The Strategy Unit.

Black Country LWAB Scenario Analysis

Part One: Exploring the Contextual Environment

An analysis of key forces likely to affect clinical services and the associated workforce 2020-2030

July 2019

NHS
Midlands and Lancashire
Commissioning Support Unit

Document control

Document Title	Black Country LWAB Scenario Analysis. Part One: Exploring the Contextual Environment. An analysis of key forces likely to affect clinical services and the associated workforce 2020-2030.
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Date	July 2019

Contents

1. Introduction

> *The performance of any healthcare system ultimately depends on its people – the NHS is no exception. The NHS is the biggest employer in Europe and the world's largest employer of highly skilled professionals. 1.3 million people across the health service in England are devoting their working lives to caring for others. That is one in every 25 working age adults, three quarters of whom are women. Working in the NHS demands the highest levels of skill and compassion, and the NHS attracts some of the very best people from home and abroad. But, over the past decade, workforce growth has not kept up with need, and the way staff have been supported to work has not kept up with the changing requirements of patients.*[1]

The NHS Long Term Plan identifies action on workforce supply and development as a critical enabler of future healthcare provision. National priorities are emerging, but it is also clear that there will be an increasing devolution of workforce planning responsibilities to local health and care systems.[2]

The Local Workforce Action Board (LWAB) for the Black Country and West Birmingham Sustainability and Transformation Partnership (STP) is seeking to define a strategic workforce agenda in support of Long Term Plan implementation. The purpose of that agenda, and the work that will be done around it, is to support local NHS organisations in identifying and securing the workforce needed to deliver the services that may be required in 5-10 years' time.

NHS England's Chief Medical Officer recently observed in her 2018 Annual Report[3] that

> *Futures thinking is vital to planning effective and efficient health environments and services going forward. Strategic leaders in healthcare and public health organisations need to embed futures thinking (and specifically scenario planning) in the development process of long-term plans.* [Ch.1,p.3]

The LWAB has therefore asked the Strategy Unit to assist in the development of a range of plausible future scenarios that will help to make its strategic workforce planning both more innovative and more robust. The project also involves members of the STP's Clinical Leadership Group (CLG) because of the critical dependencies between future clinical services and future workforce.

Three stages are planned:

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[1] https://www.longtermplan.nhs.uk/wp-content/uploads/2019/01/nhs-long-term-plan.pdf

[2] 'Interim Workforce Implementation Plan: emerging priorities and actions.' Letter from Baroness Dido Harding and Julian Hartley, Wednesday 6 March 2019

[3] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/767549/Annual_report_of_the_Chief_Medical_Officer_2018_-_health_2040_-_better_health_within_reach.pdf

1. **Environmental Analysis** (February-April 2019)

   The first critical stage, reported in this document, has been to identify and explore the driving forces (and their constituent factors) in the contextual environment that may impact clinical services and the associated workforce over the next 10 years, either directly or as mediated through the transactional environment (see Figure 1).

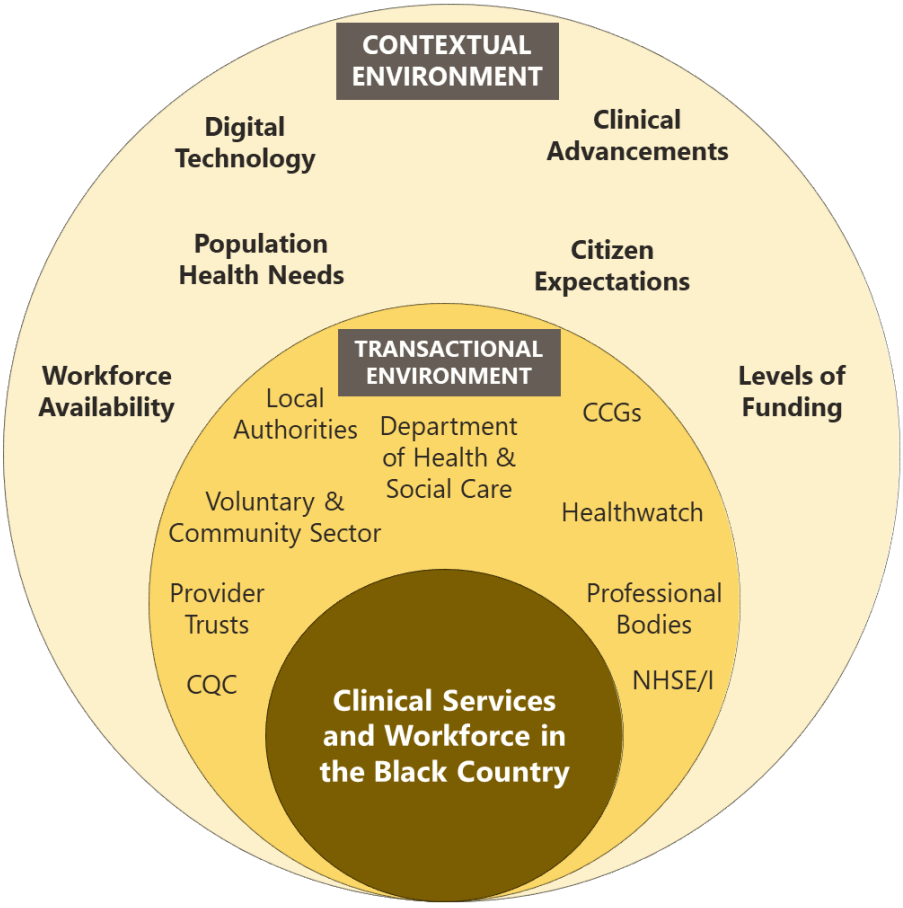


Figure 1 - The contextual environment[4]

This analysis has involved undertaking:

a) A Delphi process with LWAB and CLG members to identify the relevant factors in the contextual environment, and to assess them in terms of both the degree of uncertainty around them and their potential impact on future workforce requirements;

[4] Based on the model in - https://sloanreview.mit.edu/article/using-scenario-planning-to-reshape-strategy/

b) Desktop research in relation to the factors identified through the Delphi analysis as being the likely driving forces within the contextual environment over the next 5-10 years.

The six driving forces identified in the contextual environment of Figure 1 have been derived from the responses of participants to the Delphi process. That process generated fifty-three factors in total, as set out in Table 1 (a summary description of each factor can be found in Appendix 1 – Factor descriptions).

Ref.	Factor	Ref.	Factor
POLITICAL AND LEGAL		**CLIMATE AND ENVIRONMENT**	
PL1	Work and pensions policy	CE1	Climate-related disease burden
PL2	Healthcare policy	CE2	Climate-related natural events
PL3	Social care policy	CE3	Air quality
PL4	Public health policy	CE4	Physical environment
PL5	Trade policy	CE5	Food supply
PL6	Immigration policy	CE6	Water quality
PL7	Higher education policy	CE7	Migration
PL8	Secondary education policy	**DEMOGRAPHY**	
PL9	Transport policy	DP1	Population age profile
PL10	Environment policy	DP2	Workforce age profile
PL11	Industrial policy	DP3	Population diversity
PL12	Housing policy	DP4	Workforce diversity
PL13	Global politics	DP5	Population size
SOCIAL ATTITUDES		DP6	Deprivation and inequality
SA1	Patient expectations of health and care services	DP7	Burden of disease
		ECONOMY	
SA2	Trust in 'experts'	EE1	Workforce market competitiveness
SA3	Work-life balance	EE2	Health and care funding
SA4	Local social capital	EE3	Commercial power
SA5	Perceptions of health and care careers	EE4	Employee power
		EE5	Black Country economy
SA6	Scope of NHS services	**CLINICAL AND TECHNOLOGICAL**	
SA7	The future of the Black Country	CT1	AI and robotics
SA8	Public support for the NHS	CT2	Telemedicine and the 'internet of (medical) things'
SA9	Responsibility for health		
SA10	Openness to technology	CT3	Digital patient records
SA11	Novel foods	CT4	Patient-driven healthcare
SA12	Post-Brexit UK	CT5	New medical treatments and technologies
SA13	Attitudes to the environment	CT6	Personalised medicine
		CT7	Big data
		CT8	Anti-microbial resistance

Table 1 - factors in the contextual environment

For each of these factors, Delphi participants were also asked to assess:

a) The scale of the potential impact that factor could have on future clinical services and the associated workforce over a 10-year period (1= no impact, 10=enormous impact); and

b) The degree of uncertainty around the nature and/or scale of that impact through the same period (1= it is a locked-in trend, 10= it is impossible to discern what will happen).

The results of these assessments have been combined and are presented in the Impact/Uncertainty matrix (Figure 2). Our analysis of this matrix led to the identification of the six key driving forces within the contextual environment (Figure 1).

Two further stages follow from this present report:

2. **Scenario Development** (April-May 2019)

   A full-day workshop will be undertaken with a subset of LWAB and CLG members to create a set of contrasting yet plausible future scenarios. This Part One report will serve as a foundation for the workshop, along with inputs from external advisers with expertise relating to the identified driving forces.

3. **Initial Scenario Deployment** (May-June 2019)

   A subsequent half-day workshop will be held for all members of LWAB and CLG plus other designated STP leaders. This event will allow participants to immerse themselves in each scenario, to begin to identify the potential impact of the scenarios on the STP's clinical services and workforce, and to consider how that impact might be maximised or mitigated (as appropriate).

   Part Two of our report will be completed at this stage. The evidence is clear, however, that isolated strategic events are of limited value. The Strategy Unit will therefore be supporting subsequent processes within the STP to ensure that the best value is realised from this work.

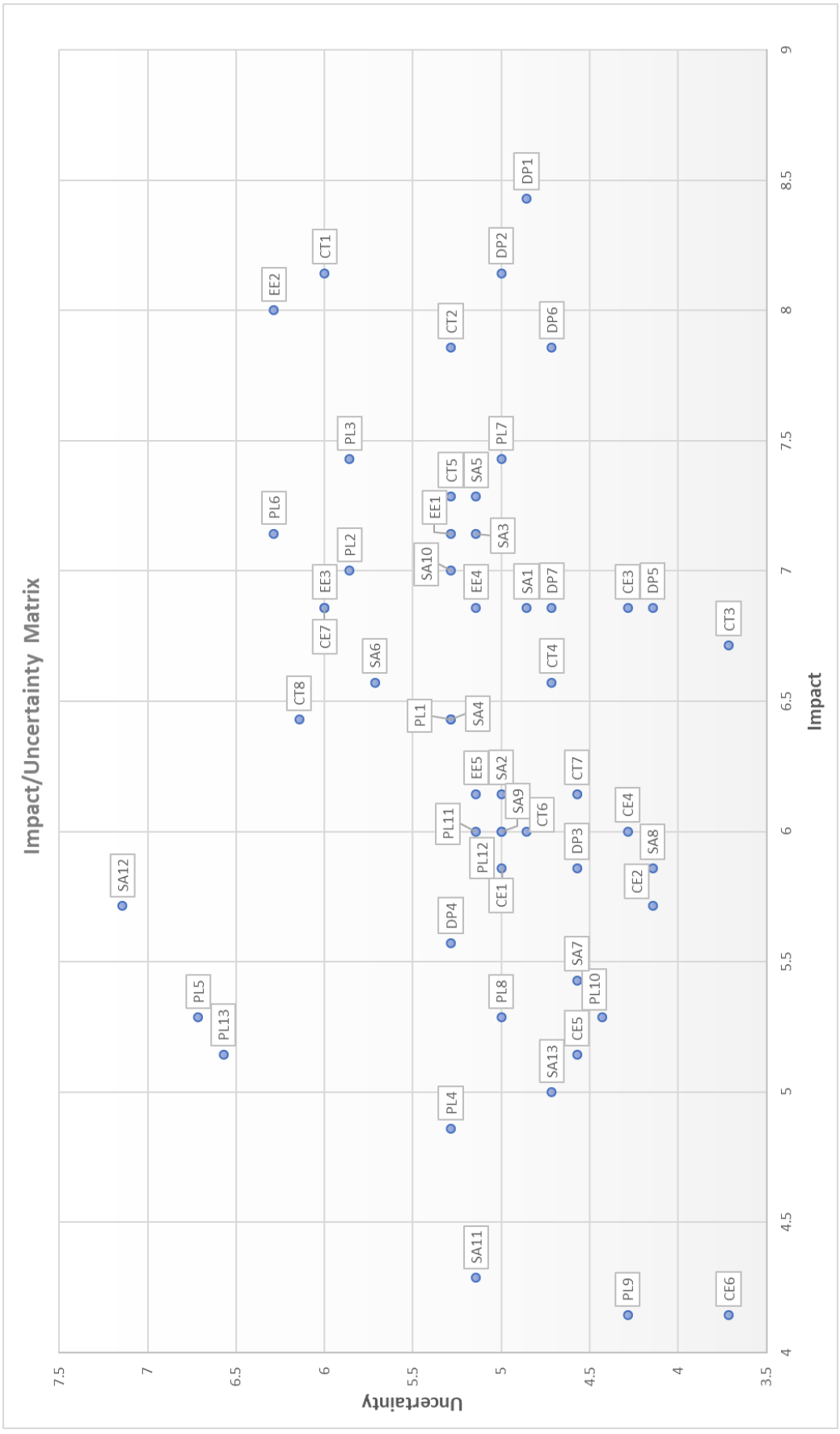
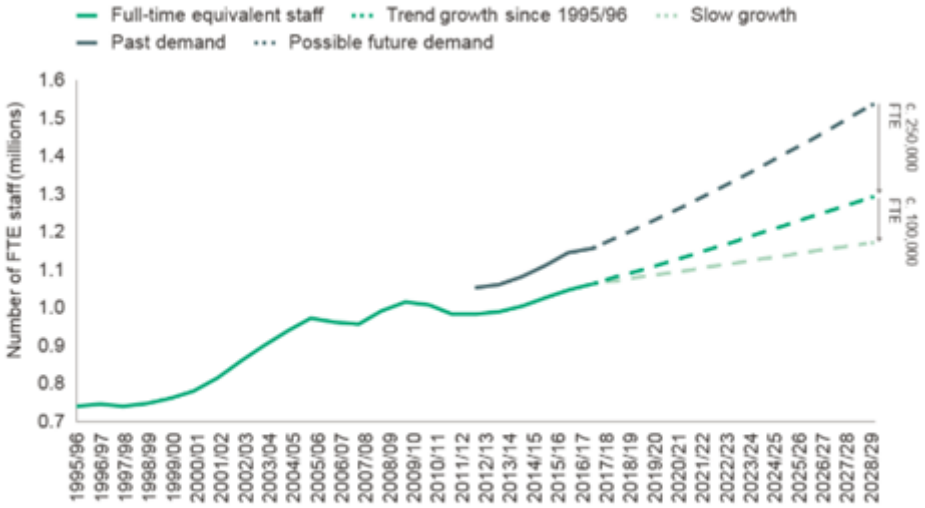


Figure 2 - Impact/Uncertainty Matrix

2. How might workforce availability change?

Between the 1990s and 2005, the number of full-time equivalent staff in the NHS increased rapidly, after which the rate of increase slowed[5] (Figure 3). The rate of increase has also varied across disciplines. Although, for example, the total NHS workforce increased by 2% in 2016/17, and managerial and consultant positions increased, nursing and GP numbers fell by 0.2% and 0.7%, respectively, between December 2016 and June 2017[6]. Across NHS trusts there is a shortage of over 100,000 staff and, based on current trends, the gap could reach 250,000 by 2030[5].



Source: Health Foundation projections, based on workforce data from NHS Digital and Health Education England.

Figure 3 - The current and projected future supply of and demand for NHS staff

The workforce is also ageing. Figure 4 shows the age profile of qualified nursing staff from 2006-2015[7], for example. Currently, 47% of the NHS workforce is aged 45 or over. The average age is 43 years, and this is only predicted to increase[8]. Having an older workforce retains the benefits of accumulated knowledge and experience but may lead to increased rates of sickness absence and, at least in specific professional groups, may require review of work organisation, task management and rotas.[9]

[5] https://www.kingsfund.org.uk/publications/health-care-workforce-england
[6] https://www.health.org.uk/publications/rising-pressure-the-nhs-workforce-challenge
[7] https://www.statista.com/chart/6332/the-nhss-ageing-nursing-workforce/
[8] http://www.healthbusinessuk.net/features/ageing-workforce-and-nhs
[9] https://www.nhsemployers.org/your-workforce/need-to-know/working-longer-group/working-longer-group-tools-and-resources/the-ageing-workforce-a-resource-for-staff-and-their-representatives/an-ageing-workforce-the-key-issues

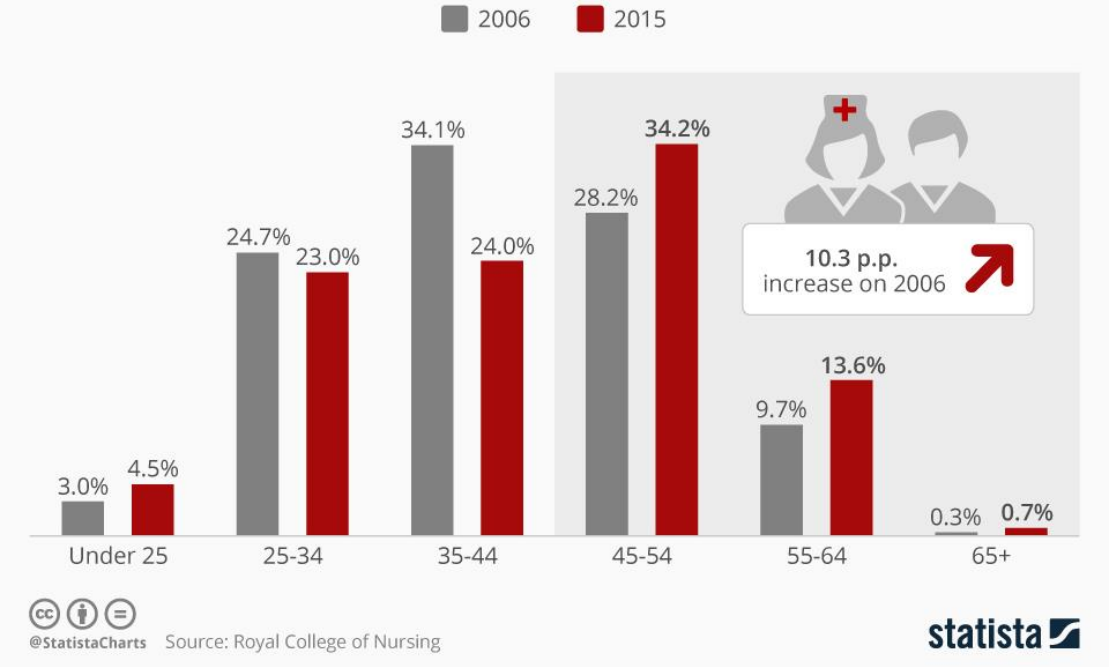


Figure 4 - Breakdown of age profiles of qualified NHS England nursing staff (2006-2015)

In 2014/15, the NHS directly employed nearly 29,000 people in 24,200 FTE (full-time equivalent) jobs in the Black Country. An additional 4,400 FTE jobs were directly funded as 'bank' staff, and a further 2,100 agency jobs were supported but employed by non-NHS organisations. A total of 30,800 FTE jobs were directly supported by NHS spending. This represents 6.3% of the Black Country workforce. Approximately 21,000 of these roles were performed by Black Country residents. NHS wages are 26% higher than the average Black Country wage.[10]

Several factors are likely to influence the availability of the healthcare workforce over the coming 5-10 years.

Government policy

Work and pensions policy

Due to increases in life expectancy, the state pension age is increasing to 66 by 2020, to 67 by 2028, and to 68 between 2037 and 2039.[11] These changes are being implemented earlier than originally planned and could be accelerated or extended further. Assuming that colleagues do not opt to retire

[10] https://www.strategyunitwm.nhs.uk/sites/default/files/2019-02/Final%20Report%20NHS%20Economic%20Impact%20of%20NHS%20Spending%20in%20the%20Black%20Country_0.pdf

[11] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/630066/print-ready-state-pension-age-review-final-report.pdf

early on reduced benefits, the average age of the workforce could increase further, and those starting their careers in their early 20s may be faced with a 50-year working life. These changes may help to relieve future workforce pressures as individuals stay in work longer. Equally, there may be a desire for increased flexible working or a loss of staff to other occupations later in life. Not uncommonly, people in their 50s and 60s have increased informal caring responsibilities for older relatives, and they may feel a conflict between these responsibilities and their need to continue in employment. Ultimately, this could drive individuals to reduce their hours or take early retirement, putting pressure on current staff to deliver services. Where employment is chosen above informal caring responsibilities, demand for care services may increase.

The decisions that people make about employment in later life may also be influenced by the nature of pension benefits available to them. Changes to pension benefits, lifetime allowances, or tax thresholds could impact the decisions that people make (e.g. when they retire, the number of hours they work, the relative attractiveness of NHS roles). Since the budget announcement in 2015 cutting tax relief for higher earners, senior clinicians have been disincentivised from taking on additional work[12]. A recent British Medical Association survey found that 60% of NHS consultants planned to retire early, with many citing the penalties incurred by breaching pension allowance limits as the chief driver[13].

Beyond pensions issues, the introduction of the EU working time directive twenty years ago had a significant impact on NHS workforce availability, cost, and, potentially, quality[14]. Outside of the EU, the UK would be able to diverge from the directive. This could reverse some of the directive's impact. Any increase in working hours could relieve demand and cost pressures but could also impact the relative attractiveness of NHS roles.

In some sectors, there are experiments with a 4-day working week. The potential to adopt such practices may be very limited for most NHS roles but, if the practice became a growing trend in society, an impact on NHS recruitment and retention might be experienced.

Education funding policy

Education policy is also a factor in NHS workforce availability. Changes to the primary or secondary curriculum could affect the knowledge and skills of future NHS workers, as well as their understanding of health and care professions. In tertiary education, changes to the number of training places and/or how they are funded could either encourage or deter people from seeking

[12] https://www.hsj.co.uk/workforce/government-admits-pensions-policy-a-disincentive-to-take-on-extra-work/7024794.article

[13] https://www.bma.org.uk/news/2019/january/pension-rules-force-consultants-to-retire-early

[14] https://bmjopen.bmj.com/content/4/2/e004390

NHS employment[15]. Changes in the modes of training could also affect the scale and nature of workforce supply: for example, degree-level apprenticeships[16]; part-time options including Less Than Full Time training (LTFT)[17]; and salaried training. The choices people make following training – whether they stay in the NHS, for how long and how many hours they work – may evolve as a result of a wide range of social, political and economic factors.

Health and social care policy

Policy that will alter the health and social care environment could impact the motivation and experience of staff. Similarly, changes to models of care, to the integration of health and social care, and to the boundaries of professional roles could each impact the motivation and satisfaction of existing staff or alter the attractiveness of the NHS or social care to potential new starters. Letters from healthcare professionals in the media in 2017 have highlighted that NHS staff are feeling drained by endless reorganisation[18]. Staff have also previously reported feeling subject to endless change, operating to an agenda that appears to have been politicised and with new initiatives (seemingly with no rationale) regularly imposed[19].The 2018 NHS staff survey also showed that on average nationally, only approximately 52% of staff between 2014-2018 felt involved in deciding on changes introduced that affected their work area, team or department, with a particularly low value of approximately 28% for those in the ambulance service[20].

Other policy areas

Transport and housing policy can impact the supply of workforce due to the accessibility of work locations and the availability and desirability of local areas for staff to live in. Transport is a key theme of the West Midlands Combined Authority[21], embracing HS2, Midland Metro extensions and a new transport hub for Wolverhampton[22].

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[15] https://www.rcn.org.uk/get-involved/campaign-with-us/student-funding-fund-our-future; https://www.bbc.co.uk/news/education-47405054

[16] https://www.theguardian.com/careers/2019/mar/05/the-nhs-apprenticeships-offering-a-new-route-to-health-and-social-care

[17] https://www.healthcareers.nhs.uk/explore-roles/doctors/career-opportunities-doctors/less-full-time-training-doctors

[18] https://www.theguardian.com/society/2017/aug/30/nhs-staff-feeling-drained-by-endless-reorganisation

[19] https://webarchive.nationalarchives.gov.uk/20130124043049/http:/www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/@dh/@en/documents/digitalasset/dh_085535.pdf

[20] https://www.nhsstaffsurveyresults.com/national-trend-questions/

[21] https://www.wmca.org.uk/media/1371/2016-06-01-mfg-summary-document_wmca.pdf

[22] https://www.expressandstar.com/news/local-hubs/wolverhampton/2019/03/20/wolverhampton-railway-station-project-one-step-closer-to-completion/

The economy

The health and care workforce is sourced from a pool of workers over which private and public sector employers compete. The level of economic activity, nationally and regionally, could impact the level of competition for employees between sectors, with the potential for leakage from public to private sectors in periods of economic growth (moderated by any concurrent increase in public sector funding). The public sector is a proportionately larger employer in economically challenged areas and, as in the Black Country, makes a disproportionate contribution to the local economy, partly through the higher average skills level of the NHS workforce. Over the ten years from 2008-2018, public sector employment in the West Midlands reduced further as a proportion of total employment (from 19% to 15.7%) than was the case nationally (from 19% to 16.2%)[23]. How the UK (and regional) economy performs over the next 10 years, especially in the light of Brexit, could have a variety of impacts on healthcare workforce availability. One element of future economic impact will be the degree of automation experienced. There is a high risk (a >70% probability) that between 8.0% and 9.4% of Black Country jobs will be lost due to automation (Figure 5)[24]. Alongside the economic and health impacts of such a loss, there may also be opportunity to recruit more local people into health and care services, increasing skills and productivity at the same time.

Local authority	Probability of automation	Proportion of jobs at Low Risk of automation 2011	Proportion of jobs at Medium Risk of automation 2011	Proportion of jobs at High Risk of automation 2011
Dudley	48.3%	21.2	70.3	8.5
Sandwell	50.6%	16.0	74.6	9.4
Walsall	50.1%	14.6	76.2	9.2
Wolverhampton	49.5%	16.9	75.1	8.0

Figure 5 - Probability of jobs at risk of automation

Preferences for being employed in either the private or public sector could be also be driven by changing pay differentials or employment conditions between sectors. Some staff may choose to supplement their work in the NHS with private work. There has, for example, been rapid growth in outsourcing companies employing NHS consultant radiologists to report the backlogs of images

23 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/publicsectorpersonnel/datasets/publicsectoremploymentreferencetable

24 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/datasets/probabilityofautomationinengland

which have built up[25]. Overall, workforce market competitiveness may impact both the scale of workforce supply and the combination of workforce position that are filled, ultimately impacting service delivery.

The state of the Black Country economy is also important, including how its industries are impacted by Brexit and subsequent trade policy, and by the success or otherwise of economic development plans and local industrial strategy[26]. Staff may be attracted to or from adjacent areas depending on those that are the most economically attractive, potentially creating inequalities in service provision.

How employee power evolves will also impact health and care services. Will employees increasingly be rule takers or rule makers in future? Office for National Statistics data shows that in 2017, the health and social work sector had the second highest percentage of people on a zero-hours contract compared to other key industries[27]. Trades Unions have been less able to influence terms and conditions as Union membership fell by 4.2% in 2017, an all-time low since records began in 1995, due to the loss of "good-quality jobs", cuts to the public sector workforce and the rise of the gig economy[28]. Whether these trends are accelerated or reversed will affect the attractiveness of health and care roles.

Social attitudes

The attitudes and behaviours of the population can drastically impact both recruitment and retention into the NHS and social care.

Work-life balance

Between 2011/12 and 2017/18, the total number of NHS leavers increased by 6%. Almost 5,000 staff left an NHS job for a 'better work-life balance' during Q3 2017/18 compared with 1,521 in Q1 2011/12 - an increase of 213% (Figure 6)[29].

[25] https://www.theguardian.com/society/2015/may/05/ban-nhs-doctors-from-private-work-hospital-consultant-says
[26] https://www.the-blackcountry.com/upload/Annual%20Economic%20Review%202019/29981%20-%20Annual%20Economic%20Review%20Brochure%202018-19_f_(Email).pdf
[27] https://www.the-blackcountry.com/upload/Annual%20Economic%20Review%202019/29981%20-%20Annual%20Economic%20Review%20Brochure%202018-19_f_(Email).pdf
[28] https://www.theguardian.com/politics/2017/jun/01/union-membership-has-plunged-to-an-all-time-low-says-ons
[29] https://www.unison.org.uk/news/ps-data/2018/06/data-nhs-workers-quit/

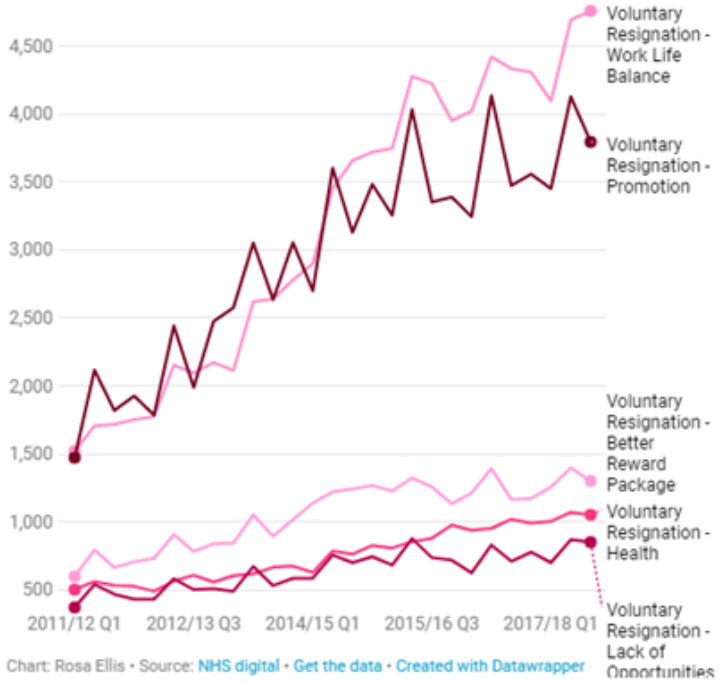

Figure 6 - Reasons NHS workers leave between 2011/12 and 2017/18

The desire for a better work-life balance may increase the proportion of individuals pursuing non-linear and portfolio careers or flexible working and training or career breaks. This desire may also be driven by commitments such as caring for children or older relatives[30]. It also links to experiments with 4-day weeks in a small number of UK companies: although some results have shown improvements in productivity and wellbeing, the Wellcome Trust has abandoned plans for a trial due to concerns around operational complexity and equity[31]. And to what extent might individual aspirations change over the next 10 years? Will people be more or less willing to commit time and resource to career progression activity such as further training and qualifications?

Perceptions of health and care careers in the Black Country

Another important attitude involves the perception of having a career in the NHS or care services. One factor will be changes in the attractiveness of roles relative to other options, including perceived job security, work pressures, role autonomy, remuneration levels and social esteem. Work–life balance has increased as a driving factor for leaving the NHS by 2.5 times between 2011/2012 and 2018/19. The numbers of applicants to nursing degree courses across all age groups fell between 2016/17 and 2017/18 whilst there has been an overall decline of 9% in applicants for nursing degree courses across the UK between the 2017 and 2018 university cycles[32] (Figure 7).

[30] https://www.hsj.co.uk/nikita-kanani/1203645.bio
[31] https://www.theguardian.com/uk-news/2019/apr/12/wellcome-trust-drops-plans-to-trial-four-day-working-week?CMP=Share_iOSApp_Other
[32] https://www.health.org.uk/sites/default/files/upload/publications/2019/A%20Critical%20Moment_1.pdf

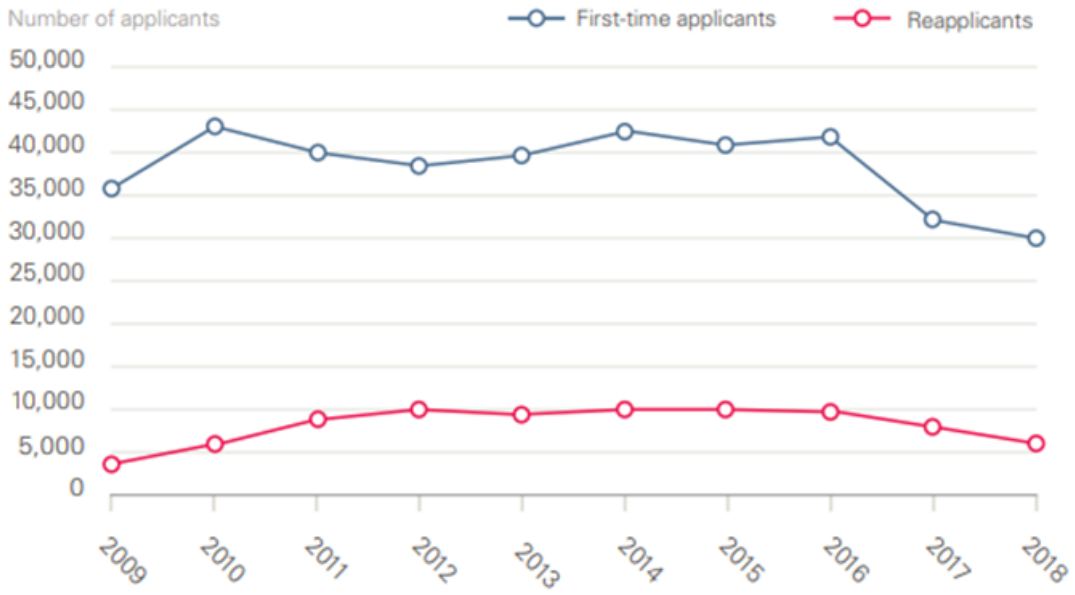

Figure 7 - The number of first-time applicants and reapplicants to undergraduate nursing degree courses in England (2009-2018)

The evolving attractiveness of the Black Country – and its four constituent areas - to potential health and social care workers will likely play a part in recruitment prospects. Relevant factors might include proximity to family and friends, accessibility of transport, the availability of social and cultural activities, the level of economic prosperity, the social and physical environment, and the performance of local school, colleges and universities. Individual preferences for living in urban, suburban or rural areas may also change, potentially impacting the numbers of workers able to deliver services in particular areas, which could create inequalities in service provision.

Migration

In June 2018, c.144,000 of 1.2 million NHS staff (12.7%) held 200 different non-British nationalities. Around 63,000 (5.6%) were EU nationals and 49,000 staff (5%) were Asian nationals (Figure 8)[33]. The movement of people from and to the UK over the coming 5-10 years will play a large role in shaping workforce availability. To what extent will EU workers be retained or replaced by other nationalities?

Several factors influence migration, including immigration policy, relative economic prosperity, global instability and climate change. Global climate change may make the UK more or less attractive for workforce immigration relative to places of origin. Meanwhile, climate-driven natural events may become an increased driver in the need to migrate. Climate-driven disease outbreaks could also drive

[33] https://researchbriefings.parliament.uk/ResearchBriefing/Summary/CBP-7783

migration patterns around the globe. For example, the 2015-2916 El Nino event was associated with outbreaks of chikungunya, hantavirus, Rift Valley fever, cholera, plague, and Zika[34].

	NHS 2017		*Whole economy 2017*	NHS 2009	
Nationality Group	*Number*	*% of known*	*estimated %*	*Number*	*% of known*
UK	988,369	87.3%	*88.3%*	850,091	88.9%
EU (PRE-2004 MEMBERS)	**43,242**	**3.8%**	***3.4%***	**21,262**	**2.2%**
SOUTH ASIA	26,244	2.3%	*1.2%*	26,668	2.8%
SUB-SAHARAN AFRICA	20,152	1.8%	*0.9%*	21,414	2.2%
SOUTH EAST ASIA	20,136	1.8%	*0.2%*	15,413	1.6%
EU (POST-2004 MEMBERS)	**19,824**	**1.8%**	***4.2%***	**6,945**	**0.7%**
LATIN AMERICA & CARIBBEAN	2,906	0.3%	*0.1%*	3,487	0.4%
OCEANIA	2,828	0.2%	*0.3%*	2,572	0.3%
NORTH AMERICA	2,112	0.2%	*0.4%*	1,773	0.2%
NORTH AFRICA	1,843	0.2%	*0.1%*	1,373	0.1%
MIDDLE EAST & CENTRAL ASIA	1,597	0.1%	*0.2%*	1,798	0.2%
EAST ASIA	1,283	0.1%	*0.3%*	1,432	0.1%
EUROPE (NON-EU)	1,137	0.1%	*0.2%*	916	0.1%
SOUTH AMERICA	870	0.1%	*0.2%*	807	0.1%

Figure 8 - Self-reported nationalities of NHS workers in June 2018

Another key factor that will influence migration (including emigration from the UK) is politics and the economy, both globally and in the UK. Overall, what individuals regard as unfavourable political decisions or economic conditions at home or abroad may prompt changes in the scale and/or pattern of migration. The migration of health professionals from emerging market economies (EMEs) to wealthier countries such as the UK is driven by factors such as low wages and poor work environments in home countries, low employment opportunities, lack of professional development and specialist training, political instability and poor socioeconomic conditions[35]. If UK policies and the economy become less attractive than those of other countries, emigration and workforce losses may occur.

Immigration was a key theme in the 2016 referendum and in subsequent debate but there is evidence that concerns around immigration have reduced[36]. How will the way in which the UK does or does not leave the EU affect relevant social attitudes and the effect they have on the decisions individual workers make? To what extent will post-Brexit immigration policy facilitate or impeded workforce

[34] https://www.nature.com/articles/s41598-018-38034-z
[35] https://academic.oup.com/jpubhealth/article/35/1/157/1592927
[36] https://www.washingtonpost.com/gdpr-consent/?destination=%2fworld%2feurope%2fimmigration-worries-drove-the-brexit-vote-then-attitudes-changed%2f2018%2f11%2f16%2fc216b6a2-bcdb-11e8-8243-f3ae9c99658a_story.html%3fnoredirect%3don%26utm_term%3d.2e7efa66fc42&noredirect=on&utm_term=.90fda0366948

availability? Over the last ten years there have been significant increases in the NHS' EU workforce (Figure 9). The scale and direction of future changes cannot be known with certainty.

Date	**All staff**	Doctors	Nurses & health visitors	Support to clinical staff
Sep 2009	**3.0%**	6.8%	2.8%	2.2%
Sep 2010	**3.1%**	7.0%	3.1%	2.3%
Sep 2011	**3.3%**	7.5%	3.3%	2.4%
Sep 2012	**3.5%**	8.0%	3.5%	2.5%
Sep 2013	**3.8%**	8.6%	4.0%	2.7%
Aug 2014	**4.3%**	9.1%	5.0%	2.9%
Sep 2015	**5.0%**	9.4%	6.5%	3.4%
Dec 2015	**5.2%**	9.5%	6.8%	3.5%
Jun 2016	**5.5%**	9.7%	7.4%	3.6%
Dec 2016	**5.5%**	9.8%	7.4%	3.6%
Jun 2017	**5.6%**	9.8%	7.3%	3.9%
Dec 2017	**5.5%**	9.7%	6.9%	4.0%
Jun 2018	**5.6%**	9.7%	6.8%	4.2%

Figure 9 - Percentage of NHS staff with EU nationality

3. How might levels of funding change?

As a percentage of GDP, UK public spending on health has increased nearly elevenfold since 1948, and now stands at £140.6bn. As a proportion of GDP, however, spending has remained fairly level from 2009 onwards[37]. The rolling 10-year average change in UK health spending has fluctuated considerably over the years, with the most recent 10-year period showing the lowest percentage change in over a decade[38]. The UK spends slightly more than average for the EU-14 (the first 15 states to join the EU, excluding the UK) but less than Sweden, France and Germany[39].

Social care spending has increased by twice the amount that was spent in 1994/95, but spending is around 17% lower than its peak in 2010/11. Although NHS employment has increased every quarter for 5 years, employment in other health and social work has fallen (Figure 11).[40]

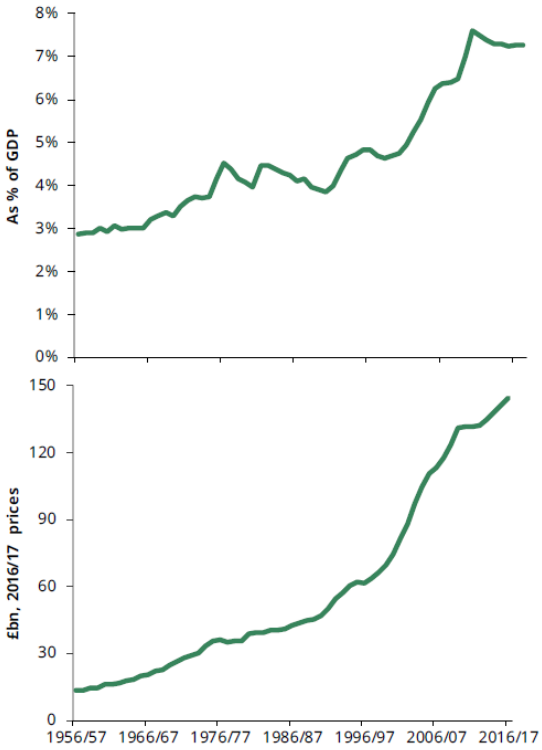

Figure 10 - UK spending on health

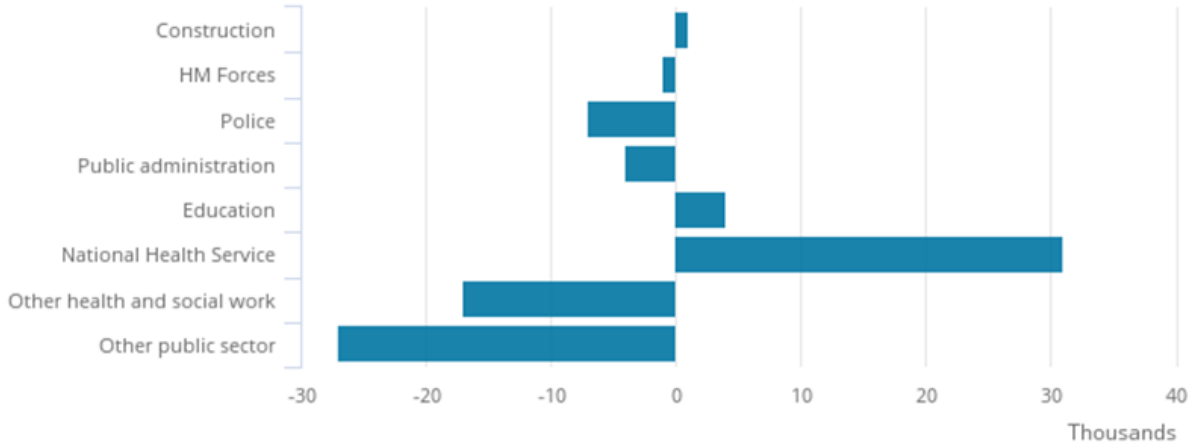

Figure 11 - Changes in public sector employment by industry (March 2016-March 2017)

[37] https://researchbriefings.files.parliament.uk/documents/SN00724/SN00724.pdf
[38] https://www.health.org.uk/chart/chart-how-funding-for-the-nhs-in-the-uk-has-changed-over-a-rolling-ten-year-period
[39] https://www.health.org.uk/chart/health-and-social-care-funding-explained
[40] https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/publicsectorpersonnel/bulletins/publicsectoremployment/mar2017

Based on current growth trends, the funding gaps that are expected to be faced by the NHS and social care are shown in Figure 12 and Figure 13, respectively.

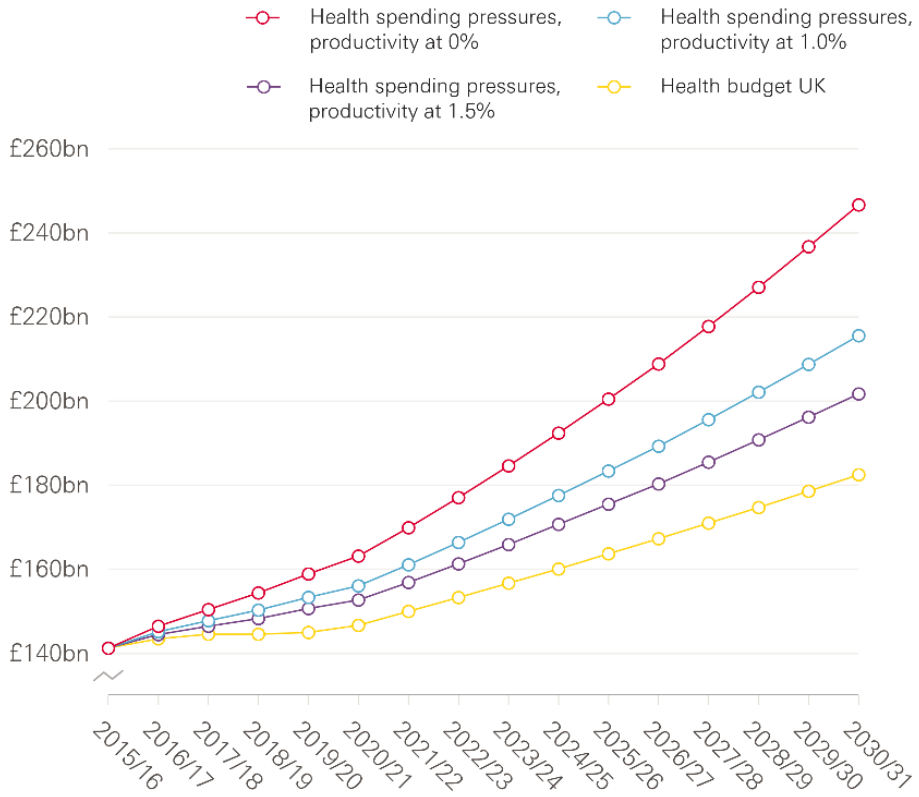

Figure 12 - Predicted gaps in NHS funding by 2030/31

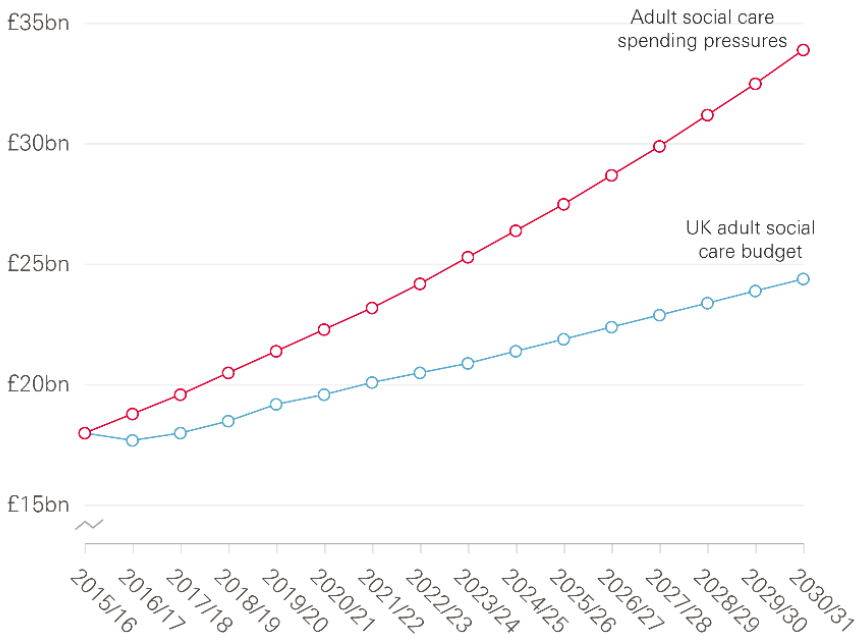

Figure 13 - Predicted gaps in social care funding by 2030/31

Several factors could contribute to funding levels over the next 5-10 years.

Policy and legislation

Changes in policy, both within and outside of the UK, can impact levels of funding available for health and social care. In direct terms, policy specifically related to health and social care, including healthcare policy, social care policy and public health policy may change funding levels and priorities. Such policy changes are also likely to have consequent impacts on other publicly funded services that may not be anticipated or understood initially.

Post-Brexit trading arrangements between countries could change the income the UK receives and the state of the UK economy, impacting the amount of funding the Government is able to invest in the NHS. Policy for other UK assets such as transport, the environment, defence, education, industrial and housing policy could also be important. The decisions Government makes regarding how spending is allocated between sectors, and how prioritisation shifts for each sector based on public or economic need, will change what funding health and social care will receive. Figure 14 shows relative changes in spending on education, defence and health between 1995-2016[41], but how these priorities will change in future – especially given the historical steepness of the health spending curve - remains uncertain.

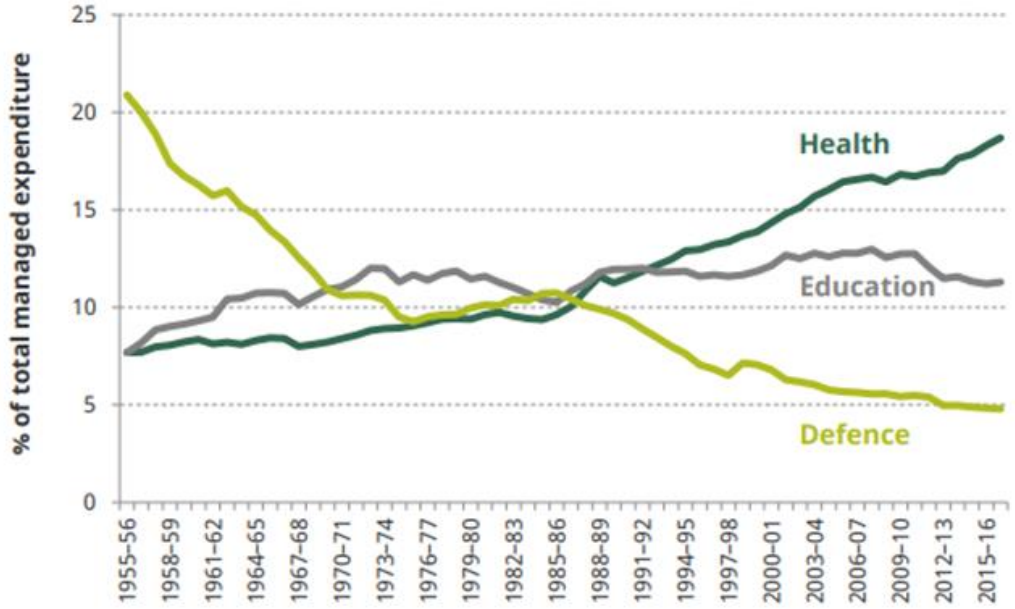

Figure 14 - Change in relative spending for different sectors (1995-2016)

[41] https://www.ifs.org.uk/uploads/R143%20executive%20summary.pdf

Social attitudes

How both the public and the workforce feel about health and social care can have a substantial influence on local and national policy decisions and the subsequent prioritisation of funding allocations. Perceptions of what the scope of NHS services should be is also important, including the range and quality of services that should be delivered and the extent to which health and care provision should be free at the point of need. An analysis of the British Social Attitudes (2018) survey shows that the second largest reason for why the public were satisfied with the NHS overall was that it is free at the point of use[42]. In principle, any material change to any of the top five reasons below (Figure 15) could alter the nature and extent of public support for the NHS. Public satisfaction with the NHS has dropped 6 percentage points in a year, taking it to 57% - its lowest level since 2011 – and can vary significantly by service type[43]. Public support for social care remains relatively low by comparison (Figure 16).

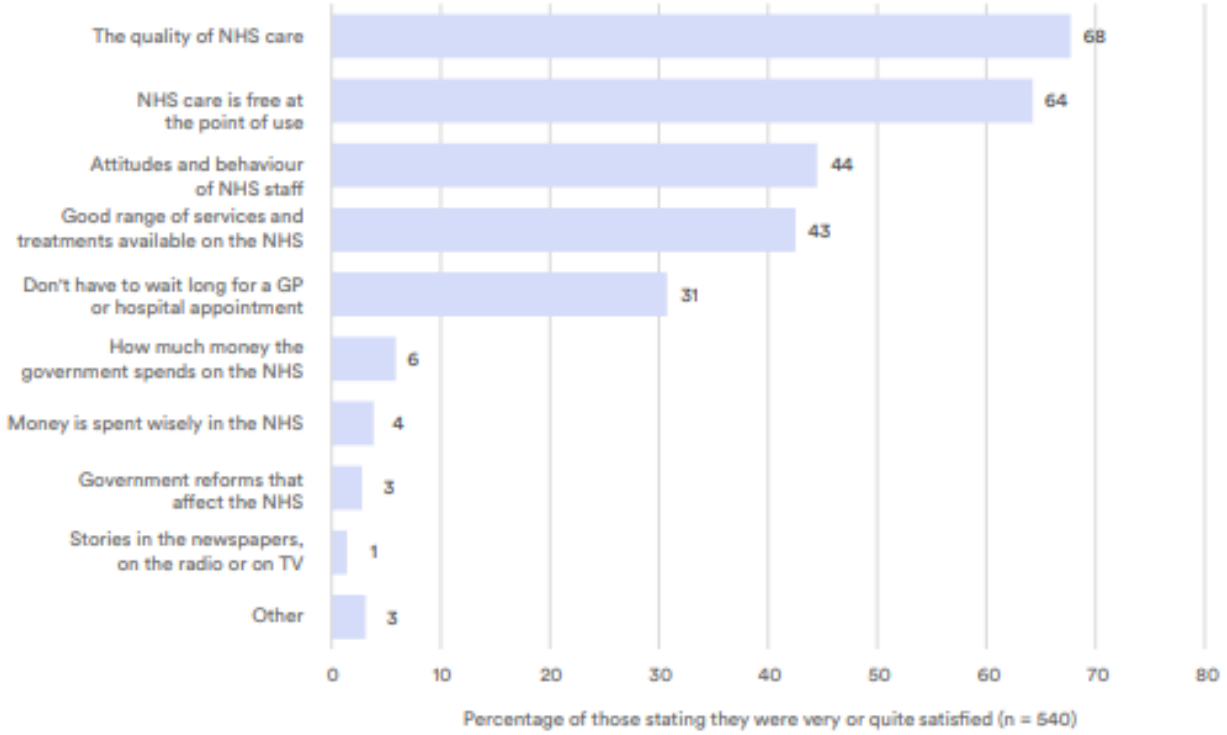

Figure 15 - Reasons for satisfaction with the NHS overall (2018)

[42] https://www.nuffieldtrust.org.uk/research/public-satisfaction-with-the-nhs-and-social-care-in-2017#what-drives-public-satisfaction

[43] https://www.nuffieldtrust.org.uk/research/public-satisfaction-with-the-nhs-and-social-care-in-2017#how-satisfied-is-the-british-public-with-different-nhs-and-social-care-services

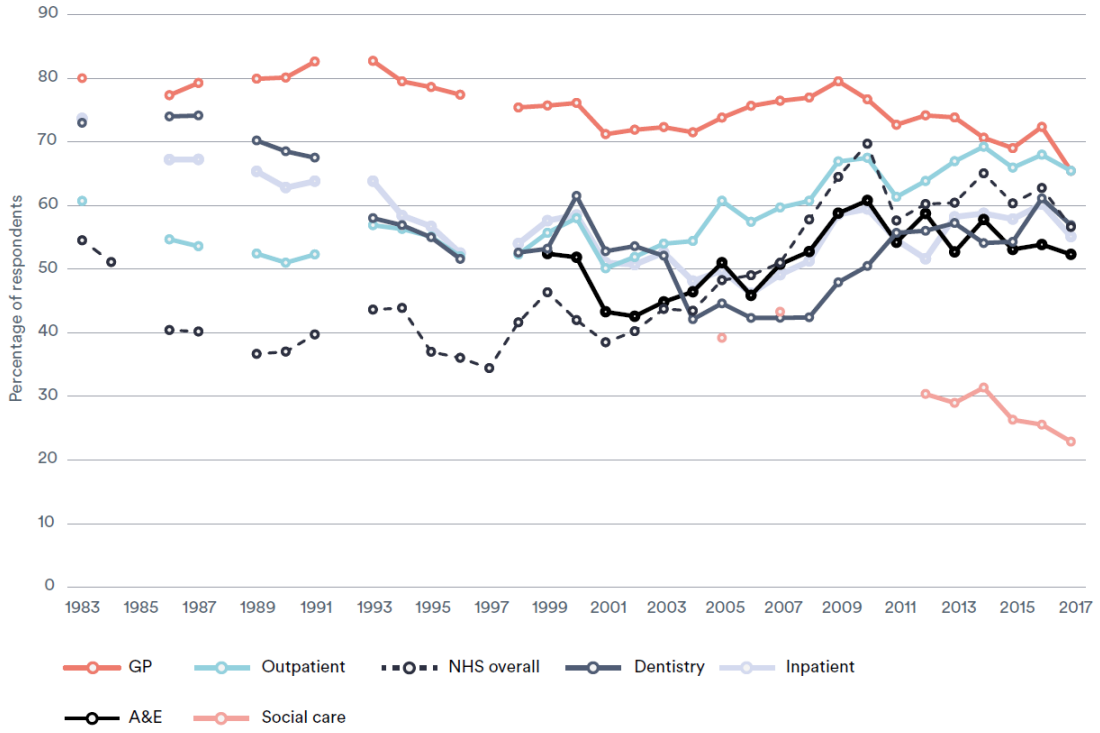

Figure 16 - Public satisfaction with NHS and social care services

Similarly, a rise or fall in public sympathy for other national priorities, such as education, policing or defence, could impact the relative growth in health and care funding. Public priorities for extra government spending between 1983-2016 fluctuated over time, but health has remained the highest priority out of all sectors, with education being a close competitor at times (Figure 17)[44].

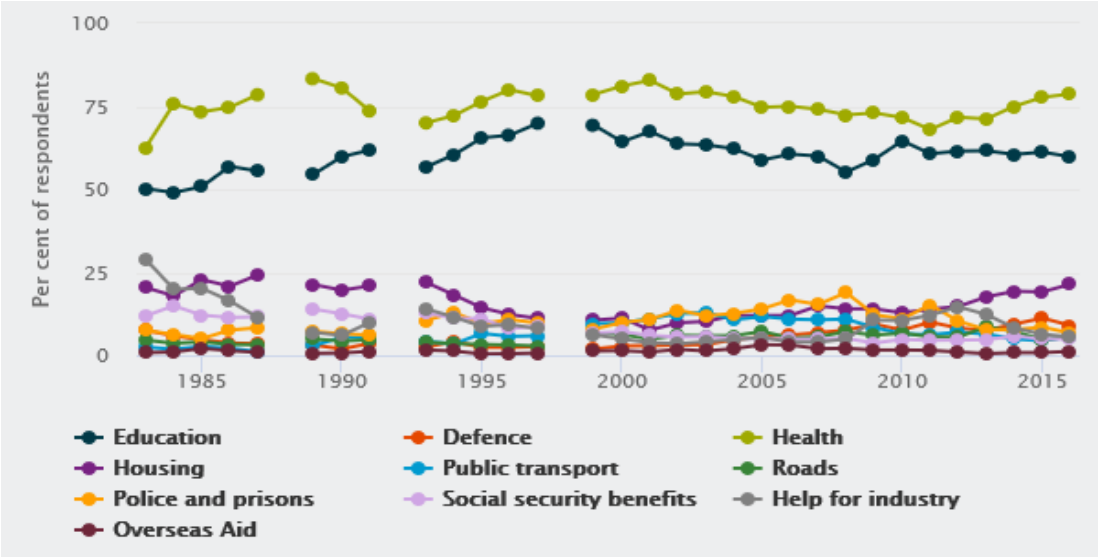

Figure 17 – Public spending priorities

[44] https://www.kingsfund.org.uk/publications/how-have-public-attitudes-to-nhs-changed#footnote1_a2e5lec

The extent to which those with adequate financial means will seek to pay for private care rather than relying on the NHS over the next 5-10 years could impact demand for, and subsequent funding of, public sector services. In 2017, it was reported that the ongoing crisis in public healthcare, combined with economic recovery, may have triggered the first rise in private healthcare insurance sales in 7 years[45]. Equally, polls indicate public support for tax rises to fund the NHS[46], and public attitudes to levels of taxation in general vary over time, perhaps linked to the state of the economy (Figure 18)[47].

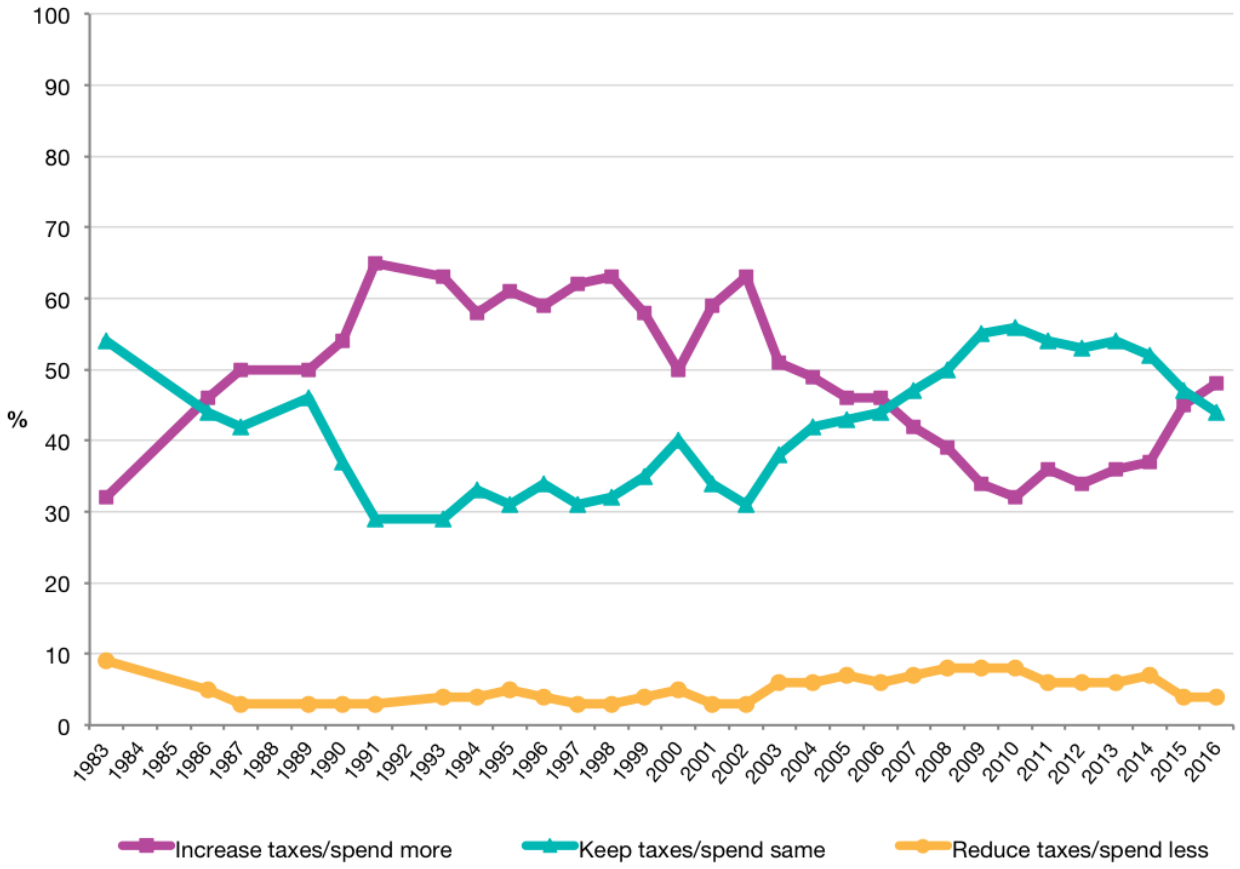

Figure 18 - Support for 'tax more, spend more'

[45] https://www.theguardian.com/business/2017/jan/16/private-medical-insurance-sales-surge-health-nhs
[46] https://www.independent.co.uk/news/health/nhs-funding-tax-rise-uk-voters-support-theresa-may-jeremy-hunt-a8301661.html
[47] http://www.bsa.natcen.ac.uk/media/39145/bsa34_role-of-govt_final.pdf

Funding for the NHS featured heavily in the Brexit referendum campaign but the impact of Brexit on NHS funding (and other matters) is a matter of public concern (

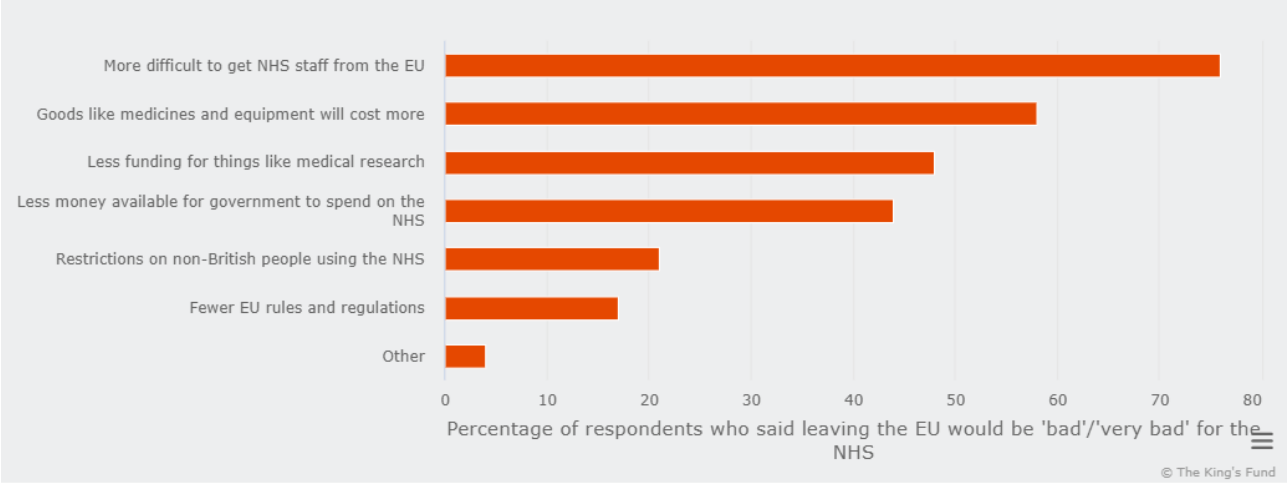

Figure 19).

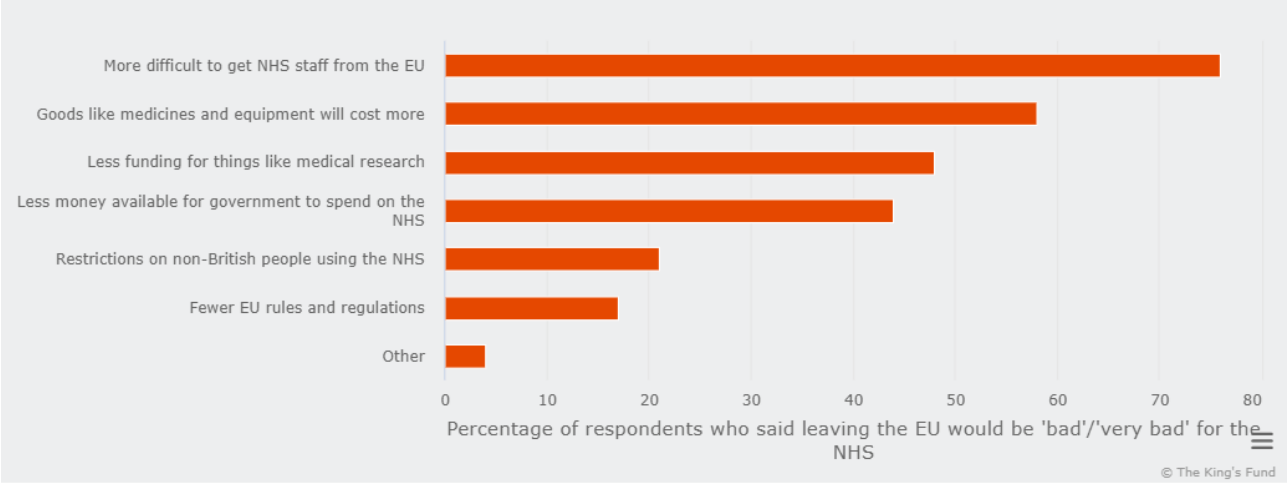

Figure 19 - Why individuals thought leaving the EU would be a bad thing for the NHS (2018)

The economy

The state of the national economy ultimately influences the levels of resource available to deploy in public services. Over the seven decades of the NHS' life, growth in funding has closely followed the ups and downs of wider economic cycles. Since the 2008 recession, the economic picture has become more challenging. Despite real-terms protection, the period between 2009–10 and 2014–15 saw the lowest five-year growth rate since a consistent time series of health spending began in 1955– 56, averaging 1.1% per year[48]. The amount of resource available to the NHS impacts the health and social

[48] https://www.england.nhs.uk/five-year-forward-view/next-steps-on-the-nhs-five-year-forward-view/funding-and-efficiency/#43; https://www.ifs.org.uk/uploads/publications/budgets/gb2017/gb2017.pdf

care service scope and volumes, capital investment and staffing levels through pay and investment in education, training, recruitment and retention. The pay of NHS doctors and nurses has fallen by around 10-18% over 10 years (Figure 20)[49]. The extent to which the state of the economy will change over the next 5-10 years remains unknown, but Brexit is expected to have a large impact on global trade dynamics and other issues regarding future economic prosperity[50].

Commercial power can also play a role in health and social care funding. The extent to which health and care services are influenced by commercial forces in coming years including pharmaceutical companies, suppliers of digital solutions and holders of Big Data (such as Google Deep Mind), may impact the amount of funding required to sustain these commercial relationships and also the scale of financial benefits arising for the NHS from these commercial relationships.

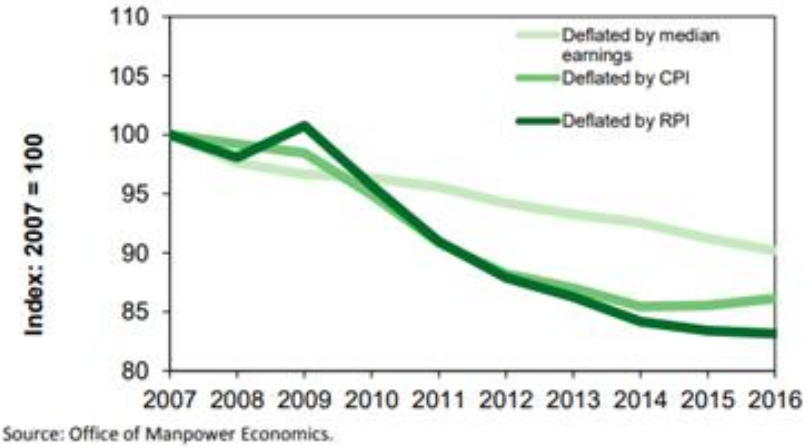

Figure 20 - Hospital doctor real pay by year relative to 2007

[49] https://www.niesr.ac.uk/sites/default/files/publications/NIESR%20Briefing%20Paper%20No5%20-%20Is%20NHS%20Funding%20In%20Crisis.pdf
[50] https://www.rand.org/randeurope/research/projects/brexit-economic-implications.html

4. What digital technology might be available?

The recent Topol Review (Figure 21[51]) sets out a series of recommendations for realising the benefits of digital technology in healthcare. There are some concerns about the impact that digital technology may have – for example, of the c.1.5m people in England at high risk of losing their jobs to automation, 70% of the roles are currently held by women, and young people aged 20-29 are most at risk. Medical practitioners, however, have one of the lowest probabilities of risk from automation (18%)[52].

Artificial intelligence and robotics

Artificial intelligence is defined as "a branch of computer science dealing with the simulation of intelligent behaviour in computers"[53]. Both AI and robotics could have a large impact on the provision of health and care services, and it has been suggested that widespread adoption of AI and the NHS embracing "full automation" could free up as much as £12.5bn a year worth of staff time for them to spend interacting with patients[54]. AI has been highlighted as a priority area in the NHS Long Term Plan[55], particularly in relation to the scaling of technology to "assist the expansion of life-changing treatments to more patients". It notes that AI could be used to "help clinicians in applying best practice, eliminate unwarranted variation across the whole pathway of care, and support patients in managing their health and condition." The uses of AI and robotics are incredibly broad.

Data capture and diagnostics.

AI has been shown to improve data capture and diagnostics, and it can incorporate the use of deep-learning algorithms which are able to learn and evolve as they gather more information. "Dr Watson", the super-computer in the US, can diagnose patients through mining patient data, combining it with current findings from tests, and then forming and testing hypotheses by examining a variety of data sources including treatment guidelines, electronic medical record data and doctors' and nurses' notes, as well as peer-reviewed research and clinical studies. It has been used with cancer patients[56].

[51] https://topol.hee.nhs.uk/wp-content/uploads/HEE-Topol-Review-2019.pdf
[52] https://www.bbc.co.uk/news/business-47691078; https://www.bbc.co.uk/news/business-47691078
[53] https://www.nuffieldtrust.org.uk/files/2018-06/1530028974_the-nhs-at-70-what-will-new-technology-mean-for-the-nhs-and-its-patients.pdf
[54] https://www.theguardian.com/society/2018/jun/11/the-robot-will-see-you-now-how-ai-could-revolutionise-nhs
[55] https://www.longtermplan.nhs.uk/wp-content/uploads/2019/01/nhs-long-term-plan.pdf
[56] https://www.news.com.au/lifestyle/health/why-robots-could-soon-replace-our-doctors/news-story/9c33db2f25e0fff6184603b38cdc641f; https://www.businessinsider.com/ibms-watson-may-soon-be-the-best-doctor-in-the-world-2014-4?r=US&IR=T

Recommendations

The Review Board recommends:

The citizen and the patient

- In a similar way to other public health education initiatives, programmes aimed at engaging and educating the public about genomics and digital healthcare technologies should be developed. (P1)
- The NHS should work with patient and carer organisations to support appropriate patient education. (P2)
- Local arrangements should be established to provide needs-based targeted education and support through existing patient support provision, where possible. (HI1)

The Genomics Panel recommends:

The citizen and the patient

- The NHS, in partnership with relevant regulatory bodies, should establish a clear, robust framework by which healthcare professionals use genomic data, which safeguards patient confidentiality, and inspires the support and confidence of citizens and the wider community. (G1)

Healthcare professionals

- All healthcare professionals should receive core training in genomic literacy to help them understand the basis, benefits and ethical considerations associated with genomics. (G2)
- Lifelong training should be available to healthcare professionals with emphasis on continuing support in this rapidly evolving field, including access to dynamic 'just-in-time' digital updates and online genomic information resources. (G3)
- Accredited genomic training for healthcare professionals should be established in key clinical specialities to incorporate genomic testing and genomic counselling into their practice. (G4)
- Capacity should be built within the NHS Genomic Medicine Service through support for specialist healthcare professionals including genomic counsellors, clinical scientists and specialists in genomic medicine. (G5)

Health system

- An attractive career pathway should be developed for bioinformaticians, including expansion of Higher Specialist Scientist Training for clinical bioinformaticians. (G6)
- A framework for genomic leadership should be developed across clinical specialities and primary care settings to encourage and disseminate best-practice and to simplify patient referral systems. (G7)
- Academic institutions should ensure genomics and data analytics are prominent in undergraduate curricula for healthcare professionals, and that there should be expansion of undergraduate capacity in genomics, bioinformatics and data science. (G8)

The Digital Medicine Panel recommends:

The citizen and the patient

- NHS online content should be a vital trusted source of health information and be resourced appropriately. (DM1)
- The NHS should expand research and development programmes, working closely with patients to co-create digital technologies and ensure that emerging technologies meet their needs. (DM2)

Healthcare professionals

- NHS organisations should invest in their existing workforce to develop specialist digital skills, including the assessment and commissioning of digital technologies, through the Digital Academy, continuous professional development (CPD), sabbaticals and secondments. (DM3)

Health system

- The NHS, working with regulators, should develop and commission courses to increase the number of specialists in the evaluation and regulation of digital technologies. (DM5)

The Digital Medicine and AI & Robotics Panels recommend:

- The NHS should create or increase the numbers of clinician, scientist, technologist and knowledge specialist posts with dedicated, accredited time, with the opportunity of working in partnership with academia and/or the health tech industry to design, implement and use digital, AI and robotics technologies. (DM4/AIR5)

The AI and Robotics Panel recommends:

The citizen and the patient

- The NHS should ensure that patients are involved from the beginning in the design and implementation of AI software for healthcare, with their needs and preferences reflected in the co-design process. (AIR1)

Healthcare professionals

- Educational resources should be developed to educate and train all healthcare professionals in: health data provenance, curation, integration and governance; the ethics of AI and autonomous systems/tools; critical appraisal and interpretation of AI and robotics technologies. (AIR2)

Health system

- The NHS should leverage its global reputation and integrated datasets to attract skilled experts from the global community of data scientists. (AIR3)
- Given the national shortage and competition for AI specialists, there should be a national programme of 'Industry Exchange Networks' that would benefit the NHS. (AIR4)

Figure 21 - Topol Review recommendations

A similar concept is being used by the start-up company doc.ai, that has been working with university researchers to create a blockchain platform on which patients can discuss their medical data with an advanced AI "doctor" (Figure 22)[57].

Figure 22 - Doc.ai visual concept of artificial intelligence "doctor"

In terms of specific conditions:

- An AI system has been designed to detect diabetic retinopathy in adults. It was approved by the FDA last April as the first-ever fully autonomous diagnostic tool for use without a specialist[58];
- AI can be trained using a large, diverse set of medical imaging data to identify intracranial haemorrhage on head CT scans and to help physicians prioritize patients for diagnostic screening[51];
- The University of Adelaide has recently announced that its AI system can predict a person's life span as accurately as a human doctor[59];

[57] https://bitcoinmagazine.com/articles/next-doctor-you-consult-could-be-robot-healthcare-meets-ai-and-blockchain/
[58] http://www.bio-itworld.com/2019/03/26/harnessing-machine-learning-and-artificial-intelligence-to-accelerate-discoveries-updates-from-bio-it-world-west.aspx
[59] https://www.bodyandsoul.com.au/wellbeing/why-robots-could-soon-replace-our-doctors/news-story/c3d92340080d63406429bcbefbda7e6e

- Doctors in China have used AI to diagnose polyps on the colon during colonoscopy[60]; and
- A 'deep learning convolutional neural network' has been more effective than experienced dermatologists in detecting malignant melanoma[61].

Eventually, AI could be used with pattern recognition to search millions of databases, studies and textbooks to pull out every case of variability for the treatment of multiple diseases[48].

Assistive technology

Robotics and AI in collaboration can produce several assistive technologies, medical devices "intended to compensate for or alleviate an injury, disability or illness or to replace a physical function"[62]. Home robots can perform basic tasks such as making emergency calls when a medical situation arises and keeping track of appointments and medications. In addition, there are more advanced forms of robots that can control equipment in the home[63]. Developments already include the following:

- Smart glasses that can improve image visualisation whilst incorporating the AI voice and assistance feature[64];
- AI cognitive hearing aids in which "Hearing Reality", the aural version of virtual reality, uses high-speed, high-definition computer processing to manage, separate and focus many layers of sound to better replicate natural hearing[65];
- A smart glove, complete with a companion app, that tracks hand motions to produce speech from sign language, allowing individuals to make up their own signs that can be translated to speech[66]; and

[60] https://www.vox.com/science-and-health/2019/3/15/18264314/ai-artificial-intelligence-deep-medicine-health-care
[61] https://www.usnews.com/news/health-care-news/articles/2018-05-28/artificial-intelligence-beats-dermatologists-at-diagnosing-skin-cancer
[62] https://www.gov.uk/government/publications/assistive-technology-definition-and-safe-use/assistive-technology-definition-and-safe-use
[63] https://www.newgenapps.com/blog/how-artificial-intelligence-is-improving-assistive-technology
[64] https://www.theverge.com/2018/1/9/16869174/vuzix-blade-ar-glasses-augmented-reality-amazon-alexa-ai-ces-2018
[65] https://www.starkey.com/blog/2018/08/Introducing-Livio-AI-Hearing-Aids
[66] https://fashnerd.com/2018/11/brightsign-assistive-wearables-technology-sign-language/

- Bedside robots to help patients eat and drink, to move around a hospital ward or to help them exercise as part of their rehabilitation from surgery[67].

Talking and befriending

AI and robotics also have several talking and befriending applications. Chat bots and avatars could be used to help people with symptoms of anxiety and depression[68]. 'Woebot', the world's first robotic therapist, can have more than two million conversations a week[69]. Other examples include Jibo, Pepper, Paro and Buddy Robots which are friendly robots that can socialise with patients who have dementia or trauma. Anybots Inc robots personally interact with patients and can book future appointments for them[70].

Triage, logistics and data capture

AI also holds some promise for supporting triage. Some primary care providers have developed AI-based online triage processes that allow patients to enter their symptoms and be guided more accurately than current online triage towards self-care, the GP, an out-of-hours clinic or A&E[71]. There is also the potential for someone arriving at hospital to begin by undergoing digital triage in an automated assessment suite[72]. AI could also be used for logistics such as scheduling for different health and social care professionals and automating basic administrative tasks. They could take over the communication of patients' notes, booking of appointments and processing of prescriptions.

Important questions remain however, regarding the impact that AI and robotics will have on the workforce – certain existing roles may be lost or the scarce workforce could be replaced.

> *I wouldn't advise my children to specialise in pulmonary disease or radiology because these are areas leading the charge in the use of artificial intelligence.* [73]

The use of AI and robotics could, however, improve processes for staff:

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[67] https://www.theguardian.com/society/2018/jun/11/the-robot-will-see-you-now-how-ai-could-revolutionise-nhs
[68] https://www.vox.com/science-and-health/2019/3/15/18264314/ai-artificial-intelligence-deep-medicine-health-care
[69] https://www.dailymail.co.uk/sciencetech/article-5143015/Worlds-robot-therapist-2m-conversations-week.html
[70] https://www.prescouter.com/2018/04/robot-replace-doctor-future/
[71] https://www.nuffieldtrust.org.uk/files/2018-06/1530028974_the-nhs-at-70-what-will-new-technology-mean-for-the-nhs-and-its-patients.pdf
[72] https://www.ippr.org/news-and-media/press-releases/embrace-full-automation-to-release-time-to-care-in-the-nhs-and-social-care-says-top-surgeon-lord-darzi
[73] https://www.news.com.au/lifestyle/health/why-robots-could-soon-replace-our-doctors/news-story/9c33db2f25e0fff6184603b38cdc641f

> *Unlike many industries, where there are fears that automation will result in mass unemployment, in health and care automation will primarily complement human skills and talents, by reducing the burden of administrative tasks – communicating medical notes, booking appointments, processing prescriptions – whilst freeing up time for clinical decision making and caring.*[74]

The growing development and usage of AI and robotics could also lead to the emergence of new roles, and this could have an impact on education and training requirements. The extent to which both the workforce and patients will adapt to and accept this technology (and how quickly) is uncertain. There are also uncertainties regarding the availability of sufficient investment to support developments.

Telemedicine and the Internet of Things (IoT)

Telemedicine is defined as "the remote delivery of healthcare services, such as health assessments or consultations, over the telecommunications infrastructure"[75]. Currently, telemedicine is not offered universally across the health and care system but the Long Term Plan outlines an ambitious effort that foresees mobile health (mHealth[76]) access for every UK citizen by 2022-23 that, at the same time, enables the provision of "longer and richer face-to-face consultations with clinicians where patients want it or need it". The NHS App will provide advice, check symptoms and connect people with healthcare professionals[77]. Babylon Health's GP At Hand video-calling service refers people for medical treatment and offers advice[78], although there have been fears of it destabilising other GP services.

The IoT in healthcare is "the collection of medical devices and applications that connect to healthcare IT systems through online computer networks"[79] (see Figure 23[80]). The IoT could, for example, enable hospitals to track and monitor patients as soon as they arrive at hospital or enabling healthcare professionals to monitor patients in their home.

[74] https://www.zdnet.com/article/robots-and-the-nhs-how-automation-will-change-surgery-and-patient-care/
[75] https://searchhealthit.techtarget.com/definition/telemedicine
[76] https://www.who.int/goe/publications/goe_mhealth_web.pdf
[77] https://www.longtermplan.nhs.uk/wp-content/uploads/2019/01/nhs-long-term-plan.pdf
[78] https://www.forbes.com/sites/parmyolson/2019/03/21/doctor-app-babylon-health-offers-quick-appointments-but-grapples-with-follow-up-care-for-mental-health/#425806c86c70
[79] https://internetofthingsagenda.techtarget.com/definition/IoMT-Internet-of-Medical-Things
[80] https://www.vodafone.com/business/industry/health/remote-monitoring

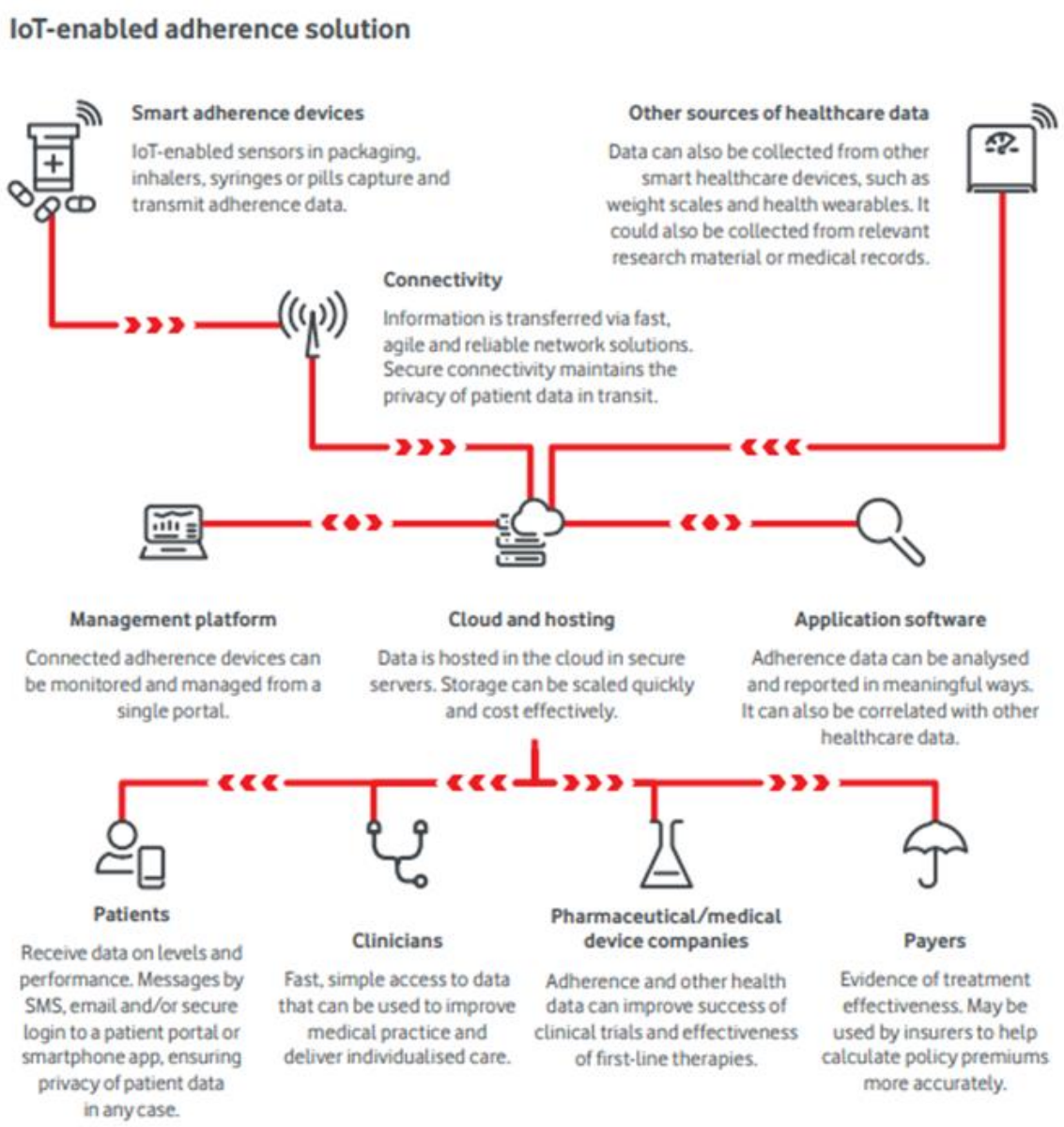

Figure 23 - The concept of the Internet of Medical Things (IoT) (Vodafone)

This works by gathering real-time data about patients that can automatically be added to patient records from sensors, without the need for nurses to take readings or update charts[81]. Smart packaging and connected drug delivery devices can provide accurate, real-time information to clinicians about patient compliance with treatment regimes. This could also be used in collaboration with prescription medication and a digestible sensor component, for example the FDA approved Abilify MyCite in 2017, a pill with a sensor that digitally tracks if patients have ingested their

[81] https://www.zdnet.com/article/iot-and-the-nhs-why-the-internet-of-things-will-create-a-healthcare-revolution/

medication[82].The IoT could also allow the NHS to track resources, such as equipment or clinicians, more effectively. The Royal Wolverhampton NHS Trust has adopted an RFID solution for all its staff and equipment, one benefit of which is monitoring hand-hygiene compliance[83]. NHS England and the Department of Health have recently awarded £10m in funding to two 'test bed' projects that are "IoT-led" – one aimed at dementia patients using sensors around the home to check that they are well and the other aimed at diabetics which has a small IoT component that links to internet-enabled glucose monitors[84]. At the moment these applications are simple, although automating more complex medical activities is possible but costly and time-consuming.

Both telemedicine and the IoT could impact how patients are monitored and cared for, in ongoing day-to-day care and in emergency and critical care situations, but there are issues regarding clinical governance and information governance, cyber security and technology standards. The speed and reliability of 5G mobile technology, expected to launch across the world by 2020 and to offer faster and more dependable connections on smartphones and other devices than 3G and 4G, will also affect opportunities[85]. Some demand pressures might be relieved by these advances through prevention, earlier detection and encouragement of self-management of conditions. Equally, increased monitoring and awareness of health might generate more demand. The remote nature of these technologies could ease challenges around staffing specialist rotas in multiple locations. New competencies and training may be required for staff in contact with these technologies, or new roles may need to emerge, for example regarding creating, testing, monitoring and fixing the technologies.

Patient-driven healthcare

Patient-driven healthcare is an all-encompassing term referring to the ability of patients to look after their own health by monitoring and collecting their own healthcare data, which could be shared with healthcare providers.

Wearable devices were highlighted as important in the Long Term Plan that anticipates a markedly different model of care in which "the connecting of home-based and wearable monitoring equipment will increasingly enable the NHS to predict and prevent events that would otherwise have led to a hospital admission"[86]. Patient-driven healthcare technology can take various forms.

[82] https://www.fda.gov/newsevents/newsroom/pressannouncements/ucm584933.htm
[83] https://www.rfidjournal.com/articles/view?11928
[84] https://www.zdnet.com/article/iot-and-the-nhs-why-the-internet-of-things-will-create-a-healthcare-revolution/
[85] https://www.techradar.com/uk/news/what-is-5g-everything-you-need-to-know
[86] https://www.longtermplan.nhs.uk/wp-content/uploads/2019/01/nhs-long-term-plan.pdf

Fitness trackers

There are many fitness trackers currently on the market[87]. All have different features but the same aim of offering wearable devices that can track an individual's health information. "Fitbits" track heart rate, different types of exercise and sleep, and calories burned[88]. Trackers are also becoming more medically sophisticated. Rooti Labs have developed biosensors that allow the wearer to find out more about their current health condition: the W/Me2 wristband tracks activity and biometric data; provides a relaxation program with breathing exercises; and uploads the data to healthcare providers for analysis and advice[89].

Monitoring systems

There are several monitoring systems currently available on the market for patients, which may be beneficial for people with specific medical conditions. Accurate Meditech provide a lightweight cell phone case called "AccuRate" that provides continuous monitoring, tracks early warning signs and reads blood pressure and heart rate vitals for people with hypertension[90]. Alivecor's Kardia Band allows medical-grade ECGs to be captured in just 30-seconds to detect if the heart rhythm is normal or if atrial fibrillation (AF) is present[91]. Abbott's FreeStyle Libre is a glucose monitoring system for diabetic patients comprised of a sensor applied to the skin and a reader that can scan, even over clothes, to display current glucose levels, levels over the previous 8 hours, and whether glucose levels are trending upwards or downwards (and how fast)[92]. Freestyle Libre 2 has Bluetooth as an addition, allowing the device to deliver alerts to the wearer when their glucose gets dangerously high or low[93].

Apps

These may be employed in tandem with the fitness trackers and monitoring systems, for example the Kardia App shows the ECG readings from the KardiaBand (Figure 24)[94] and the GoogleFit and Samsung Health apps can be synced to wearable devices to visually show the health information that has been recorded alongside other information that may have been entered into the app such as diet and exercise information[95]. Apps can also be used on their own to assess personal health

[87] https://www.telegraph.co.uk/recommended/leisure/best-fitness-trackers-watches/
[88] https://www.fitbit.com/uk/inspire
[89] https://www.rootilabs.com/#/about/brand
[90] https://www.wearable-technologies.com/2017/10/know-your-body-wearables-for-vital-sign-monitoring/
[91] https://www.theverge.com/2018/3/12/17109036/apple-watch-kardiaband-alivecor-ekg-reader-hyperkalemia-health-artificial-intelligence
[92] https://www.nice.org.uk/advice/mib110/chapter/The-technology
[93] https://www.mobihealthnews.com/content/abbott-gets-ce-mark-freestyle-libre-2-adds-bluetooth-real-time-alerts
[94] https://www.alivecor.com/how-it-works/
[95] https://www.samsung.com/global/galaxy/apps/samsung-health/

information. There are a wide variety of apps available over many different functions: Fitness22 and Runkeeper are used as running distance trackers; FitNotes and Strong Exercise Gym log can be used to store information about exercise routines that can be tracked over time; Leap Fitness Step Counter allows your steps to be tracked; and My Fitness Pal allows you to keep track of your diet and exercise regime over time[96].

Figure 24 - An example of how KardiaBand links with a smartphone app to provide visual patient information

Overall, these patient-driven technologies might increase awareness and the health of the population, reducing demand on the health service through early detection and prevention. Conversely, greater awareness and information might drive additional demand.

It is also important to consider linked ethical issues[97] such as the privacy and security of digital data; whether insurers, employers or others will seek to access such data to inform their decisions; the standards of these systems, if they are regulated or endorsed by the NHS and how this can be done is also important; and the ability of users to access and utilise this technology.

Big data

Big data refers to the vast quantities of information that are generated by digital technologies and how they can used to improve health and social care. Such data can contribute to clinical learning and service planning, disease prediction, the identification and subsequent management of at-risk populations and the identification of more efficient ways to utilise resources and target interventions. The Long Term Plan anticipates the linking of "clinical, genomic and other data to support the development of new treatments to improve the NHS, making data captured for care available for clinical research".

[96] https://www.androidauthority.com/best-fitness-tracker-apps-android-913959/
[97] http://futureadvocacy.com/wp-content/uploads/2018/04/1804_26_FA_ETHICS_08-DIGITAL.pdf

An example of the use of big data includes the use of new software that processes all free-text patient feedback (c. 20,000 patient comments a month) and groups it into themes in order to better identify and prioritise areas for improvement. This information, provided in near real-time, is then seen by frontline staff via data visualisations to allow them to improve the quality and safety of care in a timely manner based on current patients' needs[98].

Big data has also been used to:

- Help personalise the diagnosis and treatment of severe asthma. The Europe-wide research project improved understanding about the different types of severe asthma by processing large quantities of data with the aim of uncovering information that could lead to the creation of effective new treatments[99].
- 'The Care Information Exchange programme', an innovative system that allows patients across North West London to access their clinical records and securely exchange the data with their care teams[100].

The ability to use big data in a predictive setting could revolutionise prevention and ultimately impact service delivery.

There are questions however about who will own data, who will be able to access it and how associated security issues can be managed. In the 'Care Information Exchange programme', for example, patients are placed at the centre of how their data is used. Whether there will be an open access approach or whether data will be commoditised in different situations remains uncertain. There will also be an impact on the workforce as staff competencies and behaviours will be expected to adapt.

Digital patient records

The use of digital patient records has been widely discussed for some time, to better connect health and care services and to enable patients to become a more active and equal partner in their own care. The Long Term Plan outlines the need to "ensure that clinicians can access and interact with patient records and care plans wherever they are" and expects associated apps to be released that ensure all providers are advanced to a core level of digitalisation by 2024. The NHS app will also give

[98] https://www.imperial.nhs.uk/about-us/news/experts-explain-how-big-data-and-ai-will-help-patients
[99] https://www.imperial.ac.uk/news/173206/imperial-college-ahsc-seminar-series-kicks/; https://www.mdmag.com/medical-news/bringing-together-big-data-and-the-scientific-process-to-treat-asthma
[100] https://www.careinformationexchange-nwl.nhs.uk/

patients access to their GP record (a function already available through some other apps)[101]. The CEO of NHSX, has defined success as ''if in 2 years we have reduced the crazy amount of time that clinicians spend inputting and accessing patient information…and if we have started to build a system in which patient information can be securely accessed from wherever it is needed, ensuring safer and better care as patients move around the system, and saving patients from having to tell every doctor and nurse their story over and over again."[102]

There are uncertainties, about how effectively and consistently the records will be used, and, although timeframes have been discussed, how quickly and robustly they will be rolled out in practice. Data security is also a key issue and data breaches can happen. An NHS data breach in 2018 due to a coding error was believed to have affected 150,000 patients in England who had specifically requested that their confidential health information was only used to help provide them with care[103]. How patient and providers may respond to breaches in future remains uncertain: whether they accept the more open sharing of their data between providers and agencies or whether a stronger drive for privacy and control develops. Digital records could have a large impact on the workforce, generating better connections between health and social care services and enabling efficiencies in care provision, quality improvements, and, potentially, reduced demand on health and care services. On the other hand, patients having more access to their medical records may increase their health consciousness and subsequently increase demand.

Policy and economy

As well as the types of digital technology that will be available in the next 5-10 years, it is also important to consider what other factors will influence their availability to the NHS. Firstly, political decisions and economic factors can influence digital technology availability. Industrial policy could play a key role. The composition of both national and local industrial strategy (including actions undertaken by the West Midlands Combined Authority) could impact investment in digital technology and subsequently the availability for its use in the UK. The Government has formed an Artificial Intelligence Sector Deal to boost the UK's global position as a leader in developing AI technologies, and it has outlined its grand challenge to put the UK at the forefront of the AI and data revolution, with the first mission being to use data, artificial intelligence and

[101] https://www.digitalhealth.net/2018/02/nhs-england-digital-patient-services-plan/
[102] https://www.gov.uk/government/news/nhsx-digital-experts-will-be-part-of-cancer-and-mental-health-teams?utm_source=b6e824d5-8761-4f35-b88d-5c98eee168f4&utm_medium=email&utm_campaign=govuk-notifications&utm_content=immediate
[103] https://www.bbc.co.uk/news/technology-44682369

innovation to transform prevention, early diagnosis and treatment of chronic diseases by 2030[104]. There is also a plan to deliver a major upgrade to the UK's digital infrastructure with 5G networks that would facilitate advances in telemedicine and IoT delivery[105]. Such support for digital technologies could provide a springboard for its development, but the extent to which industrial policy support will change in the following 5-10 years, as political priorities and economic circumstances evolve, remains uncertain.

There may also be a global political dimension in relation to the control and security of devices and their data, with potential knock-on effects for the confidence and willingness that citizens have in using the technology. Levels of public engagement with digital technology could also vary across social groups, cultures and generations. The government has, however, showed further backing for digital technologies by outlining an education policy to allocate funding for specialist AI research including 1,000 PhDs to ensure that the UK is "the go-to destination for AI innovation and investment."[106]

The other important economic factor to consider is the amount of health and care funding available to support digital innovation.

Social attitudes

> *75% of people think it is likely that machines and computer programmes will definitely or probably do many of the jobs currently done by humans….. Just 10% of workers are "very" or "quite" worried that machines or computer programmes will replace their job, while 81% are "not very" or "not at all" concerned that they might lose their jobs.*[107]

The attitudes that people have towards digital technologies and whether people can use them will impact how effective digital technologies will be in the NHS.

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[104] https://www.gov.uk/government/publications/artificial-intelligence-sector-deal; https://www.gov.uk/government/news/tech-sector-backs-british-ai-industry-with-multi-million-pound-investment--2

[105] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf; https://www.gov.uk/government/publications/forging-our-future-industrial-strategy-the-story-so-far/forging-our-future-industrial-strategy-the-story-so-far

[106] https://www.gov.uk/government/publications/forging-our-future-industrial-strategy-the-story-so-far/forging-our-future-industrial-strategy-the-story-so-far

[107] http://www.bsa.natcen.ac.uk/media/39284/bsa35_full-report.pdf

Trust

Trust in experts plays a key role. The level of trust in official and expert opinions and guidance may impact how willing patients will be to utilise digital technologies. This will depend on whether patients place more trust in their doctors and healthcare professionals, their friends and family or what they hear in the media or on internet platforms such as Google. The Edelman Trust Barometer (2019) survey of 2,350 British people found that 60% trusted traditional media (broadcasters and publishers) as a source for general news and information, 1% down from 2018 but the second highest level since 2012. Their trust in online-only media (including Buzzfeed and Huffington Post) also decreased by 4% from 2018-2019 to 41%. Alternatively, trust in social media increased by 5% from 2018-2019 to 29% as well as trust in search engines which rose by 8% from 2018-2019 to 55% (Figure 25)[108]. The 2018 survey also found that 53% of British people said they were worried about being exposed to fake news on social media[109].

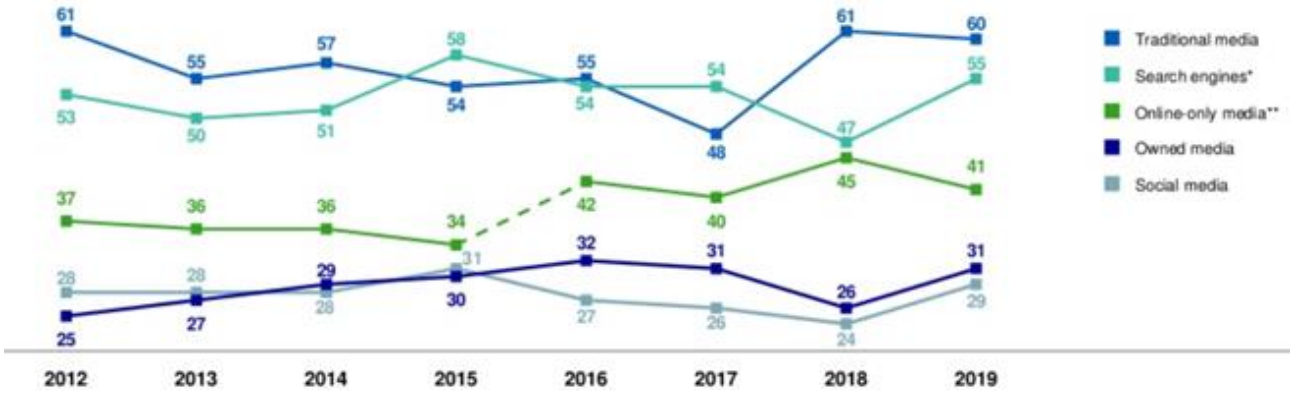

Figure 25 - Edelman Trust Barometer UK findings (2019)

Acceptability

Patient expectations about what digital technology should achieve is also important, as this could put pressure on innovation companies and the NHS to deliver what patients want. Research has shown that patients want to take control of their healthcare data[110], with more people accessing their electronic health record (EHRs), from 9% in 2014 to 13% in 2016. At the same time, the use of health apps has vastly increased, trebling from 13% in 2014 to 36% in 2016, as has the use of health wearables, from 6% in 2014 to 20% in 2016. The use of social media for health management also increased from 9% in 2014 to 21% in 2016. Patients and physicians disagreed over what patients should have access to in their EHR, as 81% of patients believed they should have full access to their

[108] https://www.slideshare.net/Edelman_UK/edelman-trust-barometer-2019-uk-results-132908642
[109] https://www.campaignlive.co.uk/article/trust-traditional-media-grows-uk-a-nation-news-avoiders/1455095
[110] https://www.accenture.com/t00010101T000000Z__w__/gb-en/_acnmedia/PDF-27/Accenture-Patient-Engagement-Survey-Infographic-UK.pdf

records, while only 22% of physicians shared this belief (Figure 26). However, both English patients (65%) and doctors (86%) agreed that using wearables helped a patient engage in their health. A 2018 poll asking the public whether NHS or commercial organisations should be allowed to access lifestyle data collected via and app or fitness trackers, found that most (57%) were in favour of allowing access to NHS organisations if it is ultimately used for delivering care. There was more opposition towards commercial organisations gaining access to health data which is routinely gathered by the NHS (Figure 27). The poll also collected about their views on machine learning technologies, finding a high level of scepticism about the benefits of a range of machine learning possibilities. A significant minority (44%) thought that the benefits of computers analysing medical records in diagnosing patients would outweigh the risks but 29% felt that the risks were bigger than the benefits[111].

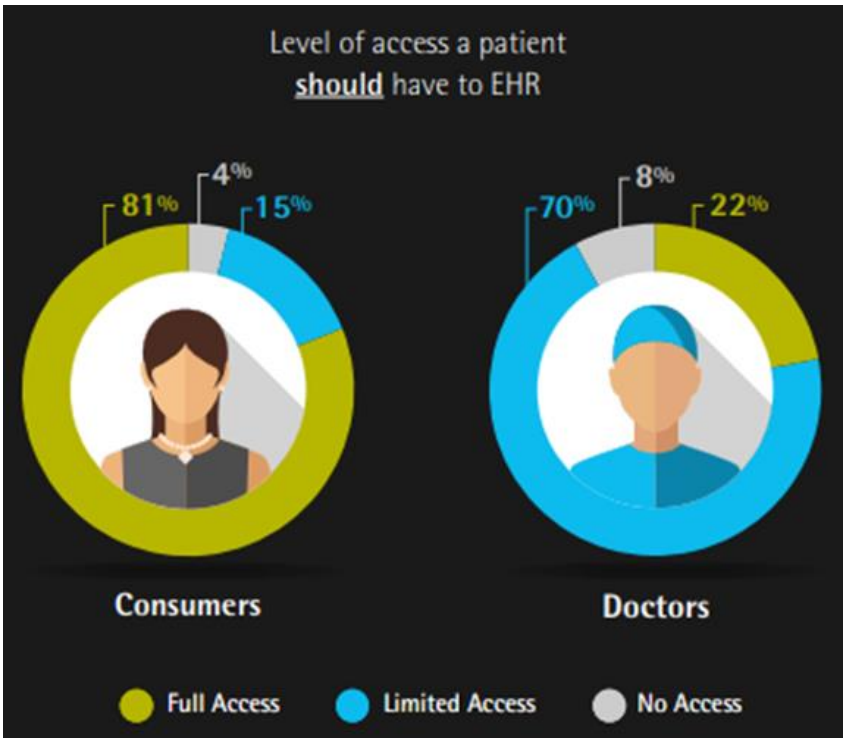

Figure 26 - Difference between patients' and doctors' views on access to EHRs (Accenture 2018)

Changing attitudes around the responsibility for preventing ill-health and providing self-care and self-management of health conditions will impact the popularity of utilising many of these digital technologies and subsequently impact the demand and need for them in future. If there is a trend towards expecting that services should deal with the effects of individuals' choices, this could reduce the need for and reduce the subsequent availability of digital technologies.

[111] https://www.health.org.uk/sites/default/files/NHS%20at%2070-Public-perceptions.pdf

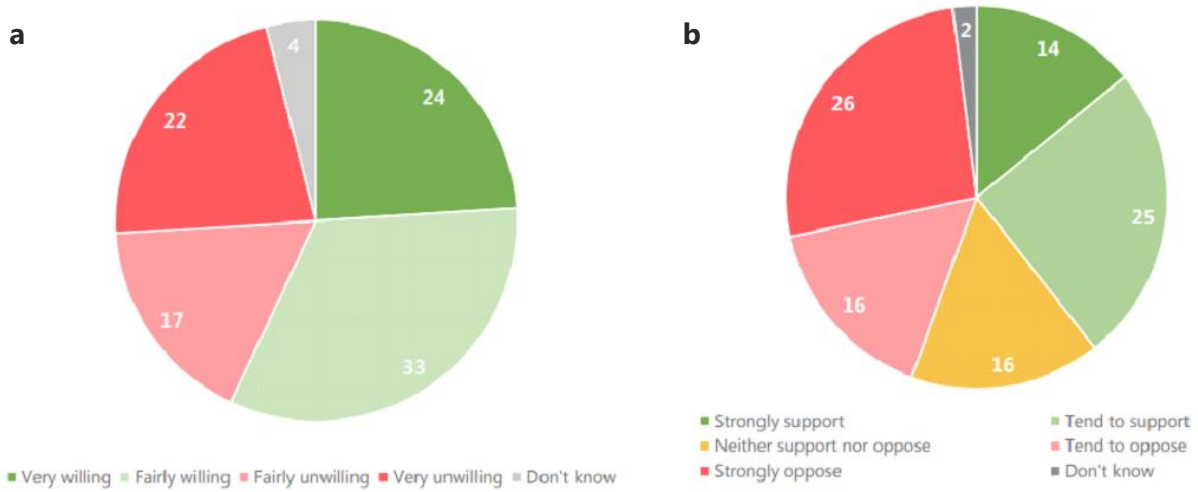

Figure 27 - Willingness to share lifestyle data collected via and app or fitness trackers with NHS organisations (a) or commercial organisations (b) (Ipsos MORI 2018)

National surveys reveal that:

- Over 40% of people want to be more involved in decisions about their care, which has remained largely unchanged over the past 10 years;
- 40% of people living with long term conditions want more support to manage their health and wellbeing on a day to day basis[112];
- 97% feel that individuals have a 'great deal' or 'fair amount' of responsibility for ensuring that they stay healthy; and
- 75% also placed similar levels of responsibility on the food and drinks industry[113] (Figure 28).

Staff and patient attitudes to using digital technologies could impact the need for and subsequent availability of digital technologies, the deliverability of new care models, the shape of workforce roles and the attractiveness of those roles to staff.

In respect of online consultations, 63% of respondents would be willing to have a video consultation with their GP for advice on a minor ailment, 55% for advice on an ongoing problem or condition and 43% for immediate or emergency medical advice[114] (Figure 29). Similar results were also found when respondents were asked if they would use video consultations with a previously unknown GP. A survey of 500 UK adults revealed that the security of the NHS systems raised the biggest concern for

[112] https://www.england.nhs.uk/wp-content/uploads/2017/04/ppp-involving-people-health-care-guidance.pdf
[113] https://www.ipsos.com/sites/default/files/2018-07/public-perceptions-of-the-nhs.pdf
[114] https://www.kingsfund.org.uk/sites/default/files/2018-06/NHS_at_70_what_will_new_technology_mean_for_the_NHS_0.pdf

87% of people. Of those respondents who said they had worries about cyber security within the NHS, 34% stated they were 'very concerned' about this[115].

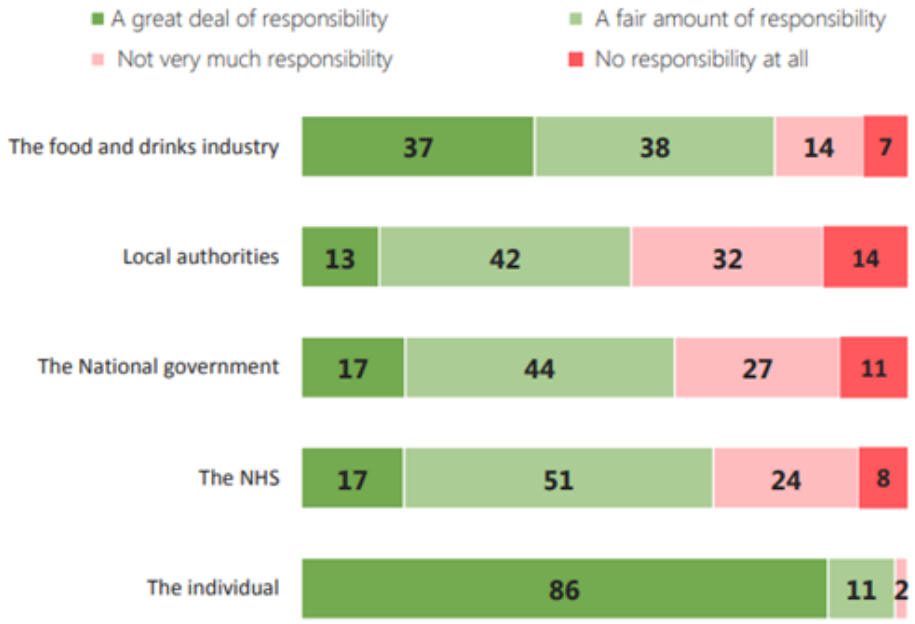

Figure 28 - Responsibility for ensuring that people generally stay healthy (Ipsos MORI 2018)

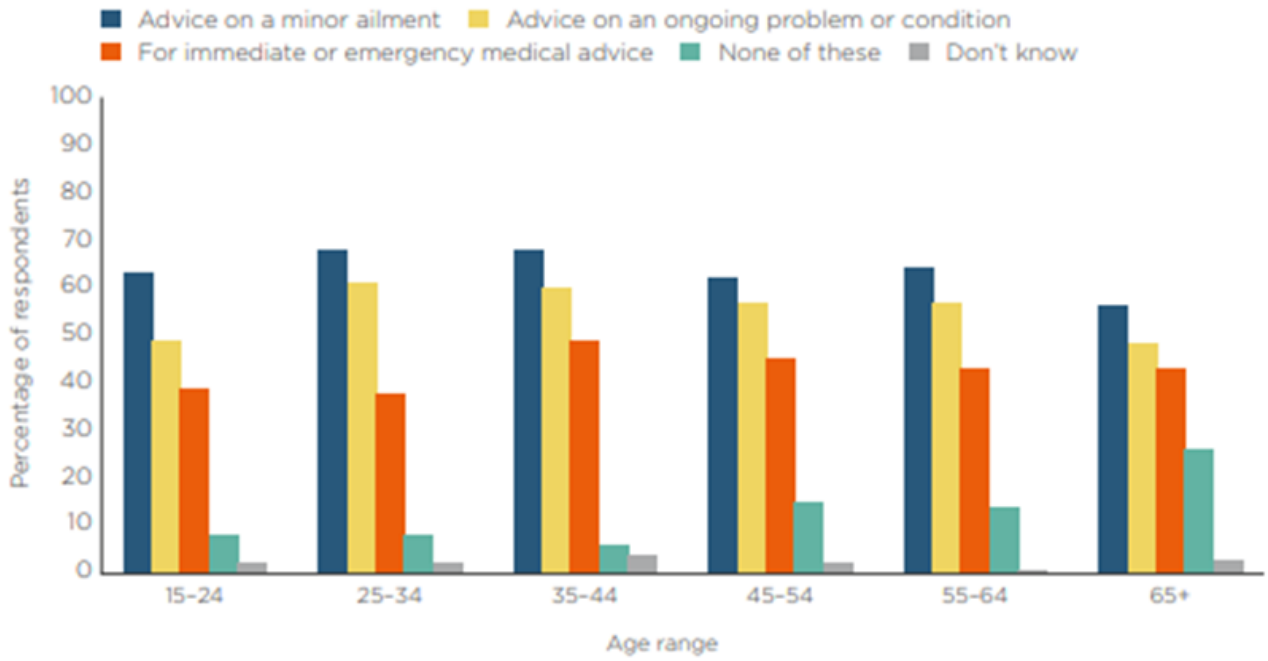

Figure 29 - Public willingness to use video consultations with their own GP (Ipsos MORI)

[115] https://www.openaccessgovernment.org/british-adults-concerned-nhs-data-security/42936/

Levels of deprivation impact equality of access to digital technologies. Willingness to use video consultations, for example, varies across income groups: 71% of those in households earning over £25,000 per annum were willing to use a video consultation with a GP they knew for advice on a minor ailment, compared with 60% of those in a household earning between £11,500 and £24,999 and 54% of those in households earning less than £11,500[116]. There could also be a knock-on effect on whether patients will be able or willing to comply with the expectations of them in new models of care, for example regarding accessing care, prevention, self-care and the provision of new clinical roles. These issues can be mitigated: an innovative digital outreach project in Hastings has helped 122 homeless people access medical treatment through health-information websites[117].

Over 25% of over 65s report that they would not want a video consultation with their GP compared to around 10% of all other ages for advice on a minor ailment, advice on an ongoing problem or condition or for immediate or emergency medical advice[118]. Support or training may be needed to increase engagement. Age UK South Tyneside has an Online Centre that supports older people to improve their health and wellbeing through different methods, including the use of technology[119].

[116] https://www.kingsfund.org.uk/sites/default/files/2018-06/NHS_at_70_what_will_new_technology_mean_for_the_NHS_0.pdf
[117] https://digital.nhs.uk/news-and-events/latest-news/digital-inclusion-project-brings-healthcare-technology-to-the-homeless
[118] https://www.kingsfund.org.uk/sites/default/files/2018-06/NHS_at_70_what_will_new_technology_mean_for_the_NHS_0.pdf
[119] https://digital.nhs.uk/about-nhs-digital/our-work/digital-inclusion/who-to-work-with

5. What clinical advancements might be made?

In this section, some key areas of potential advancement are highlighted, alongside factors that may influence the development and deployment of medical technologies, techniques and treatments.

Personalised medicine

Genome sequencing, gene editing and gene re-writing can increase the personalisation and targeting of interventions as well as the prediction and elimination of disease. These could become widely available or remain limited to a minority or applications or individuals. If these techniques do become more routine, they could impact the prevalence of certain conditions, affecting the scale and nature of the demand for services. The workforce may need to change to acquire more skills specific in these areas or the prevalence of certain specialities may need to increase to meet demand, such as of bioinformaticians or genetic counsellors.

Gene sequencing

Personalised medicine is the ability to target interventions, and it includes genomics and gene editing. Scientific understanding of the human genome has grown rapidly over the past 20 years. The first complete human genome was sequenced just 15 years ago. There is now a growing ability to sequence genomes more quickly and much more economically with the help of advancements such as next generation sequencing technology[120]. Ongoing innovation in this area might be expected to extend these operational and financial benefits[121]. The Long Term Plan sets an aim for the NHS to be "the first national health care system to offer whole genome sequencing as part of routine care". The NHS Genomic Medicine Service is expected to sequence 500,000 whole genomes by 2023/24, with early priority being given to adult and children cancers, and those who are seriously ill or have rare conditions. If genomic screening becomes routine, this could allow diseases to be detected early, managed or eliminated. If screening revealed the presence of the BRCA gene mutations, for example, a person may opt for an early mastectomy to vastly reduce their risk of developing breast cancer[122].

[120] https://www.genome.gov/27565109/the-cost-of-sequencing-a-human-genome/
[121] https://www.nuffieldtrust.org.uk/files/2018-06/1530028974_the-nhs-at-70-what-will-new-technology-mean-for-the-nhs-and-its-patients.pdf
[122] https://www.nhs.uk/conditions/predictive-genetic-tests-cancer/

Gene editing

Using new methods such as CRISPR technology, "problem" genes can be isolated and either modified or removed to eliminate conditions. Ethical issues are raised by genome editing but trials have shown great progress. The CRISPR-cas9 gene-editing technique can be used to repair faults in DNA that can cause an often-fatal heart condition called hypertrophic cardiomyopathy (Figure 30)[123].

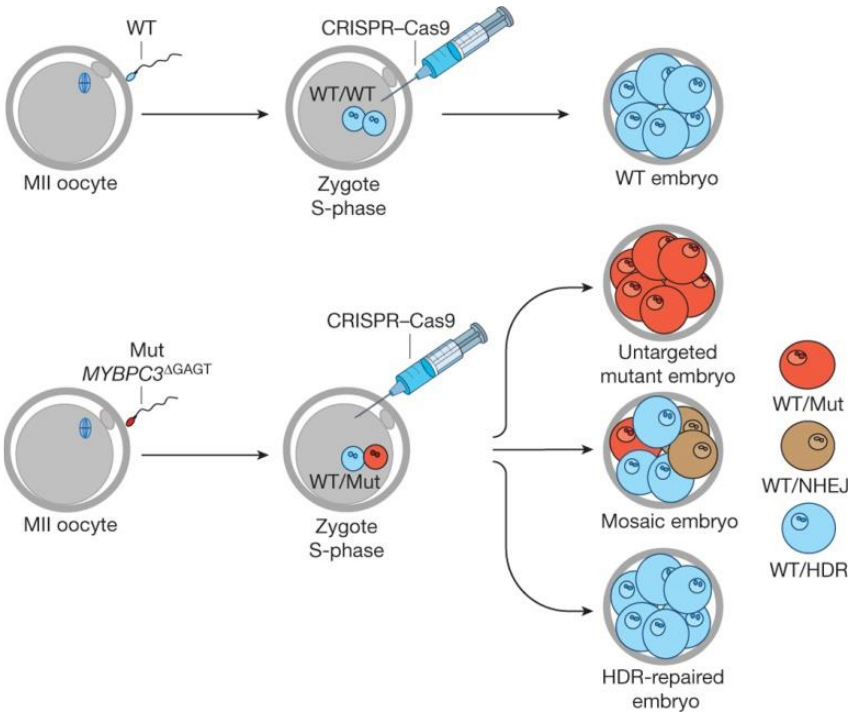

Figure 30 - Gene correction in S-phase-injected human embryos

Gene re-writing

More comprehensive editing could be achieved: 'Project Recode' is a proposal to build entire artificial human genomes, with significant potential for treating diseases and for creating bioengineered cells or organs (though securing funding has been difficult)[124].

Projects involving creating individual human cells that are invulnerable to infection have been approved for funding. These projects involve re-writing certain genes[125] and would enable the production of drugs, vaccines, and antibodies without the risk of viral contamination, lowering the risk of a person's immune system rejecting new drugs. As technology continues to advance over the

[123] https://www.nature.com/articles/nature23305?foxtrotcallback=true; https://www.nhs.uk/news/genetics-and-stem-cells/gene-editing-used-repair-diseased-genes-embryos/
[124] https://www.nature.com/articles/d41586-018-05043-x
[125] https://wyss.harvard.edu/harvards-wyss-institute-partners-with-cellectis-to-recode-the-human-genome/; https://www.wired.com/story/live-forever-synthetic-human-genome/

coming 5-10 years, the prospects for re-writing and creating "perfect" segments of the human genome could be realised.

New treatments and technologies

It is possible to identify treatments and technologies that are likely to play a part in future healthcare provision. What remains uncertain is likely the scale of their impact, and the further treatments and technologies that may emerge. Some advancements enhance the quality or efficiency of existing treatment approaches; others introduce entirely new approaches. Existing roles or specialities could become redundant, and new specialisms may be required. There may be a need to attract staff from technical backgrounds that have not generally been linked with front-line healthcare. New advancements could widen the gap between what is possible and what can be afforded by the NHS, meaning some individuals may be unable to access potentially life-changing treatments. It is also uncertain how quickly these advancements will continue to develop, and whether they will be adopted routinely by the NHS. Will patient and clinicians necessarily welcome all the possibilities that science generates, and how will citizens and politicians respond to the ethical issues that may be raised?

Robotic surgery

There has been a growing use of robots in surgery over the past 40 years, with the first robot to assist in surgery being the Arthrobot, developed and used for the first time in orthopaedic surgery in Vancouver in 1983[126]. Since then, other milestone advancements have been made, including for example the da Vinci surgical system, released in 2000, that allows surgeons' hand motions to be translated into smaller, more precise robotic movements. Future advancements may focus on open consoles, lighter instruments, greater portability and automation. In 2016, the Smart Tissue Autonomous Robot (STAR) was able to suture the bowels of a pig better than a human hand by amalgamating 3-D imaging and sensors[127].

Nanotechnology

Nanotechnology incorporates the use of extremely small robots, "nanobots", that are small enough to be injected in the bloodstream and carry out duties in the body. The technology is still under development, but in 2018 scientists from China's National Centre for Nanoscience and Technology (NCNT) and Arizona State University said they had developed nanobots that could shrink tumours by

[126] https://www.brianday.ca/imagez/1051_28738.pdf
[127] https://spectrum.ieee.org/the-human-os/biomedical/devices/in-fleshcutting-task-autonomous-robot-surgeon-beats-human-surgeons

blocking their blood supply[128]. In 2019, researchers at Indiana University School of Medicine and the University of Maryland had used nanotechnology to kill cancerous cells in triple negative breast cancer[129]. Other future applications could include the delivery of drugs to specific parts of the body, disease monitoring, and finding and eliminating damaged tissues, cancers and plaques in blood vessels.

Stem cells

Stem cells are unspecialised cells that, when maintained in specific conditions, have the ability to become any type of specialised cell. They have the potential to be used to repair damaged parts of the human body. Trials in Australia have shown that stem cells can reduce the extent of brain injury and improve recovery after stroke[130], and researchers at Tufts University School of Medicine have developed a method of growing and maintaining olfactory stem cells in culture, for use in restoring nasal tissue[131]. Other research has been able to transform stem cells into glucose-sensing, insulin-secreting beta cells, curing type 1 diabetes in mice[132].

3D printing

3D printing offers the potential to print aids for patient treatment or recovery; biological tissues, replicas for use in surgical training; and surgical instruments. Customised 3D printed fingerboards can aid limb rehabilitation in cerebral stroke patients through preventing and treating their finger spasms[133]. There is also a bioprinting process that converts cells from donor organs into a printable bio-ink: layers of cells can then be laid down to create small sections of liver tissue[134]. In future, it may be possible to 3D print entire organs, reducing the need for donors and making them more personalised to specific patients.

New medicines

The creation of new medicines could impact the treatments of many conditions. One new drug under development has been shown to reduce the blood pressure of patients, the precursor to strokes,

[128] https://www.nbcnews.com/mach/science/these-tiny-robots-could-be-disease-fighting-machines-inside-body-ncna861451
[129] https://www.technologynetworks.com/genomics/news/nanotechnology-approach-for-treating-aggressive-breast-cancer-317153
[130] https://www.sbs.com.au/news/vic-stem-cell-trial-to-aid-stroke-patients
[131] https://phys.org/news/2019-03-cultured-stem-cells-reconstruct-sensory.html
[132] https://www.novonordisk.com/about-novo-nordisk/perspectives/the-exciting-potential-of-stem-cell-research.html
[133] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6019708/
[134] https://www.ft.com/content/67e3ab88-f56f-11e7-a4c9-bbdefa4f210b

who do not respond to traditional medications[135]. Fevipiprant can reduce the number of inflammatory cells and muscle mass in asthma sufferers, reducing their risks of suffering from an asthma attack and reducing their dependency on steroids[136].

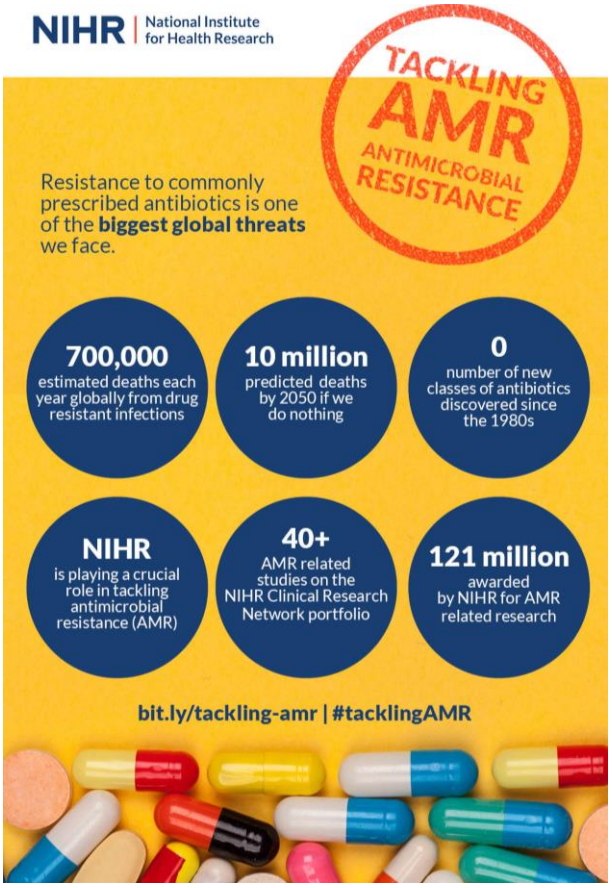

Figure 31 - NIHR campaign poster - "Tackling AMR"

Anti-microbial resistance

Growing concerns about the pace of change in anti-microbial resistance have prompted desires to investigate and find new treatments to combat drug-resistant bacteria. Without these, the impact on patient mortality and morbidity could be very significant, as could the resulting demand on clinical services. The UK Government states that at least 20% of antibiotic prescriptions in primary care are inappropriate, and highlights the risks associated with such behaviours:

The rise and spread of antimicrobial resistance is creating a new generation of 'superbugs' that cannot be treated with existing medicines. Already, the organisms that cause many common diseases such as tuberculosis, HIV/AIDS, malaria, sexually transmitted diseases, urinary tract infections, chest infections, bloodstream infections and food poisoning, can resist a wide range of antimicrobials. Some cases of tuberculosis and gonorrhoea are already resistant to antibiotics of last resort. For most antimicrobials, there are few replacement or alternative products in the development pipeline. The impacts of unchecked antimicrobial resistance are wide-ranging and extremely costly, not only in financial terms, but also in terms of global health, food security, environmental wellbeing, and socio-economic development. Already, antimicrobial resistance is estimated to cause at least 700,000 deaths around the world each year. [137]

[135] https://www.theadvocate.com/new_orleans/entertainment_life/health_fitness/article_74f40e1c-4b6d-11e9-aa28-bb38dda6f6db.html

[136] https://theconversation.com/a-new-drug-promises-to-lower-risks-of-asthma-attack-112125

[137] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/773065/uk-20-year-vision-for-antimicrobial-resistance.pdf

The Long Term Plan sets out to "continue to optimise use, reduce the need for and unintentional exposure to antibiotics, as well as supporting the development of new antimicrobials." Researchers at Oregon State University have found that new antibiotics could be developed using the layer of mucus that coat the outer surface of young fish. Bacterial strains in swabs taken from 17 fish species were able to tackle the methicillin-resistant *Staphylococcus aureus* or MRSA and a small proportion could also tackle E coli[138].

Policy and economics

Clinical advancements occur in a context significantly influenced by policy decisions and economic factors. The UK industrial strategy, for example, includes a Life Sciences Sector Deal that focuses on ensuring new pioneering treatments and medical technologies are produced in the UK, improving the lives of patients and economic growth. This incorporates over £1.5 billion co-investment in long-term medical challenges and early diagnostics and precision medicine and to speed up the approval for clinical trials. It also aims to offer a Digital Health Catalyst, £35 million funding over 4 years, to encourage small to medium sized enterprises to work with the NHS to develop new technologies and to create a new research and development hub[139]. The maintenance and effectiveness of such political interventions is necessarily uncertain. The affordability of new advances is likely to remain a key question, in which trade and tariff policy may also play a part.

Social attitudes

Trust in experts

To what extent will individuals trust official and expert guidance in connection with medical technologies and treatment? A 2016 ComRes survey of 2,041 British people for the Academy of Medical Sciences[140] found that:

- *Fewer than four in ten (37%) say they would trust data from medical trials, placing it in the middle of the types of evidence tested.*
- *When thinking about the long term prescription of medicine, 90% of British adults agree that they would feel confident asking their doctor for more information if they needed it, and 82% agree that they would trust their doctor to decide on the best medicine for them …… 71% also agree that they would want to read up on the medicine and make their own decision about*

[138] https://www.theguardian.com/society/2019/mar/31/new-antibiotics-could-be-developed-using-fish-slime-scientists-say
[139] https://www.gov.uk/government/publications/forging-our-future-industrial-strategy-the-story-so-far/forging-our-future-industrial-strategy-the-story-so-far
[140] https://acmedsci.ac.uk/file-download/59091244

whether they want to take it – suggesting that stated trust in their doctor to decide what's best is somewhat mitigated by a wish to be informed.

- *82% of GPs and 67% of British adults agree that clinical trials research funded by the pharmaceutical industry are often biased to produce a positive outcome.*
- *40% of GPs choose assessments of medical evidence carried out by government agencies as the most trustworthy, compared to only 12% of British adults who say the same.*

Patients expectations

A survey of 2000 UK adults by NIHR found that only 14% of people have ever taken part in a clinical trial although 85% say that they want to help the NHS to find better treatments. The survey also revealed that 70% of adults think the public should have a say in decisions around what research receives funding, with their top priorities being cancer, Alzheimer's and dementia, and genetic diseases (Figure 32)[141].

The public also has expectations about who should benefit from clinical advancements. An IpsosMORI survey with the King's Fund found that 67% of people think that treatments and services should only be available on the NHS if they are available to everyone and not dependent on where people live, whereas 31% think that

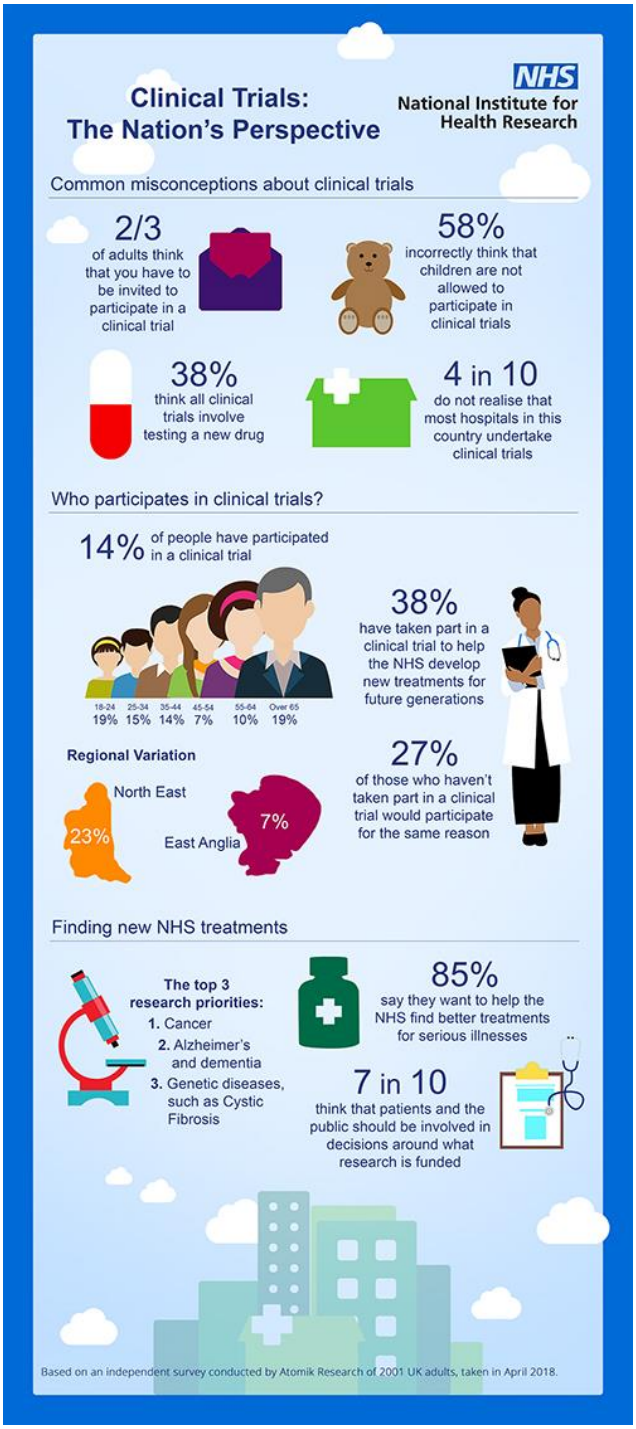

Figure 32 - NIHR clinical trials survey

[141] https://www.nihr.ac.uk/news/public-urged-to-take-part-in-clinical-research-to-find-new-nhs-treatments/8549

treatments and services should be based on local need[142]. This highlights that engaging with the public may be important when making decisions about clinical advancements.

Another key expectation that will affect how well clinical advancements are received and subsequently used regards staff and the general public's openness to the technology. These views could impact the deliverability of new care models, and the attractiveness of workforce roles to staff and the shape of workforce roles.

[142] https://www.kingsfund.org.uk/publications/what-does-public-think-about-nhs

6. How might citizen expectations evolve?

There is a wide variety of patient expectations that could impact the delivery of health and care services in the future, including what is expected of the workforce. Citizen and workforce expectations may not necessarily always be in alignment – perhaps because of the cost involved or the lack of a workforce willing to meet specific population needs. Many of these factors feature in other sections of this analysis, and they relate to expectations concerning:

- Public and patient involvement in the design and delivery of services and care plans;
- The personalisation of health and care services;
- Interactions with NHS staff – the nature of the power relationship, the accessibility of clinicians in specific roles, whether patients are 'done to' or done with';
- Whether quantity or quality of life is preferred. A 2011 survey of 9,344 people from England, Germany, The Netherlands, Portugal, Spain and Italy found that most respondents would value quality of life over its duration if faced with an untreatable serious illness[143];
- Where care should be delivered, including the proximity to home of specific types of services;
- How they respond to lifestyle advice and guidance – whether this is welcomed or seen as an intrusion;
- Contributing to the maintenance and development of social capital – for example, through participating in voluntary and community sector activities or other neighbourhood activities;
- Career preferences, particularly stability or flexibility in employment, and the image of health and care careers;
- The acceptability of new technology, including attitudes to data security and sharing, responses to machine errors, and the contexts in which (even though more efficient and/or effective non-human provision may be available) human interaction is held to be critical;
- The scope of services across health and social care that should be provided for free at the point of need, including how 'need' is determined; and
- The amount of financial resource citizens are willing to commit to health and/or care services – through investing in a healthier lifestyle, through accessing private health and care services, or through willingness to support higher taxation.

[143] https://blogs.bmj.com/spcare/2011/03/29/individuals-place-greater-value-on-quality-than-quantity-at-end-of-life/

The 2019 British Social Attitudes survey found that:

> *People increasingly want a new spending settlement on public services and expect employers to pay wages that cover the basic cost of living. Most people feel the NHS has a major funding problem and a large proportion want to see the minimum wage increased.*[144]

In a 2017 survey[145], that included a focus on the NHS, it was found that:

- Satisfaction with the NHS remains high, the leading reasons for which are quality of care, being free at the point of use and having a good range of services and treatments (see Figure 33);
- 93% felt the NHS had a funding problem, with a third of them believing that problem to be severe;
- 42% expressed a willingness to pay more tax, with around a quarter supporting a separate tax for the NHS);

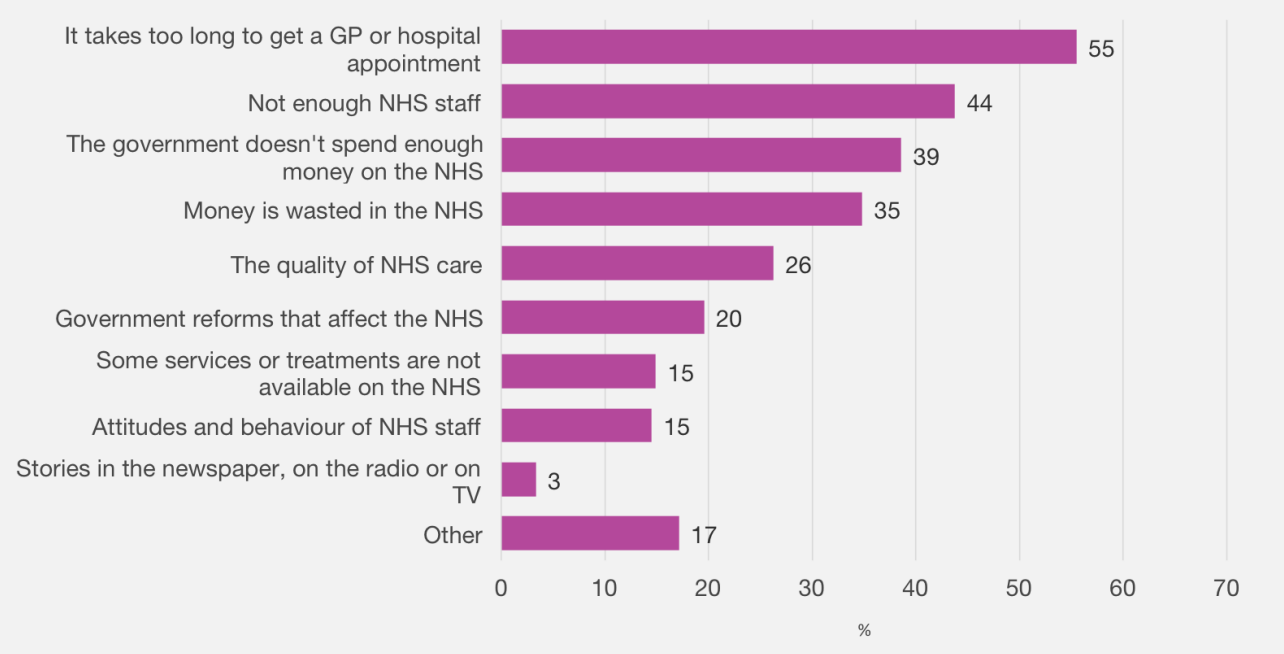

Figure 33 - Reasons for dissatisfaction with the NHS

- Around three quarters of the population consistently continue to oppose the suggestion that the NHS should only be for those on lower incomes; and

[144] http://bsa.natcen.ac.uk/media/39285/bsa35_key-findings.pdf
[145] http://bsa.natcen.ac.uk/media/39062/bsa33_nhs.pdf

- To cope with excess demand, 4 in 10 people would prefer the NHS to stop providing treatments that are poor value for money, and 1 in 4 would limit access to non-emergency treatments.

A 2017 Ipsos MORI survey found similar results regarding taxation, with 66% of the general public saying that they personally, not taxpayers in general, would be willing to pay more taxes to maintain the current level of service in the NHS[146]. Other relevant surveys reveal that:

- The general public are more receptive to public health interventions than the government assume. 54% of survey participants said that they 'strongly supported' or 'tend to support' a minimum unit price for alcohol and 70% indicated they 'strongly supported' or 'tend to support' limiting fast food outlets near schools. There was also net support for other measures which are yet to be introduced, such as banning junk food advertising before 9.00pm on TV (Figure 34)[147].

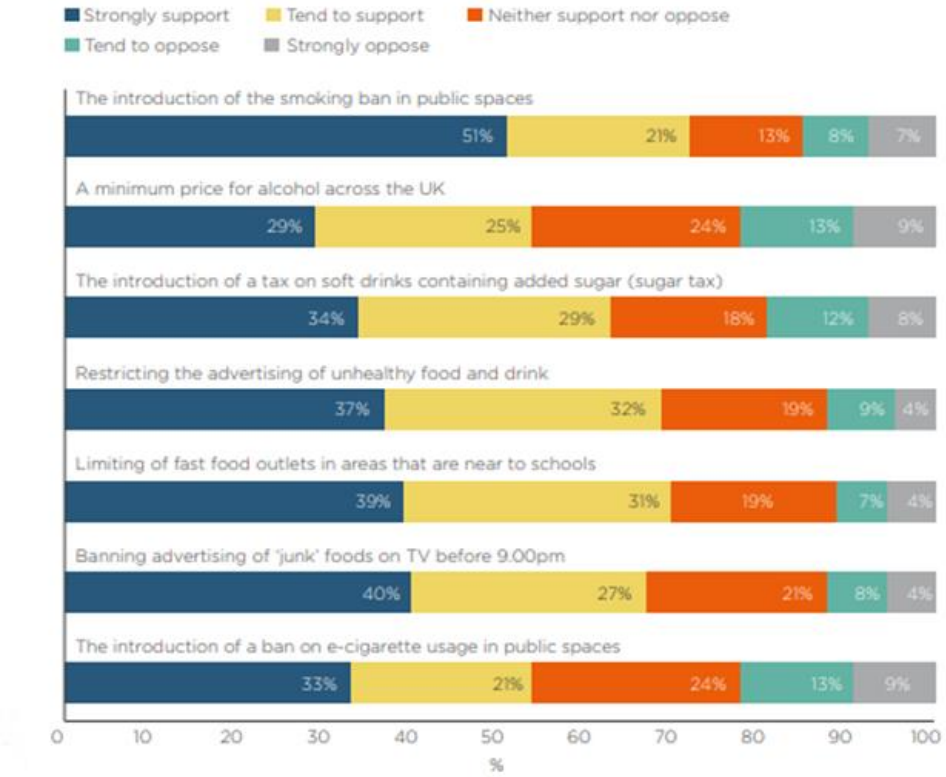

Figure 34 - Support for public health interventions (Health Foundation, Institute of Fiscal Studies, The King's Fund and Nuffield Trust, 2018)

[146] https://www.kingsfund.org.uk/publications/what-does-public-think-about-nhs
[147] https://www.nuffieldtrust.org.uk/files/2018-06/nhs-at-70-are-we-expecting-too-much-from-the-nhs.pdf

- The public has sympathy with the NHS, as they blame political involvement on reducing stability in the NHS with *"constant political interference and reorganisation wasting time and resource"*[148]; and
- Some of the general public are willing to accept the reality of scarce resources for the NHS, but only to a limited extent. For example, some would be willing to delay treatment for certain procedures for people who are overweight or who smoke[149].

The changing size, age, social or ethnic make-up of the population may influence how citizen attitudes and expectations evolve. A King's Fund analysis of generational differences in patient expectations found a marked difference in rates of satisfaction with the NHS between those over 65 and those under 65 (Figure 35), suggesting that the pre-war generation are most likely to be satisfied with the NHS, whereas the baby boomer generation (1945-1965) will be more demanding and generally more economically wealthy in retirement.

Pre-war	'Make do or do without' 'Stay in line' 'Be heroic'
	Jobs for life, traditional patterns of marriage
	More likely to be satisfied with NHS services
Baby Boomers	'Be anything you want to be' 'Change the world' 'Work well with others'
	Relatively well-off property owners
	Eternal youths - retirement as freedom
Generation X	'Don't count on it' 'Heroes don't exist' 'Take care of yourself' 'Always ask why'
	Importance of work-life balance
	Financial anxiety - what will retirement hold?
Generation Y	'You are special' 'Connect 24/7' 'Achieve now!'
	Technologically savvy
	Goal and achievement-orientated

Figure 35 - Generational differences in patient expectations from market and workforce research (King's Fund)

Ipsos MORI and British Social attitudes data shows that younger generations are generally less supportive of welfare investment[150]. An Ipsos MORI survey in 2017 showed that younger people were more likely to say that we must do everything we can to maintain the NHS (81% of 15–34 year-olds said this best reflected their thinking compared to 74% of those aged 55+) and that the NHS should definitely provide a comprehensive service to everyone (71% of 15–34 year-olds compared to 62%) of those aged 55+). Younger people were also less likely to believe that responsibility for health lies

[148] https://www.kingsfund.org.uk/blog/2017/08/great-expectations-changing-nature-publics-relationship-nhs
[149] https://www.nuffieldtrust.org.uk/files/2018-06/nhs-at-70-are-we-expecting-too-much-from-the-nhs.pdf
[150] https://www.kingsfund.org.uk/projects/time-think-differently/trends-public-attitudes-expectations-generational-differences

with the individual compared to those aged 55+[151]. What cannot be known, of course, is how the attitudes of a particular generation will change as it ages. Future generations may experience reduced financial security through a combination of factors such as weaker economic growth, increased house prices, less secure employment and student debt. Will this lead to greater social solidarity or an increasing prioritisation of one's own needs and wants?

How will the UK's ethnic mix change over the next 10 years, either through migration or birth rates, and how might this affect the prevailing attitudes, ethics and behaviours in UK society? Research by the King's Fund and Ipsos MORI based on interviews with 1,151 patients found that 28% of black and minority ethnic participants (BAME), compared with 12% of white participants, want the general public to be much more actively involved in shaping decisions about the availability of NHS treatments and services[152]. Other research with patients in the South East found that white British people had significantly higher overall realistic expectations of their care than those in black and ethnic minority groups, but white British individuals were more likely to believe that their high expectations were being met[153].

Another factor that could influence patient expectations relates to deprivation and inequality. Those who are more deprived and face more financial hardship may have generally lower expectations of the scope of NHS services and what healthcare professionals can do, but they may be more reliant on healthcare professionals to attend to their needs. For example, a qualitative interview study of 34 UK GPs has shown that individuals in more deprived areas were less well educated about health and therefore wanted more GP consultations for minor illness, suggesting that these patients will have higher expectations on GPs to sort their health problems rather than relying heavily on self-management. Meanwhile, more affluent patients had higher expectations and potentially higher levels of anxiety. They sought more consultations and were sometimes described as having unreasonable demands[154].

[151] https://www.kingsfund.org.uk/publications/what-does-public-think-about-nhs
[152] https://www.kingsfund.org.uk/publications/what-does-public-think-about-nhs
[153] https://journals.sagepub.com/doi/10.1258/jrsm.2012.120147
[154] https://bjgp.org/content/bjgp/early/2017/01/16/bjgp17X688849.full.pdf

7. How might population health needs change?

Future clinical services, and the workforce required to deliver them, will need to respond to the changing health needs of the Black Country population, and how the nature and scale of the burden of disease evolves.

The Black Country has various levels of disease burden relative to the West Midlands region overall (Table 2)[155]. Sandwell has the highest number of indicators that are worse than the West Midlands average (indicating higher levels of disease burden), meanwhile Dudley has the least. England disease burden projections suggest that, for example, diabetes will increase by approximately 26% (3.9 million to 4.9 million) between 2017-2035. Moreover, smoking is projected to decrease, alcohol consumption is expected to remain stable, high blood pressure prevalence is expected to decrease slightly and obesity is expected to increase slightly between 2016-2023 (Figure 36)[156].

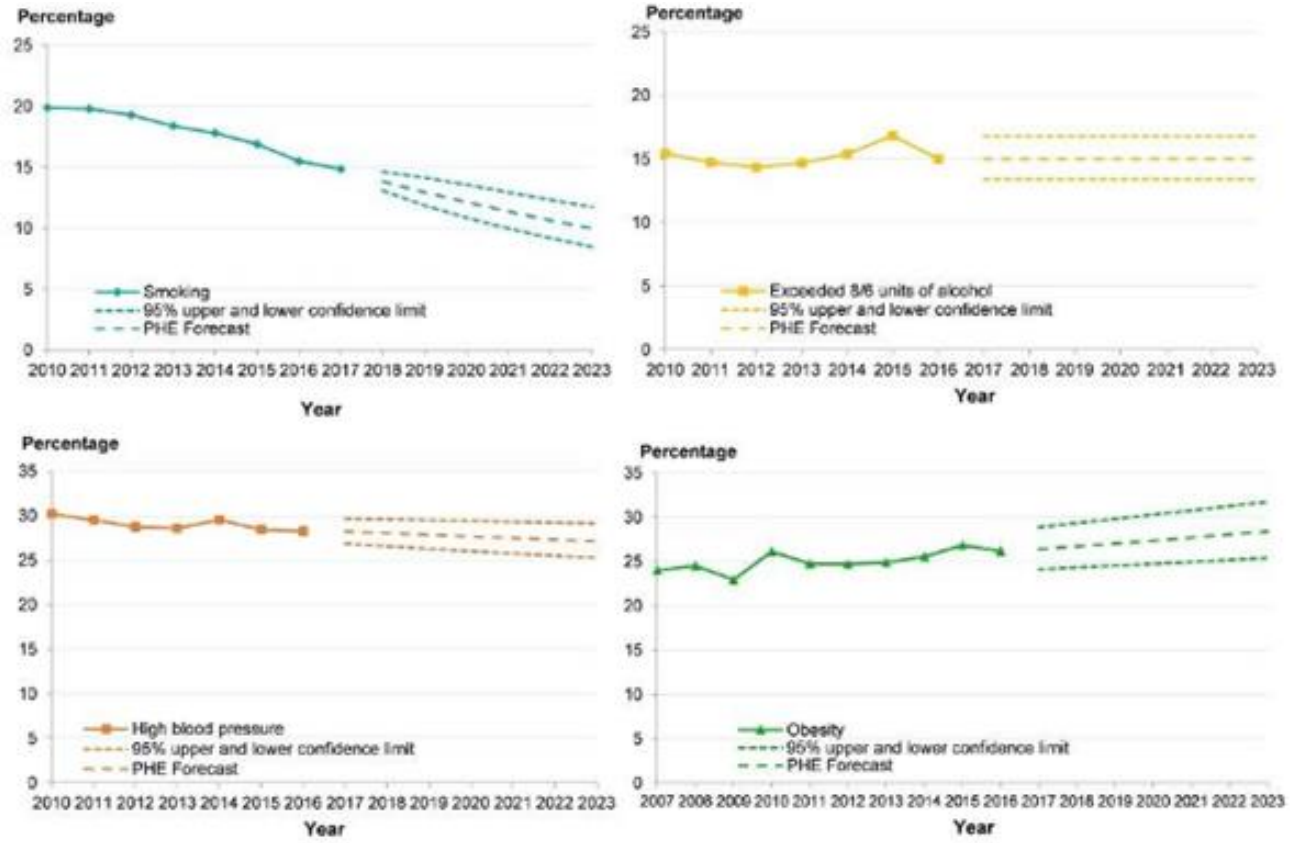

Figure 36 - Trends in the prevalence of smoking, alcohol consumption, high blood pressure and obesity in England from 2010 to 2016 and forecasts to 2023 (Public Health England, 2016)*

[155] https://fingertips.phe.org.uk/profile/health-profiles/data#page/0/gid/1938132701/pat/6/par/E12000005/ati/102/are/E08000025

[156] https://www.gov.uk/government/publications/health-profile-for-england-2018/chapter-3-trends-in-morbidity-and-risk-factors

Indicator	England	West Midlands	Dudley	Sandwell	Walsall	Wolver-hampton
Life expectancy at birth (male)	77.6	78.8	78.9	77.1	77.4	77.2
Life expectancy at birth (female)	83.1	82.7	82.9	81.3	82.0	81.3
Under 75 mortality rate: all causes	332	352	347	429	407	432
Under 75 mortality rate: cardiovascular	72.5	77.5	70.5	100.1	99.1	104.7
Under 75 mortality rate: cancer	134.6	139.0	149.4	154.4	156.9	157.5
Suicide rate	9.6	9.5	9.4	10.4	9.1	9.9
Killed and seriously injured on roads	40.8	38.4	31.1	38.3	33.7	31.5
Hospital stays for self-harm	185.5	176.8	196.0	175.7	157.0	189.8
Hip fractures in older people (aged 65+)	578	590	595	606	628	613
Cancer diagnosed at early stage	52.6	52.3	53.9	51.4	49.7	53.0
Diabetes diagnoses (aged 17+)	78.0	-	82.8	84.4	86.8	73.6
Dementia diagnoses (aged 65+)	67.5	65.1	65.4	61.9	70.1	73.3
Alcohol-specific hospital stays (under 18s)	32.9	27.5	34.6	27.1	13.6	21.9
Alcohol-related harm hospital stays	632	690	640	673	716	834
Smoking prevalence in adults (aged 18+)	14.9	14.2	13.7	17.4	14.5	14.4
Physically active adults (aged 19+)	66.0	62.6	59.9	54.2	59.0	55.9
Excess weight in adults (aged 18+)	61.3	63.6	67.4	70.1	66.8	65.8
Under 18 conceptions	18.8	21.4	20.2	27.4	30.0	25.8
Smoking status at time of delivery	10.8	11.9	14.4	9.8	13.2	17.7
Breastfeeding initiation	74.5	68.9	55.3	62.0	65.5	66.8
Infant mortality rate	3.9	5.9	5.4	6.5	6.2	5.8
Obese children (aged 10-11)	20.1	22.5	25.9	28.2	25.6	27.6
Deprivation score (IMD 2015)	21.8	-	23.0	34.6	30.4	33.2
Smoking prevalence: routine and manual occupations	25.7	25.5	26.0	29.2	21.2	21.1
Children in low income families (under 16s)	17.0	20.3	20.7	25.5	25.8	26.3
Average Attainment 8 score	46.7	45.2	43.9	42.3	43.0	44.5
Employment rate (aged 16-64)	75.2	72.7	70.3	64.2	70.6	65.0
Statutory homelessness	0.8	1.1	3.6	0.5	0.1	2.2
Violent crime (violence offences)	23.7	21.9	16.6	20.9	19.4	23.6
Excess winter deaths	21.1	20.8	21.0	23.3	23.2	19.3
New sexually transmitted infections	794	645	432	701	730	555
New cases of tuberculosis	9.9	11.9	7.8	27.2	15.5	22.2

Table 2 - Data extracted from Public Health England health profiles for the Black Country

The following sections highlight the key factors likely to influence the changing burden of disease.

Demography

Age

The age profiles of the different Black Country populations relative to that of the West Midlands and England are shown in Table 3[157]. Dudley has a higher proportion of individuals aged 65+ than the other Black Country regions and England overall, whereas Sandwell has the smallest proportion of individuals aged 65+. Across all four regions, there are on average approximately 17.8% of individuals aged 65+ in the Black Country, relative to 18% for England overall. Both the Black Country and West Midlands populations are ageing, as the average age of those in the West Midlands has increased by 1.1 years between 2002-2016 to 39.8 years[158]. The proportion of the population aged 65+ in the West Midlands is projected to increase by 17.4% by 2024 (Figure 37).

Age band	England	West Midlands	Dudley	Sandwell	Walsall	Wolverhampton
0-4	6%	6%	6%	8%	7%	7%
5-17	15%	16%	16%	18%	17%	16%
18-29	16%	16%	14%	15%	15%	16%
30-49	26%	25%	25%	28%	26%	27%
50-64	19%	18%	19%	17%	18%	17%
65-74	10%	10%	11%	8%	9%	9%
75-84	6%	6%	7%	5%	6%	6%
85+	2%	2%	3%	2%	2%	3%

Table 3 - Proportion of population by age band (note totals may not add to 100% due to rounding)

[157] https://www.rnib.org.uk/professionals/knowledge-and-research-hub/key-information-and-statistics/sight-loss-data-tool; https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2016based

[158] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/adhocs/006346medianageforlocalauthoritiesintheukmid2015; http://www.plumplot.co.uk/West-Midlands-population-changes.html

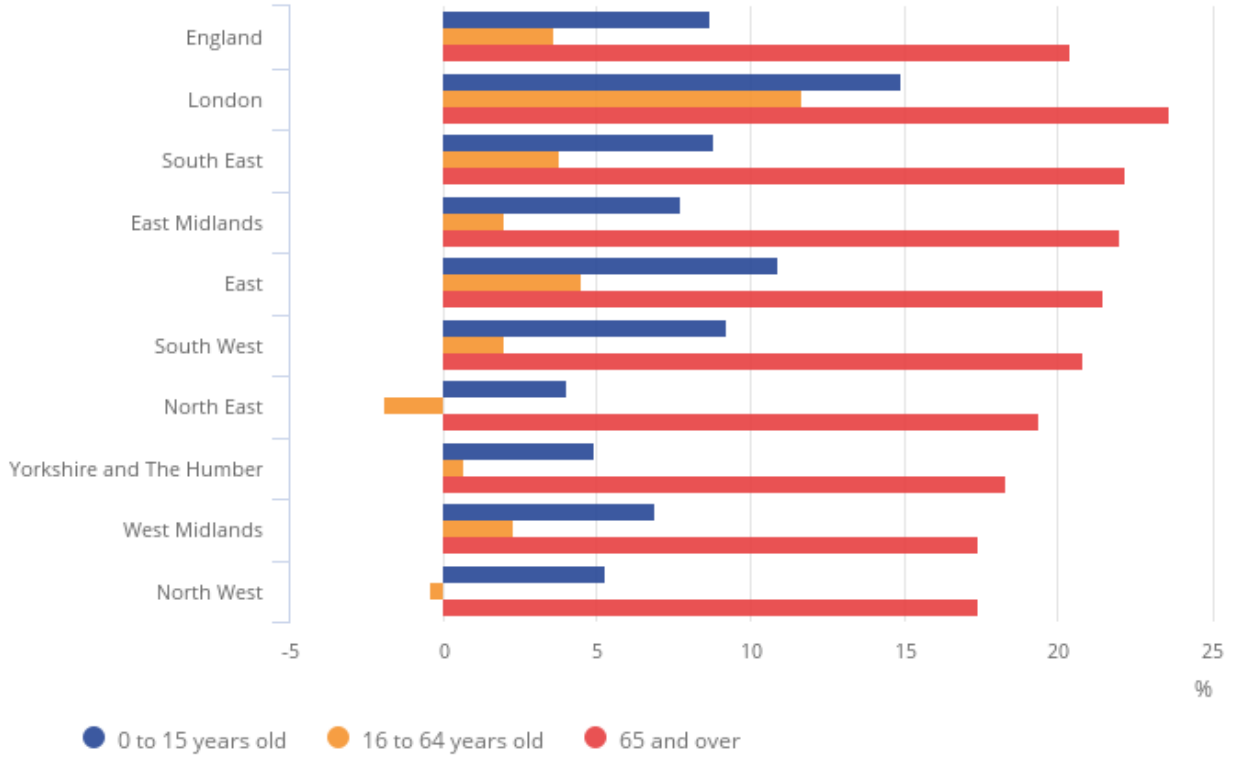

Figure 37 - The percentage population change in different UK regions from 2014 to 2024 (The Office for National Statistics, 2016)

Ethnicity

The ethnic profile of the Black Country areas relative to the West Midlands and England is shown in Table 4[159]. Dudley has a large white population than other Black Country areas and England overall, whereas Sandwell has the lowest proportion of white individuals and the highest proportion of Asian/ Asian British individuals compared to all other local areas and England overall. Between 2001-2051, projections indicate a decrease in concentration of individuals with both white and black Caribbean ethnicity in the West Midlands region and of individuals with Pakistani and Bangladeshi ethnicity in Walsall and Sandwell. There is projected to be little change in the population of individuals with Indian ethnicity[160]. Across the Black Country, the Black and Minority Ethnic populations, in particular the South Asian population, is expected to grow.

159 https://www.ons.gov.uk/peoplepopulationandcommunity/culturalidentity/ethnicity/articles/ethnicityandnationalidentityinenglandandwales/2012-12-11#changing-picture-of-ethnicity-over-time; https://www.rnib.org.uk/professionals/knowledge-and-research-hub/key-information-and-statistics/sight-loss-data-tool

160 https://www.ethpop.org/Publications/wp_eth_pop_projections.pdf

Ethnicity	England	West Midlands	Dudley	Sandwell	Walsall	Wolver-hampton
White	85%	83%	90%	70%	79%	68%
Mixed ethnicity	2%	2%	2%	3%	3%	5%
Asian / Asian British	7%	10%	6%	19%	15%	18%
Black / Black British	4%	3%	2%	6%	2%	7%
Other ethnic groups	2%	2%	1%	2%	1%	3%

Table 4 - Proportion of population by ethnicity (note totals may not add to 100% due to rounding)

There are some direct links between ethnicity and health need, for example:

- People of African or South Asian origin are twice as likely to have a stroke than those of European origin, and those of Black or South Asian origin tend to suffer stroke earlier[161];
- There is an increased risk of developing lupus in black individuals (incidence increases by 5-9 times and prevalence by 2-3 times)[162]; and
- Six separate genes that make South Asians more susceptible to type 2 diabetes than other ethnicities[163].

The future ethnic mix of the Black Country may, in turn, be affected by patterns of national and international migration, linked to the relative economic attractiveness of the area and the nature of migration policy from time to time.

Size

Table 5**Error! Reference source not found.** shows the actual and predicted changes in population size in the Black Country between 2001-2016 and 2016-2026 respectively. All local populations have increased and are expected to continue to increase over the next 5-10 years[164].

[161] https://www.telegraph.co.uk/travel/maps-and-graphics/world-according-to-tobacco-consumption/; https://www.telegraph.co.uk/travel/maps-and-graphics/world-according-to-tobacco-consumption/

[162] https://academic.oup.com/rheumatology/article/56/suppl_1/i67/2629213

[163] https://www.nature.com/articles/ng.921

[164] https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland; https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/bulletins/subnationalpopulationprojectionsforengland/2016based

Area	Population change 2001-2016	Percentage change 2001-2016 (%)	Population change 2016-2026	Percentage change 2016-2026 (%)
Dudley	12506	4.1	8086	2.5
Sandwell	48037	16.9	22705	7
Walsall	25554	10.1	16028	5.7
Wolverhampton	20001	8.4	12923	5

Table 5 – Actual and projected change in the Black Country population between 2001-2026

Inequality

The 2015 release of the index of multiple deprivation (IMD) rankings shows high variation between local authorities in the West Midlands. Wolverhampton was rated 21st in 2010 and 2015, whilst Sandwell had reduced in ranking from 17th in 2010 to 28 in 2015. Out of 39 local enterprise partnerships, the Black Country was sixth in the top 20 most deprived 10% of areas nationally[165]. Deprivation can impact population health needs, for example individuals may be unable to afford to make changes to have a healthier lifestyle (including not being able to afford a gym membership or enough fruit, vegetables and fish to meet official nutritional guidelines). Some studies have suggested that deprivation is associated with worse lifestyle factors such as increased obesity, smoking rates and alcohol consumption[166]. Most of the 'Marmot Indicators' for the Black Country are worse than the regional and national averages (Table 6), as are weekly average earnings (Table 7) with the exception of Dudley where earnings exceed the regional but not national average.

Marmot Indicators	England	West Midlands	Dudley	Sandwell	Walsall	Wolverhampton
Healthy life expectancy at birth	63.8	62.9	60.9	59.0	57.4	58.7
19-24 year olds not in education, employment or training	13.2	15.3				
Average Attainment 8 score	46.7	45.2	43.9	42.3	43.0	44.5
Fuel poverty	11.1	13.7	13.3	16.9	14.4	15.2
GCSE achieved 5A*-C including English & Maths with free school meal status	33.3	33.4	28.6	30.4	28.1	28.4
Individuals not reaching the Minimum Income Standard	30.3	34.8				
Inequality in life expectancy at birth	7.4	7.4	7.2	7.7	7.9	6.1
Long term claimants of Jobseeker's Allowance	3.5	6.1	9.1	10.7	7.3	12.9
People reporting low life satisfaction	4.4	4.3	5.4	5.5	5.0	5.8
School readiness: Good level of development at age 5	71.5	69.8	66.6	66.4	68.1	68.7
School readiness: Good level of development at age 5 with free school meal status	56.6	57.1	51.7	55.2	56.7	62.2
Unemployment	4.4	5.2	6.0	7.9	6.0	7.6
Utilisation of outdoor space for exercise/health reasons	17.9	17.7	20.5	18.2	18.0	27.6
Work-related illness	3980.0	3250.0				

Table 6 - Black Country Marmot Indications (PHE Fingertips tool)

165 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/465791/English_Indices_of_Deprivation_2015_-_Statistical_Release.pdf

166 https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0123579; https://bmcpublichealth.biomedcentral.com/articles/10.1186/s12889-016-2766-x; https://www.sciencedirect.com/science/article/pii/S1054139X15001275

	Average weekly earnings
England	440.2
West Midlands	411.9
Dudley	414.4
Sandwell	386.1
Walsall	376.8
Wolverhampton	385.9

Table 7 - Black Country Average weekly earnings

The Long Term Plan highlights the impact that housing has on young people's health and life chances (Figure 38)[167] and sets an ambition to look beyond healthcare provision as "the NHS has a wider role to play in influencing the shape of local communities". Changes in housing policy will play a key role in shaping the subsequent health needs of the population over the coming 5-10 years.

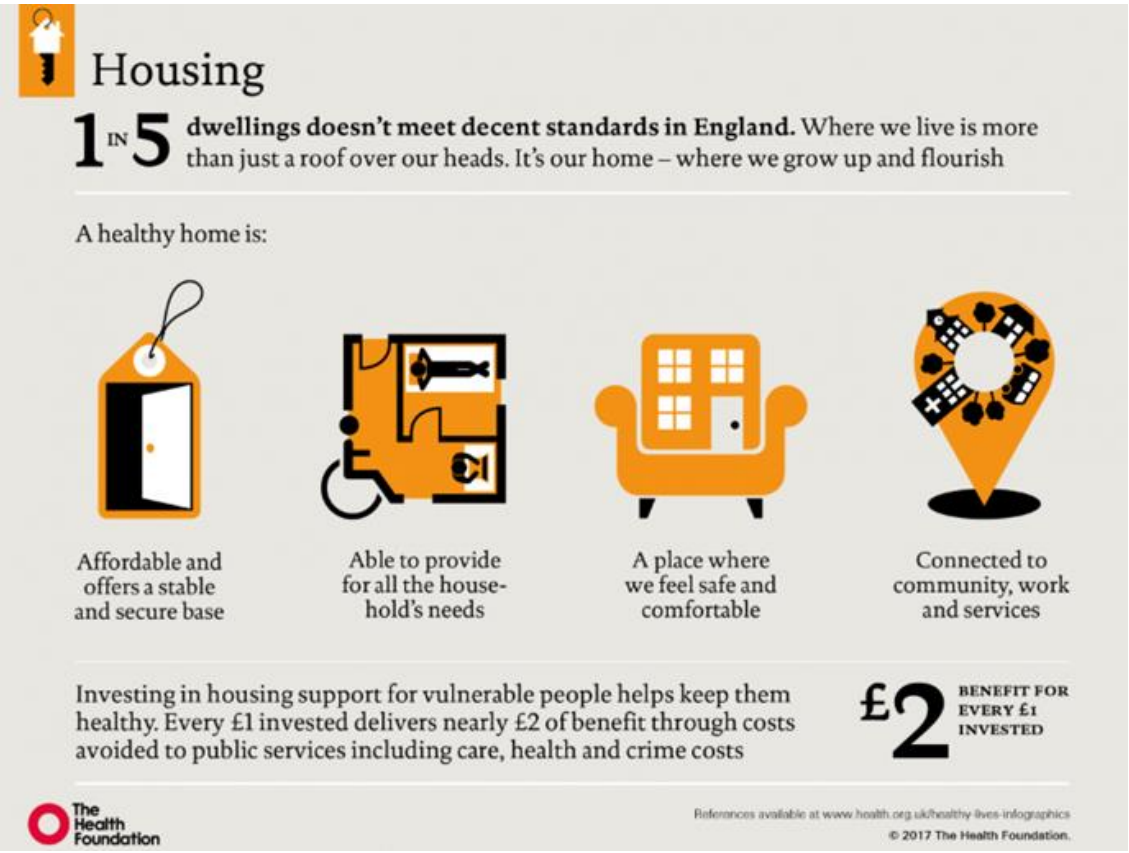

Figure 38 - The impact of housing on health (The Health Foundation, 2017)

Research has shown that economic growth can give poorer households the financial means to spend more on health and nutrition and can give governments the ability to invest in infrastructure that directly or indirectly affects health and to improve the public health system.

[167] https://www.health.org.uk/infographic/how-does-housing-influence-our-health

Social attitudes and awareness

The attitudes that individuals have towards looking after their own and others' health may be an important driver of population health needs over the coming 5-10 years. Although research has suggested that most people would rather self-manage minor ailments, this preference has declined over time. Interviews conducted by the King's Fund with GPs and practice staff echoed these thoughts that patients now seem less able or willing to self-manage minor or self-limiting illness without health care professionals' advice, with some highlighting that there is "a greater expectation of a fix" and an "expectation that you should be seen today about anything, even if it's for advice[168].

Increased awareness of certain conditions (e.g. mental health) through campaigns or initiatives such as population health management could increase expectations for them to be treated, increasing the demand for services. A qualitative interview study of 34 GPs revealed that some GPs felt that patient expectations for consultations and treatment had increased because of a growing lack of self-management and reduced tolerance for illness, increasing requests for consultations for minor illness or presenting earlier in the course of an illness. This was partly attributed to increasing public access to information about health and illness from the internet including patients Googling their symptoms and becoming alarmed, the media and public health campaigns[169]. A systematic review of 30 articles regarding treatment burden for those with chronic illnesses found that some common drivers of treatment burden include possible comorbidity, high medication use and treatment characteristics, which can result in consequences including poor health and well-being, lack of treatment adherence, ineffective resource use and burden on significant others[170].

Another consideration concerns the willingness and confidence of citizens to look after their own health. If individuals become more willing to take control of their own health, the burden on public sector services could decrease, though with the risk highlighted above that awareness could generate rather than reduce demand. The Long Term Plan states that "over the next five years the NHS will ramp up support for people to manage their own health. This will start with diabetes prevention and management, asthma and respiratory conditions, maternity and parenting support, and online therapies for common mental health problems."

A poll conducted by Ipsos MORI in 2018 (Figure 28) found that 97% of people acknowledged that individuals have a great or fair amount of responsibility for their own health, and most people thought that it was very or fairly easy to undertake healthy behaviours (Figure 39). Other research

[168] https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/Understanding-GP-pressures-Kings-Fund-May-2016.pdf
[169] https://bjgp.org/content/bjgp/early/2017/01/16/bjgp17X688849.full.pdf
[170] https://onlinelibrary.wiley.com/doi/full/10.1111/hex.12046

has shown, however, that 70% of adults in England do not meet government guidelines for two or more key risk factors of poor diet, physical inactivity, smoking and excessive alcohol consumption which are linked to ill health and diseases such as heart disease, diabetes and cancer[171].

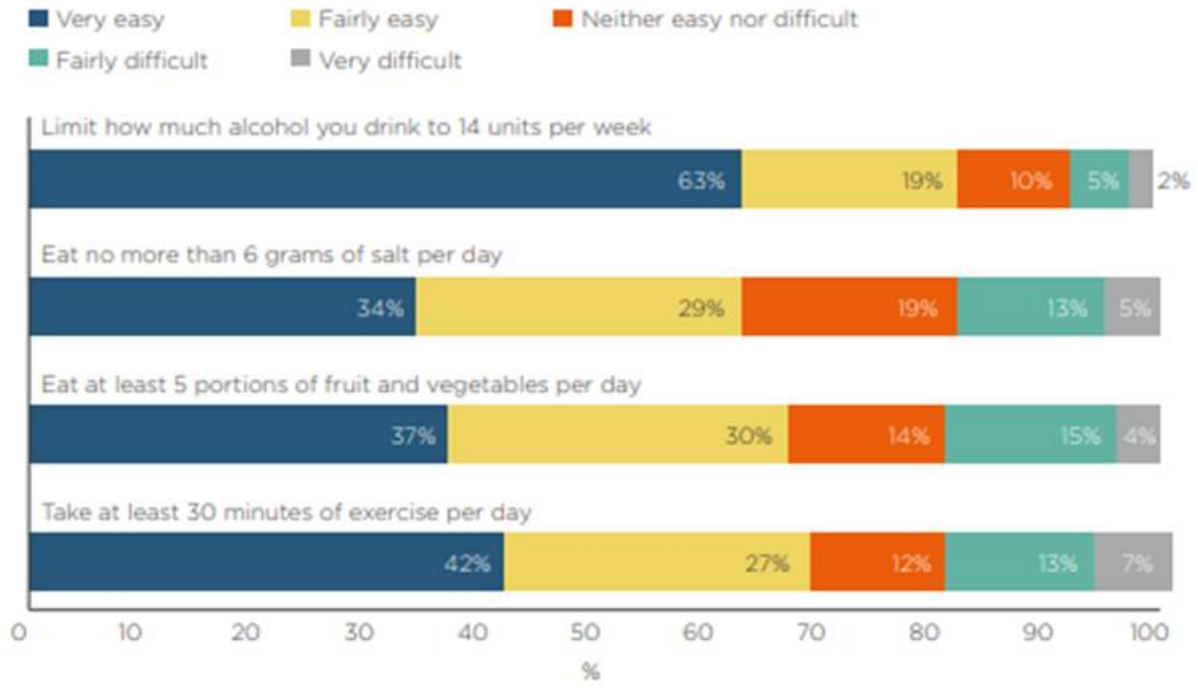

Figure 39 - Attitudes on how easy or hard people find it to do healthy behaviours (Ipsos MORI, 2018)

Attitudes to activities that generate social capital could also be significant. Interviews conducted by the King's Fund with GPs and practice staff suggested that a breakdown of social capital and informal friend and family networks could be to blame for rising expectations on health and care services: "we haven't got that extended family support any more, I think that that has a knock-on effect on expectations"[172]. Research from the 2017 wave of the Understanding Society survey of approximately 40,000 households in the UK found that 6.7% of adults were providing informal care for someone else who lived with them in the same household and 13.4% were caring for another family member or friend who they did not live with[173].

[171] https://www.kingsfund.org.uk/sites/default/files/2018-06/NHS_at_70_are_we_expecting_too_much_from_the_NHS.pdf
[172] https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/Understanding-GP-pressures-Kings-Fund-May-2016.pdf
[173] https://www.understandingsociety.ac.uk/documentation/mainstage; https://blog.bham.ac.uk/caregivingblog/2017/11/29/caring-for-family-and-friends-in-the-uk/

Natural and built environment

The environment in which people live affects their mental and physical health. Public Health England data (Table 8) reveals a mixed picture for the Black Country, especially in Sandwell.

Natural and Built Environment Indicators	England	West Midlands	Dudley	Sandwell	Walsall	Wolverhampton
Access to Healthy Assets & Hazards Index	21.2	14.7	11.9	57.7	29.4	28.0
Access to woodland	16.8	16.6	29.1	20.1	29.7	17.0
Affordability of home ownership	7.9	6.6	5.7	5.7	6.1	5.7
Air pollution: fine particulate matter	9.3	9.6	9.9	11.2	10.9	9.9
Density of fast food outlets	88.2	83.2	81.7	114.3	93.7	95.7
Excess winter deaths index	21.6	21.4	24.4	23.6	20.9	23.3
Exposure to road, rail and air transport noise of 55 dB(A) or more during the night-time	8.0	7.5	7.0	13.4	10.1	6.7
Exposure to road, rail and air transport noise of 65 dB(A) or more during the daytime	5.2	4.1	5.2	6.2	5.6	4.8
Fuel poverty	11.1	13.7	13.3	16.9	14.4	15.2
Injuries due to falls in people aged 65 and over	2170.4	2021.0	2269.8	1992.0	1756.6	1908.2
Killed and seriously injured (KSI) casualties on the roads	40.8	38.4	31.1	38.3	33.7	31.5
Overcrowded households	4.8	4.6	3.7	6.8	5.2	6.0
Percentage of adults cycling for travel at least three days per week	3.3	2.2	1.1	1.3	1.9	1.1
Percentage of adults walking for travel at least three days per week	22.9	19.0	16.8	21.1	20.3	20.7
Rate of complaints about noise	6.3	5.2	4.1	2.9	9.4	9.1
Utilisation of outdoor space for exercise/health reasons	17.9	17.7	20.5	18.2	18.0	27.6

Table 8 - Natural and built environment indicators (PHE Fingertips tool)

Natural environment

Data from the Royal Meteorological Society shows that 2017 was the 5th warmest year in the UK in a series from 1910, and the 8th warmest for Central England (Central England Temperature – CET) in a series from 1659 (Figure 40).

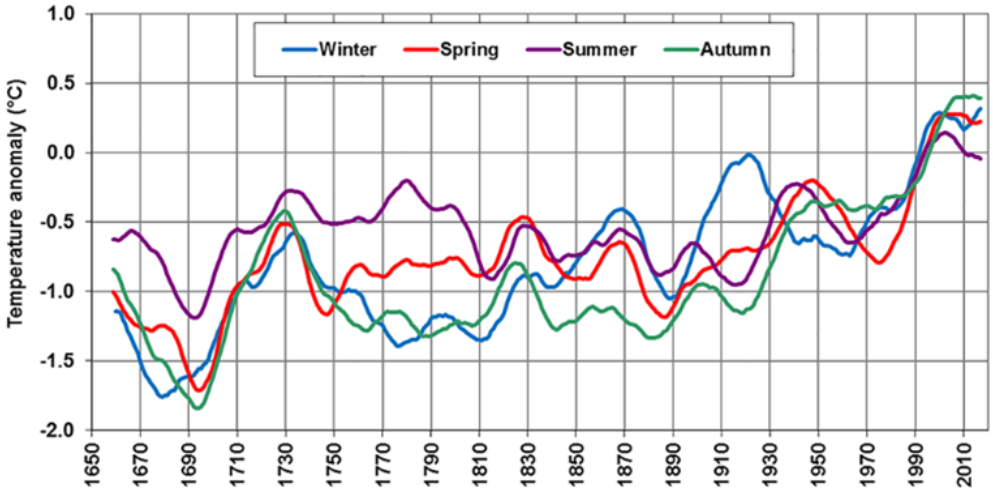

Figure 40 - Seasonal Central England Temperature (CET) series, 1657-2017, expressed as anomalies to 1981-2010 average (Royal Meteorological Society, 2018)

The series shows that the 21st Century so far has been warmer than the previous three centuries[174].

[174] https://rmets.onlinelibrary.wiley.com/doi/epdf/10.1002/joc.5798

Projections by the Met Office suggest that we will experience warmer, wetter winters over the coming 100 years and hotter, drier summers[175].

An increasingly warm UK climate could attract vector-borne insects, bringing diseases such as malaria to our shores. Cataracts and skin cancer prevalence may also increase in a warmer climate. An associated increase is disruptive weather events such as storms and flooding could impact demand for emergency services, including during the already pressured winter period. Significant weather events noted in 2017 included unseasonably wet and windy weather in early June, the June heat wave, July flash flooding in South England and widespread snow in December[176]. In addition to the health impact of climate-related events, they also have the potential to disrupt workforce supply due to travel problems.

Climate change also could impact the ability to grow high quality food both in the UK and abroad, with knock-on effects on diet, for good or ill[177]. Certain foods may become harder to produce and new foods might become indigenous due to climate, such as bananas. It is unknown which foods will be produced or imported into the UK in future and how production may need to change. The availability and quality of the water supply could also be impacted (Figure 41)[178].

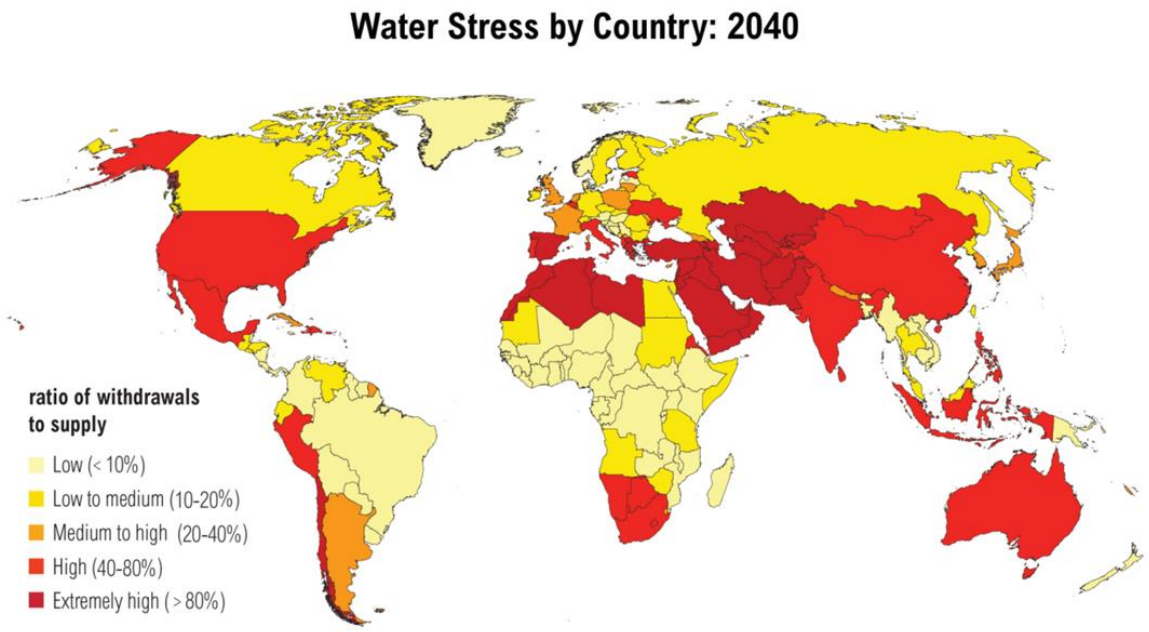

Figure 41 - Projected water stress by country by 2040 (World Resources Institute, 2015)

[175] https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/research/ukcp/ukcp18-fact-sheet-temperature.updated-02.19.pdf
[176] https://rmets.onlinelibrary.wiley.com/doi/epdf/10.1002/joc.5798
[177] https://cgspace.cgiar.org/bitstream/handle/10568/35215/IPCC_info_note-3April14.pdf
[178] https://www.wri.org/resources/data-sets/aqueduct-projected-water-stress-country-rankings

Built environment

The environments in which people live and/or work can impact their physical and mental health and wellbeing[179]. This includes the real or perceived safety of the environment, influenced by levels of anti-social behaviour, violent crime and traffic, for example. Knife crime appears to be on the rise (Figure 42)[180].

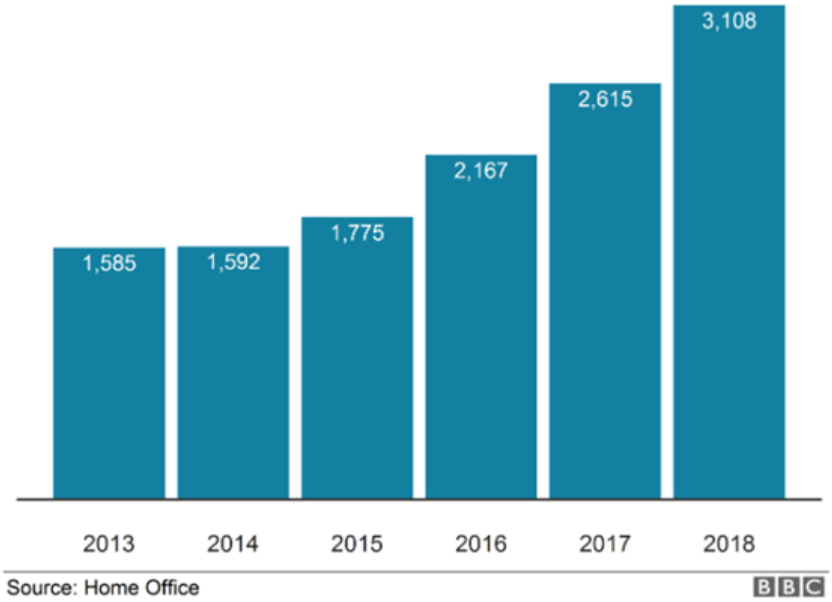

Figure 42 - Knife crime in the West Midlands (recorded offences in the year to 30th September) (Office for National statistics, 2018)

The Black Country has laid out ambitions to improve its economy by 2030, addressing housing, jobs, services and infrastructure[181].

Future levels of pollution generated by industry, travel and home energy consumption could impact the burden of respiratory disease, including asthma, lung disease and cancer. In 2013, outdoor air pollution was identified as causing cancer by the International Agency for Research on Cancer (IARC)[182], and research from 2018 has found that air pollution is responsible for 33% of asthma

[179] https://www.academia.edu/471564/The_effect_of_the_physical_environment_on_mental_wellbeing; https://www.gcph.co.uk/assets/0000/4174/BP_11_-_Built_environment_and_health_-_updated.pdf
[180] https://www.bbc.co.uk/news/uk-england-birmingham-47385824
[181] https://www.the-blackcountry.com/upload/Annual%20Economic%20Review%202019/29981%20-%20Annual%20Economic%20Review%20Brochure%202018-19_f_(Email).pdf
[182] https://www.iarc.fr/wp-content/uploads/2018/07/pr221_E.pdf

hospitalisation cases around the world[183]. Research suggests that levels of particulate pollution, particulate matter and nitrogen dioxide have shown long term improvement and decreased in concentration from 1992-2017 and ozone levels have remained fairly stable since 2003 with a trend of long-term increases shown since 1987 in urban environments[184]. The Government has pledged to ban the sale of new petrol and diesel vehicles by 2040 and has earmarked £90 million to create "future mobility zones" where new transport systems involving extra privileges for ultra-low emission vehicles and alternative transport methods will be tested. It has given £20 million to the West Midlands to make this happen[185]. Overall, the extent to which our dependency on fossil fuels and air polluting resources will change over the coming 5-10 years, how legislation will fight to combat it and how population health will be impacted remains to be seen.

The nature and extent of environmental interventions and regulation can impact the levels of climate related disease or disruptive events, air quality, the physical environment and food and water supply and quality. The most recent Climate Change Risk Assessment includes 6 priority areas[186] (Figure 43). The other key factor concerns public attitudes to the environment. On one hand, there can be displays of significant public support for increased environmental measures. This includes the recent protests undertaken by the "extinction rebellion" campaign group regarding tackling climate change, noted as "the biggest civil disobedience event in recent British history"[187] and the young climate activist Greta Thunberg who has inspired young people from around the world to take action on climate change[188]. David Attenborough has also been credited for causing a reduction in the use of single use plastic in the UK[189]. But at the same time, there can be significant public opposition to certain measures such as wind-farms and congestion zones. Research by the European Commission in 2017 showed that 65% of UK people believe that protecting the environment is important to them personally, 54% think that as an individual they can play a role in protecting the environment and the environmental issues that they consider to be most important are shown in Figure 44[190].

[183] https://www.thelancet.com/journals/lanpla/article/PIIS2542-5196(19)30046-4/fulltext; https://publichealth.gwu.edu/content/new-study-finds-millions-children-worldwide-develop-asthma-each-year-due-traffic-related-air
[184] https://uk-air.defra.gov.uk/news?view=238
[185] https://www.birminghammail.co.uk/news/midlands-news/eight-ways-roads-future-different-16035880
[186] https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Launch-slidepack.pdf
[187] https://www.theguardian.com/environment/video/2019/apr/23/extinction-rebellion-a-week-of-protest-in-three-minutes-video
[188] http://time.com/5577251/greta-thunberg-uk-mp-speech-climate/
[189] https://www.plantbasednews.org/post/attenborough-effect-single-use-plastic
[190] http://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/80357

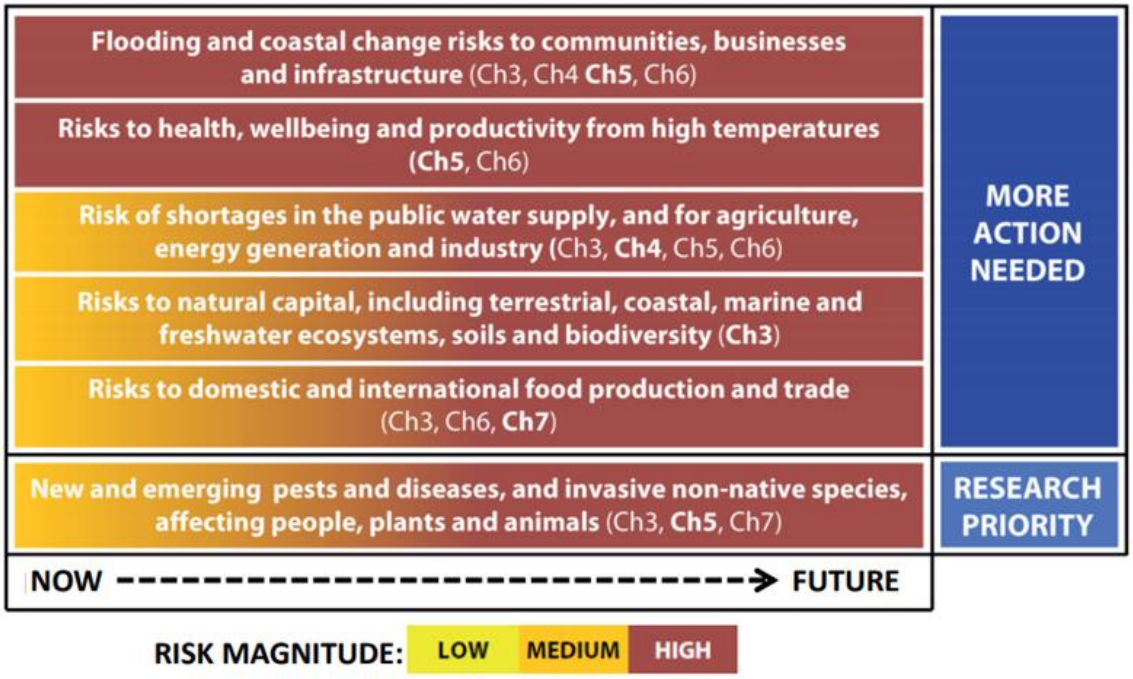

Figure 43 - Six priority areas for the UK committee for climate change over the next 5 years

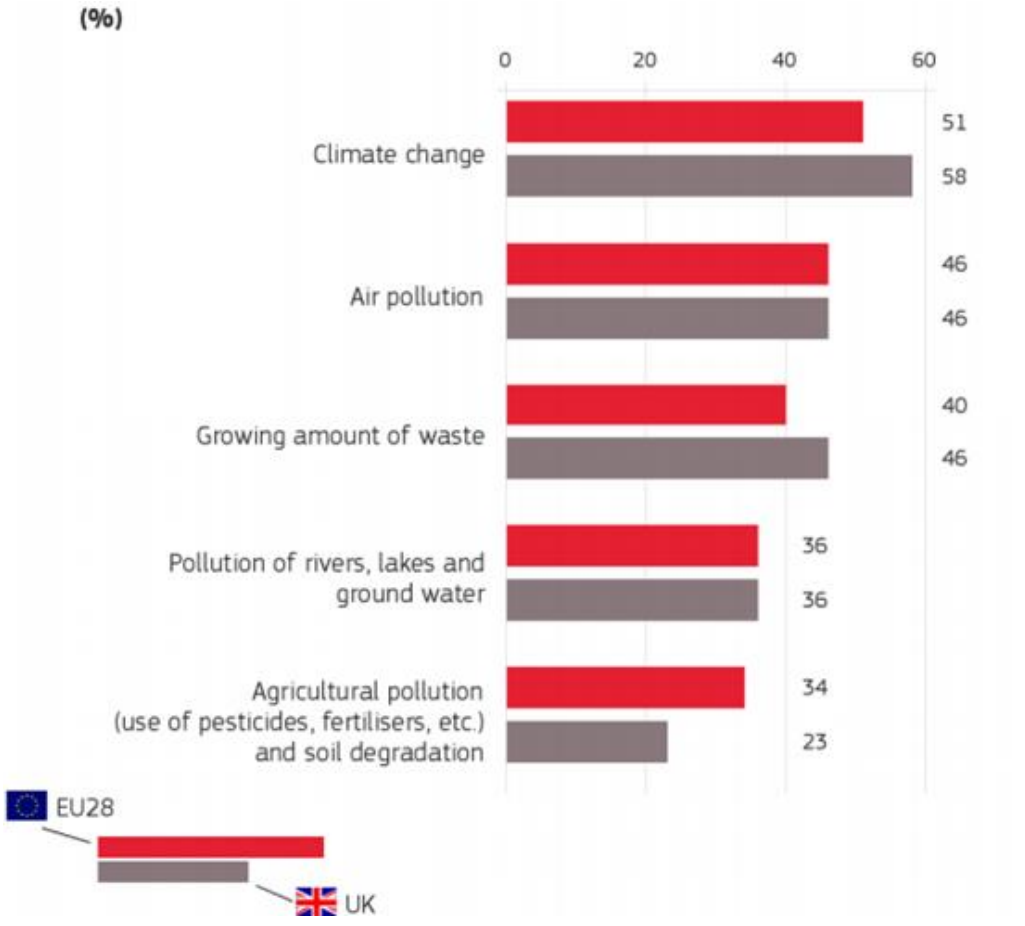

Figure 44 - The first four environmental issues that European and UK individuals considered to be the most important (European Commission, 2017)

Appendix 1 – Factor descriptions

Ref.	Factor	Description of impact
POLITICAL AND LEGAL		
PL1	Work and pensions policy	Raising pension age could help to relieve workforce pressures but could also bring challenges to service delivery (e.g. managing changing capabilities) and impact attitudes to work. Equally, reducing pension benefits/lifetime allowance or moving to a defined contribution scheme could lead to people retiring/reducing hours earlier or being put off NHS careers, increasing workforce pressures. Working time directive could be reviewed.
PL2	Healthcare policy	Changes in government policy re: healthcare models, structures or professional regulation could affect the shape and quality of services, and the motivation of staff.
PL3	Social care policy	Changes in the service or funding model of social care and/or its management relative to health (e.g. extent of integration, balance of local vs. National control) could change day-to-day service delivery and impact experience of staff (so also recruitment and retention).
PL4	Public health policy	Nature/extent of local or national government intervention (from campaigns to legislative measures) could impact the burden of disease.
PL5	Trade policy	Post-Brexit trading arrangements could alter the availability, cost or regulation of goods and services used in service delivery.
PL6	Immigration policy	The level of workforce supply - and the countries/health systems immigrant workers come from - may vary over time, impacting service delivery and workforce culture/expectations.
PL7	Higher education policy	Changes to tuition fees, the supply of places on specific courses and the modes of course delivery (e.g. apprenticeships, part-time options, salaried training) may impact the scale and nature of workforce supply.
PL8	Secondary education policy	Changes to the secondary curriculum could affect the skills, knowledge and/or supply of the health and care workforce, and the ability of citizens to manage/improve their own health and wellbeing.
PL9	Transport policy	Local/national policy and initiatives (e.g. HS2, Metro) could affect workforce and patient/user mobility and choice, impacting delivery of care and workforce supply.
PL10	Environment policy	Nature and extent of environmental interventions/regulation could impact burden of disease and costs/models of service delivery (including travel for work and to/from work).
PL11	Industrial policy	Extent of success of national/local industrial strategy (including WMCA actions) could impact the type of work available locally, with knock-on effects for (in)equality and health outcomes. Relative attractiveness of other industries would also impact health and care recruitment and retention.
PL12	Housing policy	Nature/extent of housing development could impact the nature/extent of the local population and its needs, as well as workforce supply.

Ref.	Factor	Description of impact
PL13	Global politics	Political decisions in other countries could impact the trade of goods and immigration and emigration, ultimately impacting workforce and patient numbers.
CLINICAL AND TECHNOLOGICAL		
CT1	AI and robotics	AI and robotics could have a broad impact on the provision of health and care services (e.g. assistive technology, diagnostics, surgery, home care and befriending, and data capture/analysis) and could continue to expand into new service areas. This might lead to a loss of existing roles, replacement of a scarce workforce and/or the emergence of new roles. To what extent (and how quickly) might both the workforce and patients adapt to and accept this technology? Will there be sufficient investment to support developments?
CT2	Telemedicine and the 'internet of (medical) things'	Telemedicine developments could impact how patients are monitored and cared for. This covers both ongoing day-to-day care and applications in emergency/critical care situations. The speed and reliability of 5G mobile technology rollout will affect opportunities. Some demand pressures could be relieved through these advances, equally increased monitoring might generate demand. Remote monitoring/diagnostic technology could see new roles and competencies emerge and could ease challenges around staffing specialist rotas in multiple locations. There could be an employment impact around the production and maintenance of devices. How will patients and clinicians respond to such devices, and what training/support requirements might there be? What clinical governance, information governance and cyber security issues might arise, and how might people respond to them?
CT3	Digital patient records	Digital patient records could better connect health and care services and enable patients to become a more active/equal partner in their own care. How effectively and consistently will such records be used? How quickly and robustly will they be rolled out? How will patients and providers respond to data breaches? Will there be net efficiencies in care provision (and quality improvements) or will there be increases in induced demand?
CT4	Patient-driven healthcare	Patient-driven healthcare technology (e.g. fitness trackers, monitoring systems and apps) allows people to monitor and collect their own healthcare data and share it with healthcare providers. This could contribute to increased health and reduced demand, or it could generate additional demand. There could be a differential equalities impact. Might insurers, employers or others seek to access such data to inform their decisions, and how would people respond to this (or to data security breaches)?
CT5	New medical treatments and technologies	Ongoing advancements have the potential i) to enhance current care (e.g. robotic surgery, nanotechnology), or ii) to transform the model of care (e.g. new treatment modes or medicines) (e.g. stem cell utilisation, 3D printing and digital medicine). To what extent will new advancements widen the gap between what can be done and what can be afforded? How quickly might these advancements

Ref.	Factor	Description of impact
		emerge and be adopted/funded? What levels of resistance might they provoke in either clinicians and/or patients? Existing roles/specialities could become redundant, new specialisms emerge and new competencies be required (perhaps different to those currently attracted to healthcare).
CT6	Personalised medicine	There is growing ability to sequence genomes more quickly and cheaply, to build artificial genomes, to edit genes and therefore to increase the personalisation and targeting of interventions and the prediction and elimination of disease. This could become very widely available or remain limited to a minority of applications/individuals. What impact might genomics have on the services that are demanded/provided and the workforce skills/ numbers required to deliver them (e.g. genetic counsellors) – re. to "delete" conditions, to highlight predisposition to disease or to genetically personalise treatment?
CT7	Big data	Digital technologies generate vast quantities of information (Big Data) that can contribute to clinical learning and service planning, including through disease prediction, the identification and subsequent management of at-risk populations and identification of more efficient ways to utilise resources and target interventions. Who will own data, who will be able to access it, and how will associated security issues be managed? Will there be an open access approach or the commoditisation of data? What might be the impact on existing or future workforce roles/competencies from accessing Big Data? What scope is there for utilisation of predictive analysis? What workforce will be required to conduct and communicate this knowledge?
CT8	Anti-microbial resistance	Pace of change in AMR - and of the emergence of replacement treatments - could impact mortality and morbidity, and associated demands on services.
SOCIAL ATTITUDES		
SA1	Patient expectations of health and care services	Patients may expect to have increased knowledge of conditions ('Dr Google') and to be offered more choice regarding making decisions about their care. There could be a shift to more personalised care and away from 'take what you are given' to 'demand what you want'. Patients may expect care to be delivered closer to home and at times they want it. How open will they be to changes in skill-mix and new roles (rather than seeing a GP or Consultant)? How might attitudes to quality vs. quantity of life evolve as the population ages? Will citizens expect a greater say in service change? Could high expectations drive the formation of a two-tiered system for those who can afford to pay more?
SA2	Trust in 'experts'	Levels of trust in official/expert opinions and guidance impacts the effectiveness of clinical/public health advice. Who will be trusted more – Dr Smith or Dr Google? (e.g. MMR vaccination, lifestyle advice, effectiveness of novel treatments).
SA3	Work-life balance	The desire for non-linear/portfolio careers and flexible working/career breaks could increase. There could be further moves towards a 4-day week. Levels of career ambitions and the desire to progress at work may be impacted if other

Ref.	Factor	Description of impact
		aspects of life have greater attention/provide more life-satisfaction. How much will training provision and roles (be able to) adjust to meet expectations? Could health and care work become attractive as an early or late stage career (as with Teach First)?
SA4	Local social capital	The level of local social capital may vary over time, impacting the strength of local support networks (including family and friend support), the financial and volunteer resource available to the voluntary and community sector, and the loneliness/isolations felt by local people (magnified where there is anti-social behaviour). Models of care increasingly factor in community assets that depend on social capital. Changes in social capital could lead to changes in both the demand for and the supply of health and care services. There could also be shifts in how local organisations relate to NHS bodies, and the expectations they have of them.
SA5	Perceptions of health and care careers	The desirability/acceptability of health and care careers could be impacted by i) remuneration relative to other options, ii) perceptions of NHS culture/behaviours/work pressures, and iii) apparent job security, amongst other factors. How might these factors combine to affect the numbers, calibre and values of the health and care workforce, as well as the nature, scale and quality of the services they provide?
SA6	Scope of NHS services	Public expectations around the range and quality of services 'free at the point of need' affect local and national decisions about resource allocation and prioritisation. To what extent could these increase, decrease or change over time?
SA7	The future of the Black Country	The relative attractiveness of the Black Country (and its constituent areas) could impact workforce recruitment and retention. This may depend on any changes to its social, economic, environmental and other conditions. To what extent will people prefer to live in urban, suburban or rural areas?
SA8	Public support for the NHS	The NHS continues to benefit from strong public support that impacts political decision-making, especially re: funding. Any change in public attitudes to the NHS and their valuation of it (e.g. through poor experiences of care, frustrations over access) could impact the NHS' social and political capital. Similar impact could also be generated by a rise or fall in public sympathy for other national priorities (e.g. education, crime). To what extent might those with adequate financial means seek to pay for private care rather than rely on the NHS? Could there be a resurgence in company health schemes that impacts support for NHS-related taxation, or leads to a two-tier health system?
SA9	Responsibility for health	Changing attitudes around the responsibility for preventing ill-health and providing self-care/self-management of health conditions could impact the demand for services, the nature of those services (e.g. direct delivery vs. support)) and the scale/nature of workforce required. To what extent will health consciousness, prevention and wellbeing be important to people? Will there be a

Ref.	Factor	Description of impact
		greater sense of individual responsibility or will there be an expectation that services deal with the effects of individual choices?
SA10	Openness to technology	Staff and patient attitudes to using digital technologies could impact the deliverability of new care models, the shape of workforce roles and the attractiveness of those roles. How will people react to opportunities/problems that emerge with digital solutions (e.g. technical functionality, data security, cyber security)?
SA11	Novel foods	How might public attitudes to novel foods change over time - e.g. GM foods, chlorinated chicken, hormone-treated beef, laboratory-grown meat? What might the impacts be on public health and the need for additional/alternative forms of treatment in response?
SA12	Post-Brexit UK	Brexit is potentially a watershed moment in UK history. To what extent might national attitudes change beyond the watershed? Will it quickly become history, or will it provoke a material change in how we view ourselves and others? Will we become less European in our social attitudes and our commercial behaviours?
SA13	Attitudes to the environment	Will there be greater support for environmental protections or cost efficiencies; a greater tolerance for wind-farms or for fracking?
CLIMATE AND ENVIRONMENT		
CE1	Climate-related disease burden	The potential for complex systemic consequences from climate change (e.g. higher prevalence of mosquitoes/vector-borne diseases like Malaria) could impact the scale and nature of the Black Country burden of disease, and the need for new interventions (e.g. increased vaccination) and workforce awareness/specialism. A warmer climate could also increase demand relating to specific conditions (e.g. cataracts, skin cancer).
CE2	Climate-related natural events	An increase in disruptive natural events could increase demand on emergency services through injuries etc...This, along with disruption to workforce travel and damage to health facility estates, could impact the delivery of both emergency and elective services.
CE3	Air quality	Levels of pollution generated by industry, travel and home energy consumption could impact the burden of respiratory disease (e.g. asthma, lung disease/cancer etc), impacting the demand for services and, potentially, the relative attractiveness of the Black Country as a place to live and work. How might our dependency on fossil fuels change over time?
CE4	Physical environment	The physical environments in which people live and/or work can impact their physical and mental health and wellbeing. This includes the real or perceived safety of the environment (e.g. anti-social behaviour, violent crime, traffic). Depending on how physical environments evolve locally, there may be greater or lesser demand on mental or physical health services, and a potential impact on

Ref.	Factor	Description of impact
		workforce supply. To what extent might environments become safer or healthier (e.g. through making walking/cycling easier)?
CE5	Food supply	Changes in the nature of food supply - through domestic agriculture and production and through international trade - could impact diet-related health conditions. Which foods will be produced or imported into the UK in future and how will production change? What foods might become harder to produce and what new foods might become indigenous due to climate? How might our health be impacted?
CE6	Water quality	The quality of water supply could impact population health. How might water quality and availability change in future, and how much impact on health could this have?
CE7	Migration	Changes in climate may make the UK more or less attractive for immigration relative to places of origin, with impact on both service demand and workforce supply.
DEMOGRAPHY		
DP1	Population age profile	Demographic change could impact demand for services, the complexity/integration of care required, specialist workforce requirements (e.g. dementia care, Geriatricians, carers) and the nature/location of treatment facilities. Greater lifespans may be linked with increases in specific diseases, more extended treatment and the need for interventions (e.g. surgery) that might have previously been ruled out on the grounds of age. Temporary marked increases in birth rate could only exacerbate the situation in years to come. An ageing population - or a growth in the child population - could increase the proportion of the workforce with informal care responsibilities. More staff may need time out of work or may consider leaving work.
DP2	Workforce age profile	An ageing workforce present a future challenge - experience, expertise and organisational memory is lost, and there may not be an adequate supply of replacements. Changes in demands on the workforce could impact how long staff feel able and willing to remain at work - whether to retire early, to seek reduced responsibilities or to stay on longer.
DP3	Population diversity	The diversity within the population affects the prevalence of certain health conditions (e.g. people of African and South Asian origins are twice as likely to suffer a stroke as people of European origin). This subsequently impacts pressure on the workforce and service delivery. To what extent could population diversity change in coming years.
DP4	Workforce diversity	Changes in the gender, age or ethnic mix of the workforce staff could introduce a greater diversity of assumptions, experience and perspectives. This diversity could play through into how services are delivered but also how staff work together, and the time needed to manage change.

Ref.	Factor	Description of impact
DP5	Population size	This is impacted by patterns of births, deaths and migration and could impact the number of individuals within the population who utilise healthcare as well as the pool of working age people who might be recruited to health and care roles.
DP6	Deprivation and inequality	Levels of deprivation impact equality of access and of outcomes, as well as the demand for services. There could also be impact on patient ability/willingness to comply with the expectations of them in new models of care (e.g. service locations, prevention and self-care, new clinical roles).
DP7	Burden of disease	The overall burden of disease is subject to a wide variety of factors - immigration, lifestyle choices, climate change, treatment effectiveness, economic prosperity, etc... This could impact on the nature and scale of the services required over time. Demand for some services may increase through greater awareness/expectations - e.g. mental health conditions, earlier identification of conditions (perhaps through population health management).
ECONOMY		
EE1	Workforce market competitive-ness	The public sector is a proportionately larger employer in economically challenged areas. The level of economic prosperity - nationally and regionally - could impact the level of competition for employees between public and private sector organisations. Pay differentials between sectors could also have an impact, as could changing conditions of employment in either sector. These wider economic changes may impact the scale and nature of health and care workforce supply.
EE2	Health and care funding	The state of the national/regional economy influences the levels of resource available to deploy in public services, impacting service scope and volumes, capital investment and staffing levels. What will be the impact of Brexit, global trade dynamics and other issues on future economic prosperity?
EE3	Commercial power	To what extent will health and care services be influenced by commercial forces in coming years - e.g. pharmaceutical companies, suppliers of digital solutions, holders of Big Data (such as Google Deep Mind).
EE4	Employee power	Will employees be increasing rule takers (e.g. zero hours) or rule makers in future? What will the power of unions be? What might the impact of changing employee power be on terms and conditions, recruitment and retention, and service delivery? How might employee power differ between different services, including between health and care?
EE5	Black Country economy	The nature and extent of changes to the Black Country economy (including through infrastructure developments such as the Metro extension) could impact the nature and extent of health and care demand and the availability of the required workforce. Staff may be attracted to/from adjacent areas.

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