	β
Gross monthly salary							
HH grade							
Point 1	321,560	12	3,858,720	-	Deterministic	-	-
Point 2	327,658	12	3,931,896	-		-	-
Point 3	333,756	12	4,005,072	-		-	-
Point 4	339,854	12	4,078,248	-		-	-
Point 5	345,953	12	4,151,436	-		-	-
Point 6	352,051	12	4,224,612	-		-	-
HG grade							
Point 1	359,609	12	4,315,308	-	Deterministic	-	-
Point 2	372,721	12	4,472,652	-		-	-
Point 3	385,832	12	4,629,984	-		-	-
Point 4	398,944	12	4,787,328	-		-	-
Point 5	412,055	12	4,944,660	-		-	-
Point 6	425,167	12	5,102,004	-		-	-
HF grade							
Point 1	458,371	12	5,500,452	-	Deterministic	-	-
Point 2	499,922	12	5,999,064	-		-	-
Point 3	541,473	12	6,497,676	-		-	-
Point 4	583,023	12	6,996,276	-		-	-
Point 5	624,574	12	7,494,888	-		-	-
Point 6	666,125	12	7,993,500	-		-	-
HE grade							
Point 1	845,070	12	10,140,840	-		-	-

Point 2	884,515	12	10,614,180	-		-	-
Point 3	923,961	12	11,087,532	-		-	-
Point 4	963,406	12	11,560,872	-		-	-
Pension							
Employer contributions	10% of salary				Deterministic	-	-
Accommodation	102,080	12	1224955	93,959	Gamma	170	7,207
Transport							
Interns and medical officers							
Minibus journey to and from work	250	2 per day	182,500	70000	Gamma	7	26,849
Specialists							
Vehicle purchase	10,000,000	One-off	-	1,000,000	Gamma	100	100,000
Monthly fuel subsidy	729	250 litres	2,187,000	218,700	Gamma	100	21,870
Communications (specialists only)							
Mobile and landline allowance	36,000	12	432,000	43200	Gamma	100	4,320
Specialty training							
All registrars							
Laptop	572,727	1	572,727	57273	Gamma	100	5,727
Book allowance	211,909	1	211,909	21191	Gamma	100	2,119
Conference allowance	257,729	1	257,729	25773	Gamma	100	2,577
Registrars in Malawi							
Stipend	2,646,000	1	2,646,000	264600	Gamma	100	26,460
Tuition fees	550,000	1	550,000	55000	Gamma	100	5,500
Registrars in South Africa							
Tuition fees	2,332,153	1	2,332,153	233215	Gamma	100	23,322
Stipend	4,467,273	1	4,467,273	446727	Gamma	100	44,673
Clinical work allowance	1,338,876	1	1,338,876	133888	Gamma	100	13,389
Health insurance	343,636	1	343,636	34364	Gamma	100	3,436
Settling in allowance	211,909	One-off	-	21191	Gamma	100	2,119
Baggage allowance	114,545	Entry & exit	-	11455	Gamma	100	1,145

9.4 CONCLUSIONS

This chapter has provided a long-term perspective of the role of specialty training in retaining doctors in Malawi, as well an evaluation of its cost-effectiveness as a potential policy lever. The next chapter draws together the findings of the research programme in a critical assessment of its contribution to knowledge.

10 DISCUSSION AND CONCLUSIONS

This thesis set out to investigate the role of specialty training in the retention of doctors, examined through the job choices of Malawian junior doctors. This chapter provides a critical assessment of the major findings of the research programme and reviews their implications for research and policy.

10.1 MAJOR FINDINGS

This section summarises key results arising from this research, presented according to the thesis objectives outlined in Chapter 5.

10.1.1 Factors influencing junior doctors to leave the Malawian public sector

The first objective sought to identify the key factors influencing junior doctors to leave the public sector, whether to other jobs in Malawi or other countries. Semi-structured interviews with junior doctors, reported in Chapter 7, found that the current incentives offered in the public sector were generally perceived as insufficient, with complaints over inadequate salary levels and difficulties accessing subsidised accommodation. Despite the salary allowances under the Emergency Human Resource Programme, the higher remuneration offered by jobs outside the public sector as well as outside Malawi was attractive to junior doctors. Indeed, the differential between sectors was substantial, with the DCE survey indicating that the average salaries of junior doctors working outside the public sector were four times those in the public sector (reported in Chapter 8). Interviews revealed, however, that a major attraction of the public sector was more reliable access to specialty training, as per the hypotheses proposed in Chapter 2. The cross-sectional survey administered at the same time as the DCE underlined the importance of specialty training to this group of doctors, with all but one junior doctor in Malawi intending to specialise in the future and the vast majority actively searching for a training place (Chapter 8). The tracing study, reported in Chapter 6, provided evidence that the constrained number of government-funded training places may be leading to doctors seeking opportunities elsewhere. Over ten percent of doctors in specialty training were found to be self- or privately funded, including all those training outside Africa.

10.1.2 Retention of junior doctors in the Malawian public sector

In order to investigate the retention of junior doctors for the second objective, I undertook the first tracing study of the Malawian medical workforce since 2006, focusing on medical graduates between 2006 and 2012. The results showed that 85% of junior doctors were in Malawi, with 15% of those working outside the public sector (Chapter 6). The sample was weighted towards more recent graduates, however, and the risk of leaving Malawi and the public sector increased with time after graduation. One third of doctors were in specialty training, including four fifths of those outside Malawi, with graduates twice as likely to be in training for every year after graduation. Compared to previous tracing studies (described in Chapter 4), these results found good public sector retention in early career and more graduates in specialty training in South Africa rather than in the UK. However, it is likely that follow-up over a longer time period would identify greater losses, given the tendency of graduates to leave Malawi or the public sector with time.

10.1.3 Junior doctors' preferences for specialty training

The semi-structured interviews revealed a far more complex perspective of specialty training than conceptualised by previous preference studies (see Chapter 3). Training within Malawi was viewed as "limiting" and of lower quality than training outside Malawi. There was also a broad preference for core specialties over several priority but low-status specialties such as ophthalmology. And junior doctors generally desired to train earlier rather than later, while their "brains were still fresh" (Chapter 7). This evidence suggested that not all specialty training was valued equally, raising concerns that indiscriminate scaling up of training would not be effective for retention. In order to answer the third objective of quantifying junior doctors' preferences for specialty training, I developed a stated preferences survey exploring these nuances and administered it to the entire eligible population in Malawi.

The results, reported in Chapter 8, showed that junior doctors in Malawi are willing to trade their time, salary and job location in exchange for the opportunity to undertake specialty training. Not all training, however, would elicit the same compromises. Desired specialties and training locations produce the greater trade-offs, in contrast to a reluctance to accept training in unpopular specialties or training in Malawi. An additional 1.3 to 8.5 years' service in the public sector would be traded for guaranteed training in a first choice core specialty, but just two to five months for an extra 10% in basic salary. Most doctors require strong incentives to trade their desired specialty, with training in ophthalmology requiring a 200% to 350% increase in basic salary. Moreover, training undertaken just in Malawi would require a 36% to 79% increase in basic salary. In contrast, doctors would forego up to 11% of their basic salary for some training in South Africa, 20% for all training in South Africa and 58% for all training outside Africa.

Using a latent class model for the first time in a health workforce DCE, distinct subgroups of Malawian junior doctors were identified with very different preferences. These ranged from those who frequently rejected the jobs on offer to others with very firm training preferences and still others with more malleable preferences. This heterogeneity in preferences could be leveraged by policymakers to maximise service in the public sector in exchange for any investment in specialty training. Policy simulations showed, however, that negative strong preferences against a specialty are unlikely to be overcome with incentives, except for those with the most flexible preferences.

In summary, I found that the single attribute used in previous DCE studies did not capture the complexity of postgraduate training preferences. Greater expansion of training may not be effective unless these preferences are taken into account.

10.1.4 Cost-effectiveness of specialty training for retaining doctors

In only the second application in HRH literature to my knowledge, I constructed a Markov model to determine the cost-effectiveness of different specialty training policies to retain doctors in the Malawian public sector, thus answering the final objective. This detailed modelling of doctors' careers over a 40-year time horizon incorporated results from the tracing study and DCE survey, as well as local cost data. The results, reported in Chapter 9, revealed that expansion of specialty training within Malawi was the most cost-effective option in the long-term, even taking into account doctors' preferences for training outside the country. The enforcement of a required period of public sector service before training was more cost-effective in terms of doctor-years, with longer periods adding more value. These policies, however, would require the government to spend considerably more on the medical workforce than currently in return for relatively modest gains in doctor-years. At the end of 40 years of expanded training in Malawi, the medical workforce would be over fifty percent larger with over six times the number of specialists compared to current trends. Yet this would cost at least 3.5 times more per doctor-year for a five percent minimum increase in total doctor-years over baseline and at least fifty percent more per specialist-year for a maximum six-fold increase over baseline. Greater increases in doctor- and specialist-years were possible in the pliant patriots subgroup, although at a higher cost.

10.2 CONTRIBUTION TO KNOWLEDGE

The contribution of this thesis can be considered in terms of empirical findings and methods.

10.2.1 Contribution to empirical findings

One of the most important contributions of this work is evidence for the complexity of postgraduate training choices. This is the first DCE to disaggregate a postgraduate training attribute into different dimensions. Doctors in this population had distinct preferences across these dimensions that would have been masked by a composite attribute. Aspects of training such as specialty, location and time before entry were influential in the choice of a training post. While some doctors were willing to trade-off between these aspects, subgroup analysis identified others with more rigid preferences. Given the multi-dimensional nature of postgraduate training identified here, the findings of previous studies with a single training attribute are more difficult to interpret as participants may have made disparate assumptions over unspecified aspects of training.

It is not yet clear what participants value about the disaggregated dimensions in this study. Different types of training may confer professional prestige or provide some type of signalling on the value of such human capital investments. For example, training in a core specialty may be associated with greater access to private practice as a specialist than training in marginal specialties. Specialty training undertaken in South Africa may be perceived as being in greater demand in international labour markets than Malawian-based training. Further research to unpack these concepts would be valuable.

The second major contribution of this thesis is the dynamic modelling of doctors' career pathways. This is novel and far more complex than what has been attempted to date, with several innovative features such as the interaction of cohorts and inclusion of existing doctors. By providing a long-term perspective of policy interventions, it demonstrates the cumulative and interdependent effects of policy recommendations based on DCE studies. For example, although doctors are more willing to accept posts offering training outside Malawi, the greater propensity for emigration in non-domestically trained doctors actually makes domestic training a better investment for the Malawian government in the long-term. It also enables a realistic assessment of the impact of these investments, finding that any specialty training intervention will only provide a relatively modest increase in doctor-years over the time horizon for a considerable increase in funding. Finally, the impact of the diversity in health workers' preferences is made clear through a comprehensive investigation of heterogeneity. Higher yields of public sector service from training investments could be achieved in doctors with more flexible preferences, albeit at a higher cost. It may be that such preferences could be selected for or encouraged in undergraduate training.

10.2.2 Contribution to methods

This thesis has also made several important contributions in terms of methods. The first systematic review of all applications of DCEs to health workforce policy was undertaken, which employed an original framework to assess quality for the first time in health. The iterative and pragmatic nature of DCE design, well known to experienced researchers, has been explicitly articulated to guide those new to the field. The employment of the marginal substitution rate of time was also innovative, to my knowledge[43]. An indication of health workers' willingness to give up their time for desirable job attributes (or the amount of time compensation required for less preferred attributes) could be considered a better measure of preferences in a population not primarily composed of wage seekers, as well as a more tangible expression of potential retention gains for policymakers. Time in this study referred to a deferral of specialty training, and further application outside this context would be useful to assess the reliability of the measure.

10.3 STRENGTHS AND LIMITATIONS

The strengths and limitations of specific methods and analytical approaches have been discussed in the preceding chapters, and this section will focus on more overarching themes.

[43] The value of time is commonly calculated in transport studies, however this is willingness to pay for time savings.

10.3.1 Study setting

The choice of Malawi as a study location could be considered both a strength and weakness of this research programme. The opportunity to collect an almost complete population dataset is unique amongst the DCE studies reviewed in Chapter 3, making questions of inference within this population irrelevant. Furthermore, the relative homogeneity of the study population in terms of undergraduate and postgraduate experiences made it an ideal sample to examine heterogeneity in specialty training preferences, which could otherwise be confounded by different teaching or work environments. The close-knit alumni network of my Malawi-based research team also afforded a level of access and tracking that would have been more difficult elsewhere. Yet these benefits for data collection and inference could be likened to a pair of golden handcuffs. Design decisions were constrained by the fear of non-significant results in a finite population. Important questions such as interactions between training attributes were considered but discarded, leading to assumptions that may not have been necessary in other populations. On reflection, excessive caution may have been taken, given the power of efficient designs and the highly significant main effects of the DCE (Chapter 8). Attempts to correlate personal characteristics with preference heterogeneity through the inclusion of observed variables in latent class and mixed logit models, however, were often not significant despite strong *a priori* bases. For example, doctors with rural upbringings did not prefer to work in district hospitals and doctors with spouses or young families did not prefer to train all in Malawi. This suggests that either the hypotheses were incorrect or the constrained population led to Type II error, lending support to the cautious design process.

10.3.2 Representation of a complex reality

As part of the DCE design process, difficult decisions had to be taken for this study in order to reduce a complex reality into a cognitively tenable choice task. This simplification process continued during the construction of the Markov model, with tractability prioritised over realism in some areas. For example, the issue of skill-mix was not considered in the model, either through the specialty of training places on offer, or alternative policies such as training more specialist clinical officers. Features of Markov modelling, such as the lack of "memory" of previous transitions once within a state, also limited representation of the real-life situation for junior doctors in Malawi (Fox-Rushby and Cairns 2009). For example, it was not possible to model a stock of junior doctors that then competed for available training places. Indeed, Markov modelling was employed here due to its popular use in cost-effectiveness analyses, but there are more sophisticated operations research techniques available. For example, systems dynamics models allow investigation of complex dynamic behaviours (such as feedback loops and time lags between actions and effects) that would align well with the impact of training on medical workforce planning (Wang 2005). While this work has deepened the debate in this area in many ways, greater complexity is always possible in order to represent reality more accurately.

10.3.3 External validity of discrete choice experiments

Finally, the limitations of stated choice research must be acknowledged, including the inevitable comparisons to the "gold standard" of actual choices. Indeed, before widespread application of DCEs to health workforce issues McPake et al. ask for further research to establish whether the hypothetical nature of DCEs can reliably predict behaviour (McPake, Scott et al. 2014). Yet it is worth asking what a lack of prediction would signify in labour market decisions. Such a discrepancy could indicate poor internal validity of the DCE, with a range of problems in previous studies highlighted in my systematic review (Chapter 3). A number of measures were taken to improve the internal validity of this study, as described in Chapter 7 and 8. For example, the extensive and iterative use of qualitative methods provided a strong foundation for the design, as well as a deeper understanding of the decision-making process. This has been termed process validity in DCEs (Lancsar and Swait 2014). The resulting preferences also provide support for the study's internal validity, with stronger preferences for higher salaries and diminishing preferences for longer periods of time before training meeting *a priori* expectations.

An alternative explanation for any discrepancy between stated and actual choices is that DCEs have poor predictive validity. Lancsar and Swait found good evidence of the external validity of DCE studies across a number of sectors, including transport, environment and market research, although there has been surprisingly little examination of this issue in health (Lancsar and Swait 2014). The authors suggest that this may be due to the relative non-consequentiality of policy and commercial decisions based on DCE studies in health to date compared to other sectors (e.g. environmental damage claims, transport congestion pricing, market share predictions). Health workforce decisions have clear consequentiality, however, particularly in low-resource settings. It is therefore surprising that there have not been more efforts to validate the results of such DCEs with subsequent labour market decisions, and this would certainly be a fruitful area for further research.

Evidence of poor predictive validity from such studies, however, could have several explanations. One would be that the choice presented to a health worker in real life was not the same as that in the DCE. For example, the political or logistical feasibility of some interventions may have diminished in the period between DCE design and policy implementation. It would be important for any attempt to compare stated and revealed preferences to document not only the revealed choice, but the actual alternatives and attributes available (Lancsar and Swait 2014). Another possible explanation would be the "hypothetical bias" of DCE studies. Acceptance of a job in real life is a very different prospect to accepting a hypothetical job, even if both align with personal preferences. The personal constraints influencing labour market decisions are generally poorly captured by DCEs and these would need to be taken into account when assessing predictive validity.

Approaches to minimising this hypothetical bias has been the subject of recent research efforts. Some researchers have advocated *ex ante* measures, such as framing the choice task so that the consequentiality of the choices is clear to participants (Fifer, Rose et al. 2014). In my DCE, the participants were made aware of the policy relevance of the study and shown good engagement during the task. The choice itself, however, could have been better worded to minimise hypothetical bias[44]. An *ex post* measure that could have been employed in this study would have been to ask participants to rate each choice on an uncertainty scale, with each choice weighted according to its level of uncertainty (Fifer, Rose et al. 2014). An uncertain decision, however, could simply be a hard decision, rather

[44] Instead of "Would you choose job A, job B or neither job?", the choice could have been phrased as "According to your personal circumstances, would you choose…." following the approach by Mangham and Hanson (2008).

than one that is less likely to be followed through on. Indeed, efficient designs purposively increase the difficulty of decisions by creating choice tasks closely balanced in utility in order to maximise information from a dataset (Choicemetrics Pty Ltd 2014). An alternative approach in labour market decisions could be the inclusion of an additional question asking participants to rate the certainty of accepting such a job in real life. Choices weighted in this way may have better predictive validity and are an avenue for future research.

Finally, it is important to consider the environment in which doctors in Malawi make labour market choices. Starting from internship, doctors are given obligatory postings to facilities around the country without consultation. Relocation from these posts can be made without warning. Little information is available to doctors on the characteristics of postings, availability of training opportunities or career pathways. In this arbitrary environment, job preferences are often revealed through the evasion of posts, whether this is through leaving the public sector or petitioning the MOH for reallocation. Moreover, qualitative work revealed that doctors were often not aware of training scholarships as they are publicised via word of mouth or newspapers, rather than an accessible systematic mechanism, and may be subject to nepotism. The opportunity for doctors to exercise their preferences for specialty training may be constrained as much by a lack of information and fair access as by limited and unpredictable training places. Yet one of the core assumptions of discrete choice experiments is that individuals will maximise utility based on complete information and free choice. The policy suggestions derived from the DCE and modelling results are based on this normative model, whereas any implementation of these policies will take place in a setting with low organisational capacity and weak governance mechanisms. Not only may this lead to discrepancy between stated and revealed preferences, but it may also cloud stated preferences. For example, a recent DCE study in Cameroon found only limited impact of preferential access to specialty training places for rural recruitment in medical students and doctors, with interviews revealing a lack of belief among participants that such a quota would be implemented fairly (Robyn, Shroff et al. 2015). From this perspective, increased transparency and stronger workforce management capacity are just as important for retention efforts as the identification of effective policies.

10.4 IMPLICATIONS FOR RESEARCH

This section considers the broad research implications of this work, along with its generalisability to other settings.

10.4.1 More routine cost-effectiveness modelling

Cost-effectiveness analysis of potential policy changes should become a more routine extension of DCE studies, as well as in health workforce policy in general. This is only the second study, to my knowledge, to incorporate DCE results into a formal economic evaluation of health workforce policy. The systematic review in Chapter 3 found 36 DCE studies focused on health workforce issues to date, yet only five studies have attempted any cost analysis of recommended policy options. More empirical evidence of health workers' preferences is only one aspect of the evidence needed for informed policy, particularly given the dynamic nature of workforces. While the availability of health workforce data in many LMIC is likely to have dampened modelling enthusiasm, this research illustrates what can be achieved with limited data sources. More widespread use would also drive more complex DCEs and modelling, for example the use of labelled designs to represent different sectors/countries in order to estimate the cross-elasticities of policy interventions.

10.4.2 The need for health workforce data

Despite the achievements with limited data in this thesis, there is an urgent need for greater data collection in health workforces. Two types of data are needed in particular: income and longitudinal data.

From a labour market perspective, a thorough investigation of income levels for doctors in Malawi would provide a wealth of information for retention efforts (McPake, Scott et al. 2014). After all, it is difficult to develop appropriate incentive levels when the *status quo* is unknown. Health workers in LMIC often have multiple sources of income, which may include their official salary, fees-for-service, informal payments, *per diems*, and non-health sector income, e.g. from farming (Roenen, Ferrinho et al. 1997). This has been termed "complex remuneration", and health workers' calculations of the total financial incentive available in different settings may lead to unexpected effects on retention (Bertone and Witter 2015). For example, junior doctors were found in this research to prefer non-remote district hospital posts over central hospitals, as the disadvantages of rural life were crowded out by the substantial extra income from *per diems* in such posts. Comparison of overall income levels between remote and non-remote posts could support provision of rural allowances for doctors in remote district hospitals as compensation for the income foregone in remote posts. Furthermore, clarification of income – rather than wage – differentials between public and other sectors would help explain movement between sectors. In light of the modelling here, it would also be important to document the change in proportions between these sources of income over time as health workers gain in human capital.

Indeed, more longitudinal data following up health workforce samples over time would enormously benefit research in this area. For example, detailed tracking of labour market decisions would enable more accurate assessment of retention, as well as identification of timepoints that are particularly vulnerable to exit. Such survival analysis has been undertaken for doctors in Thailand as part of a prospective cohort study (Pagaiya, Kongkam et al. 2015). This type of data would allow more accurate estimation of cost-effectiveness model parameters, as well as personal and training characteristics associated with retention.

10.4.3 Generalisability to other settings

Finally, we should consider the generalisability of the key findings to other populations. The literature reviewed in Chapter 2 demonstrated that Malawi is not exceptional with regard to its training capacity. Many sub-Saharan African countries are in similar positions of rapidly expanding medical student numbers and limited domestic specialty training (Mullan, Frehywot et al. 2011). As in Malawi, cross-country surveys have shown that most medical students intend to specialise (Burch, McKinley et al. 2011). Previous DCEs have also revealed that access to specialty training is highly valued by medical students and doctors in LMIC (Lagarde, Traore et al. 2011, Vujicic, Shengelia et al. 2011, Rockers, Jaskiewicz et al. 2012, Rao, Ryan et al. 2013). And migration studies have highlighted that junior doctors in particular are leaving LMIC for high-income countries (George, Rozario et al. 2007, Tankwanchi, Özden et al. 2013). Therefore, the broad conclusions of the DCE and cost-effectiveness analysis – that expansion of certain types of specialty training would be cost-effective at retaining doctors - are likely to be generalisable beyond Malawi.

Contextual factors, however, may limit the applicability of these findings. For example, the level of trust that health workers have in government initiatives is likely to influence results, as seen in the Cameroon DCE study (Robyn, Shroff et al. 2015). The unique development of health workforces in different countries is also a consideration. For example, the provision of care by clinical officers in some specialty areas in Malawi was found to influence the preferences of junior doctors for these specialties. Such concerns may be less important in other workforces. As noted by others, further work exploring the generalisability of DCE findings in health workforce policy would be a worthwhile investment in order to avoid unnecessary replication studies (McPake, Scott et al. 2014).

10.5 IMPLICATIONS FOR POLICY

Rather than reiterating the recommendations made in earlier chapters, this section considers more general policy implications of this work.

10.5.1 Not all training will be effective at retaining health workers

In contrast to the conclusions of previous preference studies, policymakers should be aware that not all training will be effective at retaining health workers. Training is certainly valued by health workers, but not all training is valued equally. Health workers may be willing to trade on some aspects, but some have strong and fixed preferences that may lead to rejection of available training. Finally, some training may be effective at retention in the short-term, but not in the long-term. Careful investigation of preferences within target populations, as well as over a longer time horizon, would support more effective policies.

When creating such policies, decision-makers need to be cognisant of the tension between the drive to deliver high quality training and the need for a workforce with locally relevant skills. For medical educationalists, there is a degree of reflected pride in the ability of their trainees to meet international standards (thus making them internationally competitive), whereas the policy priority is likely to be acquiring doctors and specialists adapted to local conditions. Indeed, the discrepancy between the future specialty expectations of recent Malawian graduates and available training in Malawi (Chapter 8) would seem to belie some of the benefits of a domestic medical school. This may be an inevitable consequence of the increasing interconnectedness of an international medical community, but may also be rooted in a teaching environment that constructs training preferences ill-aligned to the local health system. Indeed, 'upstream' measures to influence preferences during training – such as exposure to priority specialties and deliberate role-modelling - may be more cost-effective than 'downstream' incentives to entice doctors into unpopular training posts.

10.5.2 A "whole-career" approach to health workforce policy

Policymakers and development partners need to assess health workforce interventions from a "whole-career" perspective. The impact of changes to health workforce policy are protracted and complex. The time lags of training and long working lives inherent to this area means that the full effects of most policy changes only emerge years later. For example, the doubling of salaries and tripling of medical students under Malawi's Emergency Human Resource Programme has created a substantial legacy of deferred costs if retention is to be sustained over these doctors' lifetimes. The current aid freeze in Malawi has compounded this situation by further restricting government health spending. These combined factors have contributed to the situation as of October 2015, whereby the MOH has not been able to employ any of the enlarged cohort of doctors who graduated in August 2015 due to budget restrictions[45]. Despite this evident cost legacy, the EHRP is considered a success (McPake, Maeda et al. 2013). In part, this is due to the novel willingness of donors to support salary supplements and training of new health workers over a number of years. Yet both the current situation and the dynamic modelling presented in this thesis show that the appropriate time horizons for such interventions are far longer than the usual funding and political cycles. Regardless of the financing timeframe, policy interventions in this area should be assessed from a "whole-career" perspective in order to account for all costs and effects on the health workforce. This is could be supported by the type of decision analytical framework presented in this thesis.

10.6 Conclusions

A growing awareness of the importance of the health workforce has focused attention on possible incentives to retain health workers in LMIC. This thesis set out to investigate the role of specialty training in the retention of junior doctors in Malawi. I found that almost

[45] It is reported that 10 out of a total of 51 doctors have already left to work in Lesotho. In mid-October 2015, the first general strike of doctors in Malawi was called by the newly established trade union in solidarity for the new graduates.

all junior doctors desire to specialise, but not all specialty training is valued equally. Despite specialty training outside Malawi being preferred by junior doctors, expanding training within Malawi was the most cost-effective means to retain doctors in the long-term. This thesis has demonstrated the value of applying common methods from health economics to health systems research questions. Greater application of these techniques in low-resource settings would support more cost-effective health workforce policy.

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APPENDICES

APPENDIX A SEARCH STRATEGY FOR DOCTORS' MIGRATION SYSTEMATIC REVIEW

<table>
<tr><td>SEARCH QUESTION</td><td colspan="2">What factors influence the migration decisions of doctors?</td></tr>
<tr><td rowspan="3">SCREENING</td><td>Cochrane library</td><td>One review excluded as focus on rural-urban migration not emigration</td></tr>
<tr><td>Campbell library</td><td>No other reviews identified</td></tr>
<tr><td>Health Systems Evidence</td><td>No other reviews identified</td></tr>
<tr><td rowspan="3">SCOPE</td><td>Dates</td><td>No limits set</td></tr>
<tr><td>Countries</td><td>No limits set</td></tr>
<tr><td>Language</td><td>English/French/Portuguese/Spanish</td></tr>
<tr><td>DATABASES SEARCHED WITH FOCUS</td><td colspan="2">Medline (general medicine)
Embase (general medicine)
Health Systems Evidence (policy briefs, evidence reviews)
Global Health (international public health)
Social Policy & Practice (public health and economic policy)
Health Management Information Consortium (health services research and health policy, UK-focused)
Web of Science (public health and social sciences)
Global Index Medicus (biomedical and public health literature from LMIC)</td></tr>
<tr><td rowspan="2">DATABASE SEARCH TERMS</td><td>General</td><td>physician* OR doctor* OR clinician* OR medic*
AND
migrat* OR emigrat* OR immigrat*
AND
emigrant* OR immigrant* OR migrant* OR
brain-drain OR braindrain</td></tr>
<tr><td>Medline-specific</td><td>Expand:
physicians
emigrants and immigrants
emigration and immigration</td></tr>
</table>

		• transients and migrants
	EMBASE-specific	Expand: • physicians • medical specialist • medical staff • migration
	Global Heath-specific	Expand: • physicians • migrants • migration • immigrants • immigration • emigration • migrant labour
	Health Management Information Consortium **-specific**	Expand: • medical staff • medical specialists • overseas doctors • immigrant • emigration • immigration • labour migration • labour mobility • braindrain
	Global Index Medicus-specific	Expand: • Physician AND "emigration and immigration"
JOURNALS SEARCHED	• Human Resources for Health • Social Science and Medicine	
GRAY LITERATURE **REPOSITORIES** **SEARCHED**	• HRH Global Resource Center (run by CapacityPlus; www.hrhresourcecenter.org/) • Global Health Workforce Alliance Knowledge Centre (www.who.int/workforcealliance/knowledge/en/) • Centre for Research and Analysis of Migration (UCL, http://www.cream-migration.org/) • EQUINET (The Network on Equity in Health in Southern Africa, www.equinetafrica.org/) • WHOLIS (library database of the World Health Organization and its regional offices) • AFROLIB (library database of the WHO Regional Office for Africa, http://afrolib.afro.who.int)	
EXCLUSION CRITERIA	• Not an original research article • Focus on profession or cadre other than doctor • No examination of reasons for emigration	

APPENDIX B SEARCH STRATEGY FOR DCE SYSTEMATIC REVIEW

SEARCH QUESTION	How have discrete choice experiments been used to investigate health workforce policy issues?	
SCOPE	**Dates**	No limits set
	Type of health professional	All health workers, including: • doctors • nurses, • allied health professionals • mid-level cadres • community health workers
	Countries	No limits set
	Language	No limits set
SCREENING	**Expert contact**	2009 review (basis for current review)
	Cochrane library	No other reviews identified
	Campbell library	No other reviews identified
SEARCH TERMS	**General**	health*worker* OR health* personnel OR health* professional* OR doctor* OR physician* OR clinical OR medic* OR nurse* OR human resource* OR staff AND discrete-choice* OR choice experiment* OR stated preference*OR job preference* OR conjoint analysis
	MESH terms (Medline search only)	Expand: • “physicians”/ • “choice behaviour” (although mapped to terms) • “attitude” (although mapped to terms)
DATABASES SEARCHED WITH FOCUS (* = used in 2009 review)	• Medline* (general medicine) • Embase (general medicine) • Econlit* (economics including discussion papers) • Global Health (international public health) • Popline* (reproductive health) • Social Policy & Practice (public health and economic policy)	

	• Southampton University Economics Department (discrete choice experiments in health)
JOURNALS SEARCHED	• Human Resources for Health • WHO Bulletin
GRAY LITERATURE **REPOSITORIES** **SEARCHED**	• HRH Global Resource Center (run by CapacityPlus; www.hrhresourcecenter.org/) • Global Health Workforce Alliance Knowledge Centre (www.who.int/workforcealliance/knowledge/en/) • NBER Working Papers (www.nber.org/papers)
EXPERTS CONTACTED	• See following appendix

APPENDIX C EXPERTS CONTACTED FOR SYSTEMATIC REVIEW

AUTHOR	AFFLIATION	REASON FOR CONTACT	INFORMATION OBTAINED
Mylene Lagarde	London School of Hygiene & Tropical Medicine, UK	• Previous DCEs in HRH • Co-author on 2009 review	• Mali DCE • Peru DCE
Tim Martineau	Liverpool School of Tropical Medicine, UK	• HRH expert • PhD student undertaking DCE in HRH	No further studies
Barbara McPake	Queen Margaret University, Edinburgh	HRH expert, economist	No further studies
Marko Vujicic	World Bank	HRH focus	Contact Marco Alfano at UCL CREAM.
Duane Blauuw	Witswatersrand University, South Africa	• Previous DCEs in HRH • Co-author on 2009 review	Motivation Project DCE (Trinity College)
Pieter Serneels	University of East Anglia, UK	HRH focus	No further studies
Jim Campbell	Integrare, Spain	HRH focus	• Cambodia DCE • Possible Nepal DCE (Merlin)
Christophe Lemière	World Bank, Brussels	HRH and DCE interest	• Complete for published DCEs. • Several DCEs from Trinity College • Mali DCE • Benin DCE • Mozambique DCE (rural nurses)
Mandy Ryan	University of Aberdeen, UK	• Systematic review of DCEs in health.	No further studies

		• Author of user guide for DCEs in HRH	
Karen Gerard	University of Aberdeen, UK	Previous DCEs in health	Will search their database
Julie Kolstad	University of Bergen, Norway	Previous DCE in HRH	Uganda DCE paper in preparation
William Jack	Georgetown University, USA	Previous DCE in HRH	No further studies
Lindsay Mangham	London School of Hygiene & Tropical Medicine, UK	Previous DCE in HRH	No further studies
Catherine Goodman	London School of Hygiene & Tropical Medicine, UK	Involvement in DCE in HRH	Kenya nurses DCE
Margaret Kruk	Columbia University, USA	Previous DCE in HRH	• Mozambique DCE • Malawi DCE • Uganda DCE • North Sudan DCE
Anthony Scott	University of Melbourne, Australia	Previous DCE in HRH	• MABEL DCEs: • GP DCE • Nurse DCE • Junior doctor DCE
Laura Stormont	World Health Organization, Switzerland	HRH Department	Sudan DCE
Kamolnat Muangyim	Liverpool School of Tropical Medicine, UK	Undertaking PhD in HRH	Grindrod DCE on pharmacists
Peter Rockers	IntraHealth International, USA	Previous DCE in HRH	Uganda DCE Lao DCE
Wanda Jaskiewicz	IntraHealth International, USA	Previous DCE in HRH	• Lao DCE • South Sudan DCE • Rapid DCE tool • DCE User Guide
Posy Bidwell	Trinity College Dublin, Ireland	Led DCE in HRH	Tri-country DCE as part of Motivation Project

Tom Bossert	Harvard University, USA	DCE in HRH	Not area of interest
Tomas Lievens	Oxford Policy Management, UK	HRH interest	Cambodia DCE
Sophie Witter	Oxford Policy Management & Queen Margaret University, UK	Previous DCE work	Cambodia DCE
Chris Herbst	World Bank, USA	HRH focus	No other studies
Emma McIntosh	University of Glasgow, UK	Previous health DCEs	No other information
Mesrak Belatchew	IntraHealth International, USA	HRH focus	No other studies
Marco Alfano	University College London, UK	Centre for Research and Analysis of Migration	• Vietnam DCE paper • Liberia nurses DCE
Neath Net	Cambodia Development Resource Institute, Cambodia	DCE in Cambodia	Cambodia DCE details
Edson Araujo	World Bank, USA	HRH lead, Anchor	• India DCE • DCE User Guide
Tim Bolt	Southampton University, UK	DCE database	MABEL studies
Fiona Campbell	Merlin, UK	Head of Policy, possible DCE in HRH	No DCE in Nepal
Kenneth Chomitz	World Bank, USA	Previous DCE in HRH	More details on Indonesia DCE
Elsheikh E Badr	Ministry of Health, Sudan	Involved in Sudan DCE	Sudan DCE underway but not completed
Ehsanullah Tarin	WHO Country Office, Sudan	Involved in Sudan DCE	Sudan DCE underway but not completed
Adriana Galan	National Institute of Public Health, Romania	Possible DCE in HRH	Not aware of any DCEs in Romania

Kim Webber	Rural Health Workforce Australia, Australia	HRH interest	No DCE completed
Charles Normand	Trinity College Dublin, Ireland	HRH interest	No response
Krishna Rao	Public Health Foundation of India, India	Previous DCE in HRH	No response
Carmen Dolea	World Health Organization, Switzerland	HRH Department	No response
Jean-Marc Braichet	World Health Organization, Switzerland	HRH Department	No response
Gunilla Pettersson	World Bank, USA	Previous HRH work	No response
Ramlatu Attah	Oxford Policy Management, UK	Involved in HRH DCE	No response
Toby Gosden	Manchester and York University, UK	Previous DCE in HRH	No contact details found

APPENDIX D DCEs PUBLISHED SUBSEQUENT TO SYSTEMATIC REVIEW

The table below summarises key features of the DCE studies published subsequent to the systematic review shown in Chapter 3.

Notes: *N/A = Not available from report; MNL = Multinomial logit; MXL = mixed logit; GMNL = generalised multinomial logit*

Authors	Setting	Study objective	Health worker cadre	Sample size (total)	Econometric model	Major results
Li et al, 2014	Australia	To examine different rural retention incentive policies	General practitioners	1117	MXL	Limited demand for incentive packages, locum relief would have most impact
Doiron et al, 2014	Australia	To investigate job preferences of newly graduated nurses	Nursing students Nurses within 12 months of graduation	526	MNL, MXL, GMNL, rank-ordered and heteroskedastic rank-ordered versions of above	Salary, supportive management and quality of care most important attributes

Kunaviktikul et al, 2014	Thailand	To investigate job preferences of qualified nurses	Nurses	921	Random effects probit model	High-functioning work setting most valued, followed by workplace close to hometown, then income
Yaya Bocoum et al, 2014	Burkino Faso	To explore incentive packages for rural attraction and retention	Health officer Birth attendant Licensed nurse Midwife State-registered nurse	54 98 92 18 67 **(315)**	MNL and probit model	Cancellation of policy enforcing minimum length of service in one region highly preferred, along with provision of government housing
Pedersen & Gyrd-Hansen, 2015	Denmark	To examine preferences of doctors in training for organisational changes in general practice	Doctors in general practice training programmes	485	MXL	Doctors prefer to work in smaller practices compared to current general practitioners and willing to accept organisational changes in exchange for higher salary
Holte et al, 2015	Norway	To investigate young doctors' preferences for general practice job characteristics	Medical students (final-year) Intern doctors	N/A N/A	MXL	Non-financial incentives have more impact than salary increases in attracting young doctors to rural practices

				(831)		
Robyn et al, 2015	Cameroon	To inform rural retention strategies	Medical students Nursing students Doctors (general) Nurses & nursing aides	45 96 77 136 **(354)**	MXL	Rural retention bonus of 75% most valued. Limited impact of preferential training opportunities
Honda & Vio, 2015	Mozambique	To inform rural posting strategies	“Non-physician health professionals” Students Uncertain status	334 123 33 **(490)**	MNL	Provision of government housing most preferred, followed by opportunities for formal education after five years of work
Scott et al, 2015	Australia	To investigate nurses and midwives’ preferences for different job characteristics	Nurses and midwives	990	GMNL	Autonomy, no change in working hours and processes to deal with violence and bullying most valued

Efendi et al, 2015	Indonesia	To inform rural recruitment and retention strategies	Medical students Nursing students Midwifery students	150 150 100	MXL	While medical students placed the most value on postgraduate training scholarships, nurses valued salary the highest and midwifery students the quality of rural facilities.

APPENDIX E LSHTM ETHICS APPROVAL

LONDON SCHOOL OF HYGIENE
& TROPICAL MEDICINE

ETHICS COMMITTEE

APPROVAL FORM
Application number: 6042

Name of Principal Investigator	**Kate Mandeville**
Faculty	**Public Health and Policy**
Head of Faculty	**Professor Richard Smith**

Title: Incentives to retain doctors in Malawi: a discrete choice experiment

This application is approved by the Committee.

Chair of the Ethics Committee ....

Date ..22 September 2011

Approval is dependent on local ethical approval having been received.

Any subsequent changes to the application must be submitted to the Committee via an E2 amendment form.

APPENDIX F COM ETHICS APPROVAL

UNIVERSITY OF MALAWI

Principal

K.M Maleta, MBBS PhD

Our Ref.:

Your Ref.: P.09/11/1129

College of Medicine
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Chichiri
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01 877 291
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Email: comrec@medcol.mw

21st December 2011

Dr. K. Mandeville
C/O Dr. M. Madanitsa
College of Medicine
P/Bag 360
BLANTYRE

Dear Dr. Mandeville

RE: P.09/11/1129 – The Effectiveness of Incentives to Retain Doctors in Malawi: A discrete choice experiment. Version 1.0, dated 9 October 2011

I write to inform you that COMREC reviewed your proposal mentioned above, which you resubmitted for expedited review. I am pleased to inform you that your protocol **was approved** after considering that you addressed all the queries raised in the initial review.

As you proceed with the implementation of your study we would like you to adhere the amended protocol ICH GCP requirements and the College of Medicine Research requirements as indicated on the attached page.

Yours Sincerely,

Approved by
College of Medicine
21 DEC 2011
(COMREC)
Research and Ethics Committee

Dr. W. Mandala
For:CHAIRMAN - COMREC

WM/ck

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

UNIVERSITY OF MALAŴI
COLLEGE OF MEDICINE

STUDY TO DETERMINE THE JOB PREFERENCES OF MALAWIAN DOCTORS: INFORMATION SHEET

This is a research study conducted by **Dr Kate Mandeville and Dr Kara Hanson** from the **London School of Hygiene and Tropical Medicine** in England. We are looking into the **preferences of young doctors in Malawi for different jobs**. We want to know if certain jobs and specialties are preferred over other ones, and why this is so.

We are going to investigate these preferences by using a study design called a **discrete choice experiment**. We have constructed pretend job descriptions which differ in certain aspects, such as their location and salary. We will ask participants to make a choice between the two jobs. We hope to discover what aspects of a job are most important to doctors in Malawi. We will report our results to the Ministry of Health and this may lead to improvements in these job aspects.

There are a number of phases to this research. We are asking you to take part in **Phase 3**, which consists of the **discrete choice experiment and a questionnaire on your background.**

If you take part in this phase, it will take **about 45 minutes**. The survey will be conducted either in small groups with your colleagues or individually. Please fill in the questions by yourself without discussion with anyone else, so we know what you think personally. We will first ask you to fill in some questions on your background so we know more about you and can look at what might influence preferences between different jobs. We will then explain the discrete choice experiment and ask you to complete some practice exercises. We will then ask you to complete the real discrete choice experiment. We may contact some participants by telephone after the survey to clarify certain responses.

Agreeing to take part in this research

We do not anticipate that any harm will come to people through their participation in the research.

Please note that your participation in the research is entirely voluntary in all phases. If you don't want to take part, you can refuse without any penalty or loss of benefits to you. If you do agree to participate and then change your mind, please tell the researchers and they will end your participation immediately, without any penalty or loss of benefits to you. You can do this at any point during this study.

We will inform you of any significant new findings during the study which may affect your willingness to continue.

Reward

We will compensate your time and inconvenience by giving you a reward in the form of a medical textbook. This does not affect your right to withdraw from the study at any point.

Confidentiality

As a participant in the research you can expect that all the information you provide will be treated in confidence. We will anonymise the response sheets so no-one will be able to associate your answers with your name outside the research team and your contact details will be held securely separately to your responses.

We will not tell anyone at the College of Medicine or Ministry of Health about your responses and your name will not be used when we write our reports about the research.

Ethical approval

The London School of Hygiene and Tropical Medicine Ethics Committee) and the College of Medicine Research Ethics Committee (COMREC) have approved this study (reference numbers 6042 and P.09/11/1129).

More information

For further questions about this research, your rights as a subject, or any adverse effects related to the research, please contact:

Dr Kate Mandeville
London School of Hygiene and Tropical Medicine
Email: kate.mandeville@lshtm.ac.uk

COMREC Secretariat
Email: comrec@medcol.mw
Telephone: 01989766 (Please call during working hours from 7:30am - 5:00pm)

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

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COLLEGE OF MEDICINE

KAFUKUFUKU OFUNA KUPEZA ZINTHU;

ZOMWE MADOTOLO KU MALAWI AMAFUNA PA NTCHITO YAWO.

ZOFUNIKA KUDZIWA PAKAFUKUFUKUYU

Uyu ndikafukufuku yemwe akupangidwa ndi **Dr Kate Mandeville** kamanso **Dr Kara Hanson** omwe achokela ku **London School of Hygiene and Tropical Medicine** m'dziko la **England**.

Tikufufuza zomwe madokotala a m'malawi amafuna pa ntchito zawo. Tikufuna kudziwa ngati pali ntchito zina zomwe madotolo akamagwiri amakhutitsidwa kwambiri kuposa zina chifukwa cha zimene madotolowo amalandila komanso ndi dera liti lomwe amafuna kupitirizira maphunziro, nanga kuti izi zili chonchi chifukwa chiyani. Tifufuza Zimenezi pogwiritsa nitchito njira yotchedwa **"discrete choice experiment".** Njira imeneyi timagwiritsa ntchito mafunso oyerekeza amene amapereka zinthu zomwe zimapatsidwa pantchito yawo. Kenako tiwafunsa anthu amene akutenga nawo mbali m'ndimeyi kuti asankhe zomwe pantchito yawo amafuna. Tikukhulupirira kuti ndikafukufuku ameneya titha kupeza zimene ndizofunikira kwambiri pantchito ya madotolo aku Malawi. Zotsatira za kafukufuku ameneyu tikaziperekanso ku unduna wa za Umuyo ndi chiyembekezo chopititsa patsogolo ntchito za madotolo a M'malawi.

Pali magawo angapo pakafukufuku ameneyu, koma inu mukufunsidwa kutengapo gawo pa gawo lachitatu limene tagwiritsaa ntchito njira ya **"discrete choice experiment"** ndi mafunso ena amene ali mu **"questionnaire"** amene tipereke**.**

Ngati mwatenga nawo mbali, m'gawo lineneli likutengerani pafupifupi **mphindi 45 (45 minutes).** Mutha kuyankhira muli paguli kapena muli nokha. Koma yankhani mafunso onsewo panokha popanda wina aliyense kuti tidziwe zimene mukuganiza. Tiyamba takufunsani kuti muyankhe mafunso oyambilira kuti tikudziweni kenaka mutiuza zomwe mumafuna pa ntchito. Tifotokozera kuti discrete choice experiment ndi chiyani kenako tikupatsani ntchito zosiyanasiyana kuti muthe kusankhe imene mungakonde.

Titha kudzaimbira foni anthu ena mwaotengapo gawo kuti timvetsetsane pamayankho ena omwe tapatsidwa.

Kusankha kutengapo gawo pakafukufukuyu

Sitikuyembekezera kuvulazidwa kulikonse pakutengapo gawo pakafukufukuyu. Dziwani kuti Simuli ochita kukakamizidwa kuti mutengepo mbali mumagawo aliwonse a kafukufukuyu.

Mutha kukana kutengapo gawo popando chilango kapena chiwopsezo chilichonse.

Ngati mwasankha kutenga nawo gawo ndi kusintha maganizo chonde dziwitsano ochititsa kafukufukuyo ndipo adzakudulani gawo lanu popanda chilango kapena chiwopsezo kwa inu. Mutha kupanga izi pa nthawi iliyonse ya kafukufukuyi.

Chiwongola dzanja

Tidzapereka mabuku pokuthokozani kamba kovomera kutenga nawo mbali mukafukufukuyu. Komabe zimenezi zizikutanthauza kuti muli oletsedwa kusiya kutenga nawo mbali ngati mutafuna kutero.

Kusunga chinsinsi

Monga munthu amene mukutenga nawo mbali mukafukufukuyu, dziwani kuti zonse zomwe mupereke zizasungidwa mwachinsinsi. Zimenezi zikutanthawuza kuti dzina lanu silizatchulidwa kapena kugwilitsidwa ntchito pamene tikukapereka zotsatira zakafukufukuyu.

Komanso munthu aliyense sazadziwa zomwe munayakhula mukafukufukuyu kupatula amene akupanga kafukufukuyu. Sitizagawana ndi unduna wa zaumoyo pazomwe munayakhula . Zonse zimene munene zizigwiritsidwa ntchito kwina lkuli konse popanda inu kudziwika.

Zavomerezedwa ndi:

London School of Hygiene and Tropical Medicine Ethics Committee and College of Medicine Research Ethical Committee (COMREC) reference numbers 6042 and P.09/11/1129).

Pofuna kudziwa zambiri zakafukufukuyu mukhoza kufunsa kwa:

Dr Kate Mandeville
London School of Hygiene and Tropical Medicine
Email: kate.mandeville@lshtm.ac.uk

COMREC Secretariat
Email: comrec@medcol.mw
Telephone: 01989766 (Please call during working hours from 7:30am - 5:00pm)

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UNIVERSITY OF MALAŴI
COLLEGE OF MEDICINE

STUDY TO DETERMINE THE JOB PREFERENCES OF MALAWIAN DOCTORS: PHASE 3 CONSENT FORM

• I have read the study information sheet and I understand what will be required of me and what will happen to me if I take part in it

• I understand that the study involves a number of phases and that I am being asked to consent to participate in Phase 3.

• I understand that the information I will give will be treated in the strictest confidence.

• I understand that at any time I may withdraw from this study without giving a reason and that I will not be affected negatively in any way if I do not want to participate

• My questions concerning this study have been answered by ____________________________________

• I voluntarily agree to take part in this study

Participant's name (please print): ____________________________________

Date: ______________________

Participant's signature: ____

Researcher's name (please print): ____________________________________

Date: ________________________

Researcher's signature: ____

UNIVERSITY OF MALAŴI
COLLEGE OF MEDICINE

KAFUKUFUKU OFUNA KUPEZA ZINTHU;

ZOMWE MADOTOLO KU MALAWI AMAFUNA PA NTCHITO YAWO.

FOMU YOPEMPHA CHILOLEZO CHOTENGA MBALI MUCHIGAWO CHACHITATU

- Ndawerenga bwino lomwe zakafukufukuyi, ndikumvetsa zomwe ndikufunika kuchita ndinso zomwe zizichitike ndikatenga mbali m'kafukufukuyi.
- Ndamvetsa kuti kafukufukuyi akhala ndimagawo angapo ndinso kuti ndikumfunsidwa kutengapo mbali gawo 3
- Ndikumvetsa kuti ndikhoza kuyima osatenganso nawo mbali mkafukufukuyi opanda kupeleka chifukwa ndinso kuti sindizakhudzidwa m'njira iliyonse ngati nditasiya kutenga nawo mbali mukafukufukuyi.
- Mafunso anga onse a kafukufukuyi ayankhidwa ndi……………………………………………………………
- Ndavomera ndikuzipereka potenga nawo mbali pakafukufukuyi

Dzina laowotenga mbali______________________________________

Tsiku_________________

Posayina pawotenga mbali____________________________________

Dzina lawochititsa kafukufukuyi________________________________

Tsiku_____________________

Posayina wochititsa kafukufuku________________________________

Appendix H Topic Guide for Target Population

This appendix presents the initial topic guide used in semi-structured interviews with members of the target population. Following the first few interviews, this evolved to a more streamlined version aligned to the modified focus of the DCE (see Chapter 7).

TOPIC GUIDE

1. **Welcome**

Thanks for coming and giving up your time. The interview is likely to take around 1.5-2 hours. Is that okay?

Check comfortable and private setting.

2. **Purpose of study**

We are looking into the incentives given by the Ministry of Health to doctors working in Malawi. We want to know if certain incentives are preferred over other ones, and why this is so. We also want to know why doctors might decide to leave Malawi. These results together will help us to suggest better incentives which may encourage doctors to stay working in Malawi. We want to talk to those directly affected by these incentives, i.e. doctors and those who are soon to be doctors in Malawi.

3. **Recording and confidentiality**

I will be recording the interview on a digital recorder. This will then be transcribed. However, all the information you provide will be treated in confidence. No one outside the research team will know how you as an individual answered the questions and all data will be kept securely. Any quotes used in reports or papers will be anonymised with any identifying information.

4. **Outline of interview topics**

We are going to discuss the following topics, some in more depth than others:

- Current incentives for junior doctors in Malawi
- Reasons doctors stay in Malawi
- Reasons doctors migrate outside Malawi
- Postgraduate education as an incentive
- Other potential incentives (financial and non-financial)

5. Views on current incentives offered to doctors

The current incentive package for junior doctors comprises:

- A 52% salary supplement (but taxed)
- Free government housing
- Free transport to and from work

Do you think the package contains the right incentives?

- Would you prefer any others to be included?
- Which is the most important incentive to you?
- What do you think of the salary supplement? Is it sufficient/too little/too much? How much do you need to live comfortably here in Malawi? What would be your ideal salary?
- What do you think of the government housing? What is its standard? Is there much variation in housing quality?
- What do you think of the transport allowance? Is it needed?
- Have these incentives had any influence on your intention to stay working in the public sector?
- Have the incentives had any influence on your decision to stay and work in Malawi?

6. Postgraduate education

From previous discussions with Malawian junior doctors, postgraduate training seems to be very important. Is this true for you too?

What kind of training is important to you? E.g.

- Teaching ward rounds
- Good supervision and/or mentoring
- Regular hospital teaching sessions
- Study leave each year to access short courses
- Distance learning
- Formal speciality training

How important is [most favoured aspect from above] to you? For example, would you accept a lower salary if you offered any of the above as compensation? E.g. guaranteed access to postgraduate training?

Do you want to specialise?

- What speciality would you like to go into? Why?
- What specialities would you not want to go into? Why?
    - Prompts: private practice, workload, opportunity for jobs in other sectors, awareness of specialty, HIV risk, popularity overseas
- Could you imagine not being a specialist?
- What do you think of the current opportunities for postgraduate training?
- What do you think of the Masters of Medicine programme here in Malawi?
- Why do you think postgraduate scholarships offered by the College of Medicine in some specialities were not taken up?
- If the Masters of Medicine programme was not recognised abroad – would you still do it?

7. Reasons doctors migrate outside Malawi

Have any of your friends left Malawi? What was their main reason for doing so?

Can you see yourself working in Malawi for the rest of your life?

- If so, why?
- If not, where would you go?
- What would be your reasons for leaving Malawi?
    - Salary
    - Working conditions
        - Workload

        - Risk of HIV/AIDS
        - Lack of support/supervision
    - Lack of recognition/status
    - Children's education
    - Security

8. Reasons doctors stay in Malawi

Many doctors have left Malawi, but many doctors stay as well. I'd like to find out a bit more about why doctors decide to stay.

- What do you think are the most important reasons doctors stay in Malawi?
- What is your main reason for staying in Malawi?
    - The role of family
        - But pressure to leave and earn more to support family?
    - Marriage
        - Age at getting married
    - Culture
        - Difficult to adjust overseas?
    - Professional training
        - Most suited to Malawi?

9. Views on other potential incentives

There are other incentives which have been offered in other countries in sub-Saharan Africa. I would like to know whether you feel any of these are important to you:

Show sheet 1: We'll start with those which have a monetary value, i.e. financial incentives

- A supplement for working unsocial hours or overtime
- A supplement for working with higher risk patients e.g. HIV or psychiatric patients
- A good retirement package including pension
- A bonus for meeting individual or team targets
- A bonus for long service in the public sector
- Access to low-interest loans

- A childcare allowance
- An allowance for children’s education e.g. boarding or private school fees
- Subsidised food at work
- Subsidised healthcare or health insurance
- Subsidised mobile phones or internet access
- A clothing allowance

Show sheet 2: We’ll now consider those incentives which aren’t primarily given for their monetary value, i.e. non-financial incentives

- A clear career structure and access to promotion
- Timely payment of salary and allowances
- Improvements to workload
- Opportunities for study leave or sabbaticals
- Opportunities to carry out research/publish papers
- Access to HIV treatment or occupational health services
- Better security at work
- More recognition of work
- Psychosocial support services
- Flexibility in leave/working hours
- Employee representation in institution decisions
- Free tea and coffee on night shifts

10. **Thank you very much for your time.** Is there anything you would like to ask me?

11. Could you **recommend a colleague** who might want to talk to me?

APPENDIX I DCE SURVEY TOOL

LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE

Survey of Job Preferences of Malawian Doctors

2012 — 2013

SUBJECT ID: _ _ _

CONFIDENTIAL

This survey has been approved by the
London School of Hygiene and Tropical Medicine Ethics Committee (6042)
and the College of Medicine Research Ethics Committee (P.09/11/1129)

SCREENING QUESTIONS	
S1. Is participant a Malawian citizen?	YES NO
S2. Did participant complete all their undergraduate medical training at Malawi College of Medicine?	YES NO
S3. Did participant finish MBBS 5 between 2006 and 2012?	YES NO
If answer to S1, S2, or S3 is **NO** ➔**END SURVEY**	
S4. Has the participant **started** a specialty training programme of any kind?	YES NO
If answer to S4 is **YES** ➔**END SURVEY**	
➔ Give information sheet to participant and explain study purpose and requirements	COMPLETED
➔ Ask participant to read and sign consent form and sign this yourself	COMPLETED
➔ Allocate subject ID number and fill in on page 1	SUBJECT ID: __ __ __
➔ Check random number sequence for which choice task version to use	**Version 1** **Version 2**
DATE (D D / M M / Y Y Y Y)	____/_____/_________
➔ Researcher to sign here when survey and quality control completed	______________________________

PART A: YOUR FUTURE TRAINING

A1. Do you wish to specialise?	YES ⬭ → **GO TO A2** NO ⬭ → **GO TO B1**
A2. We would like to know your main reasons for wanting to specialise. Please **rank these reasons 1 to 4,** 1 being the most important and 4 being the least important.	**RANK** To earn more money (including from private practice) ☐ To obtain specialist skills or area of knowledge ☐ To have consultant status ☐ To work outside Malawi ☐
A3. Have you obtained a scholarship for scholarship training?	YES ⬭ → **GO TO A5** NO ⬭ → **GO TO A4**
A4. Are you currently looking for a scholarship?	YES ⬭ → **GO TO A5** NO ⬭ → **GO TO A6**
A5. Roughly how long did you look for or have you been looking for a scholarship?	*Please write number of :* YEAR(S): ________ MONTH(S)________
A6. If you could do any specialty, what would you do? *(please write)*	____________________________________

→ **CONTINUE TO NEXT PAGE**

A7. We now want to get a fuller understanding of your preferences for different specialties. We have listed a selection of specialties below.

Please choose for **each** specialty whether

➔you **want** to train in it,
➔you **would consider** training in it,
➔you **would prefer NOT** to train in it.

*Please tick **ONE only** for EACH specialty*	**I want to train in...**	**I would consider training in...**	**I would prefer NOT to train in...**
A7i. Paediatrics	⬭	⬭	⬭
A7ii. Dermatology	⬭	⬭	⬭
A7iii. Ophthalmology	⬭	⬭	⬭
A7iv. Obstetrics & Gynaecology	⬭	⬭	⬭
A7v. A&E	⬭	⬭	⬭
A7vi. Psychiatry	⬭	⬭	⬭
A7vii. Family Medicine	⬭	⬭	⬭
A7viii. Internal Medicine	⬭	⬭	⬭
A7ix. Histopathology	⬭	⬭	⬭
A7x. Public Health	⬭	⬭	⬭
A7xi. Anaesthesia	⬭	⬭	⬭
A7xii. Surgery	⬭	⬭	⬭
A7xiii. Radiology	⬭	⬭	⬭

PART B: YOUR WORK AS A DOCTOR

B1. What year did you finish MBBS 5 at the College of Medicine?	2006 ◯ 2007 ◯ 2008 ◯ 2009 ◯ 2010 ◯ 2011 ◯ 2012 ◯
B2. What is your current position?	Intern ◯ Medical officer ◯ District medical officer ◯ District health officer ◯ CHAM doctor ◯ Private practitioner ◯ Research doctor ◯ Other (*please specify*): ________________________________
B3. What is the name of your current place of work? *E.g. QECH, KCH, Adventist, Salima district hospital, John Hopkins*	*Please write:*______________________ __________________________________
B4. What is your current take-home salary per month? *This is after tax. Include any SWAP top-ups but exclude any income from workshops or locums.*	**MK__________,000**

B5. Please list all the jobs you have had in Malawi since finishing MBBS 5.

Fill in each job in a new box, starting with the oldest first.
Fill in the **Start and End Dates** of each job (*month and year only*).
For your **current job,** leave the End Date blank.

<table>
<tr><td rowspan="2">JOB 1
(first after finishing MBBS 5)

B5i</td><td>TYPE OF JOB (please tick ONE ☑):

Intern ◯ Medical officer ◯
DMO ◯ Private practice ◯
DHO ◯ Research ◯
CHAM ◯ NGO ◯
Other (please specify):________________________
____________________________________</td><td>START DATE:
M M / Y Y Y Y
_____ /________</td></tr>
<tr><td></td><td>END DATE:
(leave blank if current job)
M M / Y Y Y Y
_____ /________</td></tr>
<tr><td rowspan="2">JOB 2

B5ii</td><td>TYPE OF JOB (please tick ONE ☑):

Intern ◯ Medical officer ◯
DMO ◯ Private practice ◯
DHO ◯ Research ◯
CHAM ◯ NGO ◯
Other (please specify):________________________
____________________________________</td><td>START DATE:
M M / Y Y Y Y
_____ /________</td></tr>
<tr><td></td><td>END DATE:
(leave blank if current job)
M M / Y Y Y Y
_____ /________</td></tr>
<tr><td rowspan="2">JOB 3

B5iii</td><td>TYPE OF JOB (please tick ONE ☑):

Intern ◯ Medical officer ◯
DMO ◯ Private practice ◯
DHO ◯ Research ◯
CHAM ◯ NGO ◯
Other (please specify):________________________
____________________________________</td><td>START DATE:
M M / Y Y Y Y
_____ /________</td></tr>
<tr><td></td><td>END DATE:
(leave blank if current job)
M M / Y Y Y Y
_____ /________</td></tr>
</table>

B5. Continue on this sheet if necessary.

JOB 4

TYPE OF JOB (please tick ONE ☑):

Intern	⬭	Medical officer	⬭
DMO	⬭	Private practice	⬭
DHO	⬭	Research	⬭
CHAM	⬭	NGO	⬭

Other *(please specify)*:________________________

____

B5iv

START DATE:
M M / Y Y Y Y
_____/________

END DATE: *(leave blank if current job)*
M M / Y Y Y Y
_____/________

JOB 5

TYPE OF JOB (please tick ONE ☑):

Intern	⬭	Medical officer	⬭
DMO	⬭	Private practice	⬭
DHO	⬭	Research	⬭
CHAM	⬭	NGO	⬭

Other *(please specify)*:________________________

____

B5v

START DATE:
M M / Y Y Y Y
_____/________

END DATE: *(leave blank if current job)*
M M / Y Y Y Y
_____/________

JOB 6

TYPE OF JOB (please tick ONE ☑):

Intern	⬭	Medical officer	⬭
DMO	⬭	Private practice	⬭
DHO	⬭	Research	⬭
CHAM	⬭	NGO	⬭

Other *(please specify)*:________________________

____

B5vi

START DATE:
M M / Y Y Y Y
_____/________

END DATE: *(leave blank if current job)*
M M / Y Y Y Y
_____/________

PART C: YOU AND YOUR FAMILY

C1. What is your gender?	Female ◯ Male ◯
C2. How old are you?	____________________ **years**
C3. Are you in a relationship?	No, single ◯ Yes, relationship < 1 year ◯ Yes, relationship > 1 year ◯ Yes, married ◯
C4. Do you have any children?	YES ◯ → **GO TO C5** NO ◯ → **GO TO C6**
C5. Are any of your children **under 11** years of age?	YES ◯ NO ◯
C6. Roughly how many people are dependent on you?	0 ◯ 1-5 ◯ 6-10 ◯ >10 ◯
C7. In which district did you attend most of your primary schooling?	____________________________________
C8. Would you say you had a rural or urban upbringing?	Rural ◯ Urban ◯ Neither ◯

C9. What was the highest level of education that **your father attended**? *(even if they did not complete it)*	Did not attend school ◯ Primary school ◯ Secondary school ◯ Post-secondary certificate ◯ Diploma ◯ Degree ◯ Not sure ◯ Other *(please specify)*:______________ ______________________________
C10. What was the highest level of education that **your mother attended**? *(even if they did not complete it)*	Did not attend school ◯ Primary school ◯ Secondary school ◯ Post-secondary certificate ◯ Diploma ◯ Degree ◯ Not sure ◯ Other *(please specify)*:______________ ______________________________
C11. Have you ever travelled outside of Africa?	YES ◯ NO ◯

END OF THIS SECTION

INSTRUCTIONS FOR CHOICE EXERCISES

In the following exercises, **you will be presented with two job descriptions.** These jobs are made up of different characteristics which represent important factors for Malawian junior doctors. However, the jobs are **hypothetical** so don't assess how realistic they are, just whether you prefer one over the other.

In all of these jobs, you are **guaranteed a specialist training scholarship.** Even though this is not the current situation in Malawi, we would like you to pretend it is the case for these tasks.

Before you can start this specialist training, you will need to work for some time in Malawi. This job will differ in:

- Location
- Salary
- The length of time you will need to work in this job before starting specialist training

You will then start specialist training. All the specialist training programmes will last for four years and you will become a consultant at the end. However, the **training will differ** in:

- The specialty in which you will be trained
- The country where the training will take place

For each pair of jobs you are presented with, you are asked to decide which one you would choose given your current circumstances. Please use **only** the information you are given about the jobs to evaluate them. Assume all other aspects of the jobs are the same between them, even if they are not mentioned here.

There will also **an option to choose neither of the jobs** if you would really not take either of them.

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

This is an example of a choice exercise:

WORK BEFORE TRAINING

JOB LOCATION

This is the location of the hospital you will be based at *before* training. There are four types of locations:

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

- **Major central hospital = QECH/KCH**
  You will work in Queen Elizabeth Central Hospital or Kamuzu Central Hospital
- **Other central hospital = ZOMBA/MZUZU CENTRAL**
  You will work in Mzuzu Central Hospital or Zomba Central Hospital
- **District hospital near town = DISTRICT NEAR TOWN**
  You will work in district hospitals that are within two hours' drive of Blantyre or Lilongwe on good roads e.g. Thyolo or Salima district hospitals
- **Remote district hospital = REMOTE DISTRICT**
  You will work in district hospitals that are more than two hours' drive from Blantyre or Lilongwe on poor roads e.g. Nsanje or Chitipa district hospitals

SALARY

This will be the monthly salary paid to you during the whole job before you start training. This is your take-home salary, including the SWAP top-up but after tax. It does not include any other income such as from workshops or locums.

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

It will be either:

- **MK 110,000 per month = 110,000**
- **MK 130,000 per month = 130,000**
- **MK 160,000 per month = 160,000**
- **MK 200,000 per month = 200,000**

TIME BEFORE TRAINING

This is the amount of time that you will need to work in this job before you can start specialist training.

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

It will be either:

- **1 year working in this location before starting training = 1 YEAR**
- **2 years working in this location before starting training = 2 YEARS**
- **3 years working in this location before starting training = 3 YEARS**

SPECIALIST TRAINING

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

SPECIALTY

This is the specialty training that you will undertake after you have finished working. Training for all specialties will last four years after which you will obtain consultant status.

There are four possible specialties:

- **1st choice core specialty = 1ST CHOICE CORE**
- **2nd choice core specialty = 2ND CHOICE CORE**
- **Ophthalmology = OPHTHALMOLOGY**
- **Public Health = PUBLIC HEALTH**

We use the term "Core" specialty here to refer to the four major specialties of:
Medicine, Surgery, Paediatrics or Obstetrics & Gynaecology.

On the next page, we will ask you to select your first and second choices for training from these four specialties.

For Public Health and Ophthalmology, there is no choice: it is just these specialties.

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN
110,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE
ALL IN MALAWI	TRAINING LOCATION	MALAWI & SOUTH AFRICA

TRAINING LOCATION

This is where you will be undertaking your specialist training. For each specialty, you could train in any of these locations.

There are four possible locations:

- **Training all in Malawi**
  = ALL IN MALAWI
- **Training split between Malawi and South Africa**
  = MALAWI & SOUTH AFRICA
- **Training all in South Africa**
  = ALL IN SOUTH AFRICA
- **Training all outside Africa e.g. UK, USA, Australia or Canada**
  = ALL OUTSIDE AFRICA

PART D: YOUR CORE SPECIALTY CHOICES

We would now like to know your preferences for training in the core specialties. We will ask you to use your selections here in the following exercises.

Remember, the core specialties refer to:

Medicine
Surgery
Paediatrics
***or* Obstetrics & Gynaecology**

D1. If you could only choose one core specialty for training, which one would be your <u>first choice</u>?	Medicine ⬭ Surgery ⬭ Paediatrics ⬭ Obstetrics & Gynaecology ⬭
D2. If you couldn't do this specialty, which one would be your <u>second choice</u> for training?	Medicine ⬭ Surgery ⬭ Paediatrics ⬭ Obstetrics & Gynaecology ⬭

Whenever you see an option in the following exercises with **"1ST CHOICE CORE"** or **"2ND CHOICE CORE "** we would like you to think of your choices here.

→ **CONTINUE TO NEXT PAGE**

PART E: PRACTICE EXERCISES

Now that you know what the exercises are about, we are going to ask you to practice on a series of smaller choices first so you can fully consider your preferences.

Remember: there are no right or wrong answers, just what you would prefer.

First try comparing two jobs with only one characteristic. *Pretend that everything else about these jobs is the same except this aspect.* Each exercise is a new choice. Refer back to the example and descriptions if you need to.

Practice Exercise 1

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	DISTRICT NEAR TOWN

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 2

JOB A	SPECIALIST TRAINING	JOB B
MALAWI & SOUTH AFRICA	TRAINING LOCATION	ALL OUTSIDE AFRICA

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 3

JOB A	SPECIALIST TRAINING	JOB B
1ST CHOICE CORE	SPECIALTY	2ND CHOICE CORE

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Now try comparing jobs with two characteristics each. Assume that everything else about these jobs is the same. Refer back to the descriptions if you need to.

Each exercise is a new job and nothing carries forward from the last choice.

Practice Exercise 4

JOB A	WORK BEFORE TRAINING	JOB B
REMOTE DISTRICT	JOB LOCATION	DISTRICT NEAR TOWN
200,000	SALARY	160,000

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 5

JOB A	WORK BEFORE TRAINING	JOB B
QECH/KCH	JOB LOCATION	ZOMBA/MZUZU CENTRAL
3 YEARS	TIME BEFORE TRAINING	1 YEAR

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 6

JOB A	SPECIALIST TRAINING	JOB B
1ST CHOICE CORE	SPECIALTY	OPHTHALMOLOGY
ALL IN MALAWI	TRAINING LOCATION	ALL OUTSIDE AFRICA

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Now try comparing jobs with three and four characteristics. Remember to compare all information before making your choice.

Practice Exercise 7

JOB A	WORK BEFORE TRAINING	JOB B
ZOMBA/MZUZU CENTRAL	JOB LOCATION	REMOTE DISTRICT
130,000	SALARY	160,000
2 YEARS	TIME BEFORE TRAINING	1 YEAR

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 8

JOB A	WORK BEFORE TRAINING	JOB B
130,000	SALARY	200,000
3 YEARS	TIME BEFORE TRAINING	5 YEARS
	SPECIALIST TRAINING	
2ND CHOICE CORE	SPECIALTY	1ST CHOICE CORE

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 9

JOB A	WORK BEFORE TRAINING	JOB B
ZOMBA/MZUZU CENTRAL	JOB LOCATION	DISTRICT NEAR TOWN
2 YEARS	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
1ST CHOICE CORE	SPECIALTY	PUBLIC HEALTH
MALAWI & SOUTH AFRICA	TRAINING LOCATION	ALL IN SOUTH AFRICA

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Now we would like to try comparing two full job descriptions. These are exactly the same as the real choice exercises we will ask you to complete in the next section.

Practice Exercise 10

JOB A	WORK BEFORE TRAINING	JOB B
REMOTE DISTRICT	JOB LOCATION	DISTRICT NEAR TOWN
130,000	SALARY	200,000
2 YEARS	TIME BEFORE TRAINING	5 YEARS
	SPECIALIST TRAINING	
2ND CHOICE CORE	SPECIALTY	1ST CHOICE CORE
ALL OUTSIDE AFRICA	TRAINING LOCATION	MALAWI & SOUTH AFRICA

Would you choose job A or B? *(Please tick in circle ☑)*

A B

Practice Exercise 11

In this exercise, you will also have the option to choose neither job if you would really not take either of them.

JOB A	WORK BEFORE TRAINING	JOB B
ZOMBA/MZUZU CENTRAL	JOB LOCATION	QECH/KCH
110,000	SALARY	160,000
1 YEAR	TIME BEFORE TRAINING	3 YEARS
	SPECIALIST TRAINING	
OPHTHALMOLOGY	SPECIALTY	PUBLIC HEALTH
ALL IN SOUTH AFRICA	TRAINING LOCATION	ALL IN MALAWI

➔Would you choose **job A**, **job B**, or **neither job**? *(Please tick in white circles ☑)*
➔If you choose **neither,** do you **lean towards job A or job B**? *(Tick in grey circles)*

A Neither B

A B

PART F: CHOICE EXERCISES ANSWERSHEET

You are now ready to complete the full exercises. There are 16 in total.

Please think carefully about the choices offered and answer as honestly as you can. There are no right or wrong answers, just what you would prefer. You can refer back to the instructions and practice exercises at any point. Please don't hesitate to ask the researcher if you have any questions during the exercises.

Just like in the last practice exercise, there are two questions for each choice:

i) Would you choose **job A, job B or Neither job**?
➔**PLEASE TICK CIRCLE IN WHITE COLUMN**

ii) If you choose **Neither job,** do you **lean towards job A or job B?**
(This answer will help increase the power of our results)
➔**PLEASE TICK CIRCLE IN GRAY COLUMN**

	If I could choose between Job A, Job B, or neither job, I would choose...			**If *neither* chosen**	**If I had to choose be-tween JOB A or JOB B, I would choose...**	
	JOB A	**JOB B**	**NEITHER**		**JOB A**	**JOB B**
F1	A	B	N	→	A	B
F2	A	B	N	→	A	B
F3	A	B	N	→	A	B
F4	A	B	N	→	A	B
F5	A	B	N	→	A	B
F6	A	B	N	→	A	B
F7	A	B	N	→	A	B
F8	A	B	N	→	A	B
F9	A	B	N	→	A	B
F10	A	B	N	→	A	B
F11	A	B	N	→	A	B
F12	A	B	N	→	A	B
F13	A	B	N	→	A	B
F14	A	B	N	→	A	B
F15	A	B	N	→	A	B
F16	A	B	N	→	A	B

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ALL CHOICE TASKS COMPLETED	
OPT-OUT OPTIONS CHECKED	
SUBJECT ID ON EVERY PAGE	

Thank you very much for your participation.

Your insights are very valuable and will provide information to improve job choices for doctors in Malawi in the future.

All of your responses will be kept confidential and only the research team will have access to the answers. If you have any further questions, please feel free to contact the researchers (details on information sheet).

We would like to take some contact details in case we need to contact you in the future. These will be stored separately to your answers so it will not be possible to link them to you.

Please fill in:

FIRST NAME	
LAST NAME	
TNM NUMBER	
AIRTEL NUMBER	
EMAIL ADDRESS	
ALTERNATIVE EMAIL	

APPENDIX J MULTINOMIAL LOGIT MODEL RESULTS

The full survey results were explored initially with a multinomial logit model. These results, along with willingness to pay and stay values, are shown in the table below.

All coefficients were of the expected sign. All are statistically significant at the 5% level or less, except for the parameters for minor central hospital and public health, indicating that these variables did not significantly influence participants' job choices in this model although it may have been underpowered to detect small effects. Doctors preferred higher salaries, less time before training and working in a major central hospital or a district hospital near town. They also preferred training outside of Malawi in their first- or second-choice core specialty. Doctors were willing to give up considerably more income to train outside Africa compared to training with all or some time in South Africa. A junior doctor would need to be paid MWK191,000 in order to undertake training in ophthalmology and an extra MWK73,000 if this training was in Malawi. From a time perspective, a doctor would be willing to work for an extra 17 to 36 months for the opportunity to train in a core specialty of their choice. In comparison, the preferences for salary and job location are relatively weak. For example, an additional MWK10,000 in monthly salary would only generate roughly three months' extra work.

Table J Multinomial logit model results for full survey

Number of observations	2240			**Pseudo R^2**		0.08	
Number of parameters	12			**AICc**		3849.94	
Log-likelihood function	-2250.53			**Bayesian information criterion**		4593.63	
Attribute	**Coefficient**	**SE**	**P-value**	**WTP (MK)**	**95% CI**	**WTS (months)**	**95% CI**
Salary (MWK 10,000)	0.074**	0.009	0.000	N/A	N/A	-2.6**	-3.3 to -1.9
Time before training (year)	-0.343*	0.029	0.000	-46,389*	-58,530 to -34,248	N/A	N/A
Job location							
Major central hospital	0.079	[b]	[b]	10,622	[b]	-2.7	[b]
Minor central hospital	-0.035	0.056	0.539	-4,656	-19,326 to 10,013	1.2	-2.6 to 5.0
District hospital near town	0.163**	0.057	0.005	21,961**	5,994 to 37,928	-5.7**	-9.5 to -1.8
Remote district hospital	-0.207**	0.066	0.002	-27,928**	-47,749 to -8,107	7.2**	2.4 to 12.0
Training location							
All in South Africa	0.109	[b]	[b]	14,784	[b]	-3.8	[b]
Malawi & South Africa	0.129*	0.058	0.025	17,481*	1,228 to 33,734	-4.5*	-8.6 to -0.5
All in Malawi	-0.539**	0.061	0.000	-72,799**	-96,591 to -49,006	18.8**	14.5 to 23.1
All outside Africa	0.230**	0.152	0.000	40,542**	23,404 to 57,681	-10.5**	-14.5 to -6.5
Specialty							
1^{st} choice Core,[a]	1.025	[b]	[b]	138,473	[b]	-35.8	[b]
2^{nd} choice Core[a]	0.477**	0.054	0.000	64,434**	44,608 to 84,261	-16.7**	-20.9 to -12.4
Ophthalmology	-1.412**	0.090	0.000	-190,793**	-234,786 to 146,799	49.4**	42.6 to 56.1
Public health	-0.090	0.060	0.132	-12,217	-28,441 to 4,008	3.2	-0.9 to 7.2
Opt-out option	0.337*	0.152	0.026	45,601*	13,648 to 77,553	-11.8*	-22.9 to -0.6

Notes: *Effects coded data. AICc = Akaike information criteria with a correction for finite sample sizes; MWK = Malawian kwacha; SE = standard error; CI = confidence intervals; WTP = willingness to pay; WTS = willingness to stay; N/A = not applicable; *Significant at 5% level;**Significant at 1% level or less; [a]See text in Chapter 8 for explanation; [b]Reference level, therefore only coefficient can be calculated from other parameter coefficients in category*