HOUSE OF LORDS

Science and Technology Select Committee

1st Report of Session 2019–21

Ageing: Science, Technology and Healthy Living

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Evidence is published online at https://committees.parliament.uk/work/1/ageing-science-technology-and-healthy-living/ and available for inspection at the Parliamentary Archives (020 7219 3074).

Q in footnotes refers to a question in oral evidence.

The prefixes INQ and ZIN refer to items of written evidence. The prefixes are interchangeable and the same evidence will be found under each number in both series.

SUMMARY

While life expectancy in the UK has continued to increase year on year, healthy life expectancy—the time an individual can expect to live in good health—has not kept pace. People are living longer, but many of those extra years are spent in poor health.

Older people are increasingly likely to have more than one health condition, known as multimorbidity. The health and care system is not designed to cope with treating people with multiple conditions, meaning that patients often have to see multiple doctors and are prescribed multiple drugs. This fragmentation of care contributes in many cases to even poorer health in older age.

In 2017 the Government identified "Ageing Society" as one of the Industrial Strategy's four Grand Challenges, with a mission to "ensure that people can enjoy at least five extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest." We are not on track to meet this target. For men, we heard that it will take 75 years to achieve the target at current rates of improvement, not the 15 years that remain. For women, healthy life expectancy at birth has decreased in the past decade, further widening the gap between healthy life expectancy and life expectancy, and making the Government's target even harder to achieve.

The second part of the mission is also not on track to be met. Inequalities in healthy life expectancy remain stark: people in the most deprived groups on average spend almost 20 years longer in poor health than those in the least deprived groups. There are also shockingly large differences in healthy life expectancy amongst ethnic groups.

There is no time to waste if the Government wishes to achieve the Grand Challenge mission. In this report we identify approaches from science and technology that could help to increase healthy life expectancy, and assess the role of public health interventions and national regulations in helping people to age more healthily.

Understanding of the biology of ageing is advancing rapidly and holds significant promise for improving health in older age. Exciting new and repurposed drugs to target biological processes that affect the development of multiple age-related diseases are beginning to be trialled in humans. The hope is that these treatments will help people to live more healthily in old age. The Government should prioritise funding such research, to give the highest possible chance that treatments will contribute to improving healthy life expectancy by 2035. Even if such drugs are not ready by then, they will likely be an important long-term tool for improving health in older age.

There is a strong understanding of the lifestyle and environmental factors throughout life that correlate with good health in older age, including diet and physical activity. The challenge is to ensure this understanding is used effectively in interventions by public health authorities and backed up by national regulations. Further research is needed to understand how best to motivate and facilitate a change to a healthier lifestyle across the life-course. The priority for public health interventions should be those people living in deprivation and suffering the worst health.

There are numerous technologies and related services to help people live more independently and healthily in older age. The Government needs to ensure that these are deployed more widely and effectively. It should continue to invest in the development of new technologies—including robotics, artificial intelligence and data-driven technologies—that can improve health and wellbeing in older age. However, it should ensure that these technologies and services are widely accessible and do not act to increase health inequalities. As part of this, it will need to ensure all older people are equipped with digital skills and infrastructure—including high-speed internet access—to be able to benefit from these technologies.

We heard enthusiasm for the ambition of the Ageing Society Grand Challenge mission, but scepticism that it could be achieved by 2035 with the Government's current approach. This is why the Government should urgently devise a strategy for achieving the mission by 2035, including a roadmap for the steps it will take along the way and delivery mechanisms that coordinate activity and funding across relevant organisations. Given the lack of progress towards reducing health inequalities, the strategy should explicitly address this issue and the steps the Government will take to resolve it, including stating who is responsible. A combination of approaches from biomedical science, technology and services, local public health and government interventions will be required.

Improving healthy life expectancy is a vital and worthy ambition, but there has been a lack of leadership and planning for the Ageing Society Grand Challenge mission, resulting in minimal progress. The Government should act now to revitalise the mission and utilise opportunities in science, technology and public health to ensure it is achieved.

Ageing: Science, Technology and Healthy Living

CHAPTER 1: INTRODUCTION

Background

1. As in many developed countries, the population of the UK is ageing. By 2035 it is projected that there will be around 16 million people over the age of 65 living in the UK, an increase of around 4 million from 2018, and nearly 5 million people over the age of 80, a 51% increase from 2018.[1] Conversely, the population of working age people is likely to remain relatively static.[2]

2. Changes to the age profile of the population are due to a combination of lower birth rates and increases in life expectancy over the past century.[3] Between 1980 and 2018, life expectancy at birth rose from 70.5 to 79.3 for males, and from 76.6 to 82.9 for females, although since 2011 the rate of improvement of life expectancy has slowed compared with previous decades.[4] By 2043, life expectancy for males at birth is projected to increase by 3.3 years to 82.6, while female life expectancy is projected to increase by 2.6 years to 85.5.[5]

3. However, despite improvements to life expectancy, healthy life expectancy (the number of years a person is expected to live in good health, without disability) has generally not kept pace. Healthy life expectancy for males was 62.7 in the period 2009–11,[6] increasing by 0.4 years to 63.1 by the period 2016–18, while life expectancy between those periods increased by 0.8 years. For females, healthy life expectancy increased by only 0.2 years between those periods, while life expectancy increased by 0.6 years. This means that the proportion of life spent in good health has decreased from 79.9% to 79.5% for males, and from 77.4% to 76.7% for females.[7]

4. There is a pronounced social gradient to both life expectancy and healthy life expectancy. In England in the period 2016–18, the difference in life expectancy between the most and least deprived areas was 9.5 years for

1 Office for National Statistics, *Principal projection—UK population in age groups* (21 October 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea21principalprojectionukpopulationinagegroups [accessed 28 September 2020]

2 Q 2 (Professor Chris Whitty)

3 Office for National Statistics, *Living longer: how our population is changing and why it matters* (13 August 2018): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerhowourpopulationischangingandwhyitmatters/2018–08-13 [accessed 28 September 2020]

4 Office for National Statistics, *Past and projected period and cohort life tables, 2018-based, UK: 1981 to 2068* (2 December 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/pastandprojecteddatafromtheperiodandcohortlifetables/1981to2068 [accessed 28 September 2020]

5 *Ibid.*

6 Life expectancies are based on three consecutive years of data, to reduce the effect of annual fluctuations caused by seasonal events such as flu.

7 Office for National Statistics, *Health state life expectancies, UK: 2016 to 2018* (11 December 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2016to2018 [accessed 28 September 2020]

males and 7.5 years for females.[8] The differences in healthy life expectancy are 18.9 years for males and 19.4 years for females.[9]

5. In November 2017, the Government named "Ageing Society" as one of four cross-cutting "Grand Challenges" in the Industrial Strategy, committing to "harness the power of innovation to help meet the needs of an ageing society".[10] In May 2018, the Government announced that the mission of the Ageing Society Grand Challenge was to "ensure that people can enjoy at least five extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and the poorest".[11]

Our inquiry

6. In July 2019 we launched an inquiry into ageing, covering aspects of science, technology and healthy living. Our aim was to assess the feasibility of the Government's Ageing Society Grand Challenge mission, and to understand to what extent developments in science and technology will be important in reaching this goal. We also considered how current public health policy and the coordination of healthcare for older people may be contributing to more years spent in poor health.

7. In addition to receiving a large amount of oral and written evidence, we held a roundtable discussion in private with six older people, to hear about their priorities and concerns around healthy ageing. We are very grateful to all those who gave evidence and who took part in the roundtable discussion.

8. We thank our specialist adviser, Professor Janet Lord, Director of the Institute of Inflammation and Ageing at the University of Birmingham.

Structure of this report

9. Chapter 2 outlines the current and projected trends relating to ageing—including life expectancy and healthy life expectancy—and identifies some key challenges facing efforts to increase healthy life expectancy. Chapter 3 examines the biological processes associated with ageing and potential treatments that could be used to slow down the ageing process. Chapter 4 assesses the lifestyle and environmental factors that influence healthy ageing and examines the role of public health policy in improving healthy life expectancy. Chapter 5 looks at the role of technology, data and services in facilitating healthy and independent living in older age. Finally, Chapter 6 examines the Ageing Society Grand Challenge itself, including its oversight and whether the mission is on track to be achieved by 2035.

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8 Office for National Statistics, *Health state life expectancies by national deprivation deciles, England: 2016 to 2018* (27 March 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 [accessed 28 September 2020]

9 *Ibid.*

10 Department for Business, Energy and Industrial Strategy, *Industrial Strategy: building a Britain fit for the future* (November 2017), p 10: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/664563/industrial-strategy-white-paper-web-ready-version.pdf [accessed 7 September 2020]

11 Department for Business, Energy and Industrial Strategy, *The Grand Challenge* (September 2019): https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#healthy-lives [accessed 7 September 2020]

COVID-19 pandemic

10. We received most of the evidence for this inquiry before the start of the COVID-19 pandemic. The pandemic has highlighted issues related to ageing, some of which are outlined in a short post-script to this report. That section includes evidence about the impacts of the pandemic that we received from medical experts who very kindly gave of their time to write to us, having been unable to give evidence as planned in March 2020. We undertook a separate inquiry on The Science of COVID-19, including evidence about health impacts.[12]

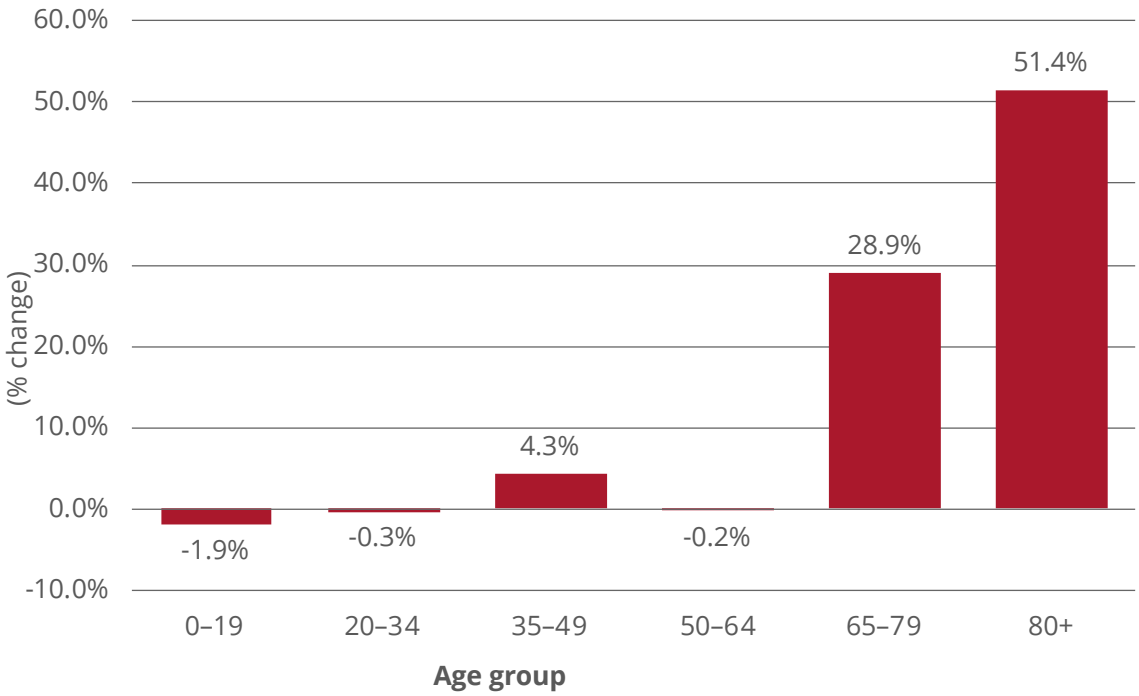
12 House of Lords Science and Technology Committee, *The Science of COVID-19* (May-October 2020): https://committees.parliament.uk/work/293/the-science-of-covid19/

CHAPTER 2: TRENDS AND CHALLENGES

Demography of ageing

11. The population of older age groups is growing more rapidly than younger age groups. This trend is expected to continue. Between 2018 and 2035 the population aged 80 and over is expected to increase by around 51%, compared with an increase of almost 29% for 65–79-year olds and a small decrease for 20–34-year olds (due to falling birth rates) (see Figure 1).

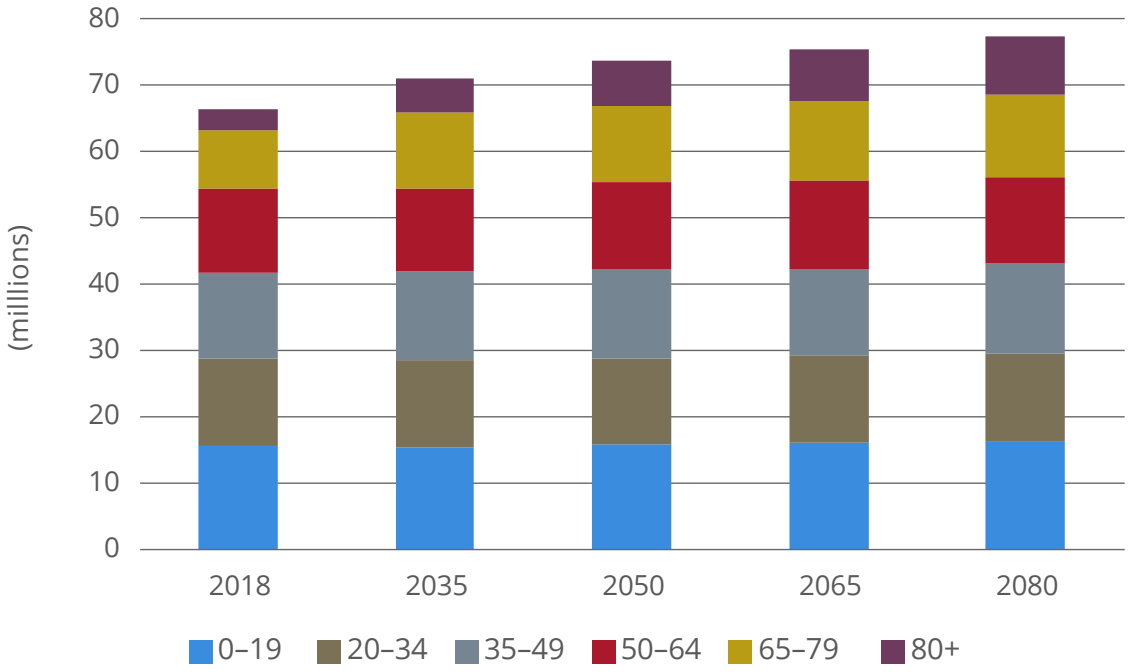
Figure 1: Expected percentage change in population by age group (2018 to 2035)



Source: Office for National Statistics (2019) Principal projection—UK population in age groups: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea21principalprojectionukpopulationinagegroups [accessed 28 September 2020]

12. This means that the proportion of the population that is older is expected to increase. In 2018, the population aged over 80 was 3.3 million, equating to 4.9% of the total population. By 2035, that population is projected to be 5.0 million (7% of the population), 7.6 million by 2065 (10% of the population) and 8.8 million by 2080 (11% of the population) (see Figure 2).

Figure 2: Projected UK population by age group (based on 2018 data)



Source: Office for National Statistics (2019) Principal projection—UK population in age groups: https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationprojections/datasets/tablea21principalprojectionukpopulationinagegroups [accessed 28 September 2020]

13. Demographic changes will not be even across the country. Professor Chris Whitty, Chief Medical Officer for England and Chief Scientific Adviser for the Department of Health and Social Care, explained that the demographic profile of cities is expected to remain relatively constant, with people arriving "at about 18 and tend[ing] to leave, classically, after their second child", meaning that the population of rural areas will get older relatively faster.[13] People in older age groups will therefore be "highly concentrated … in places where delivery of service is more difficult than it is in cities."[14]

Life expectancy and mortality

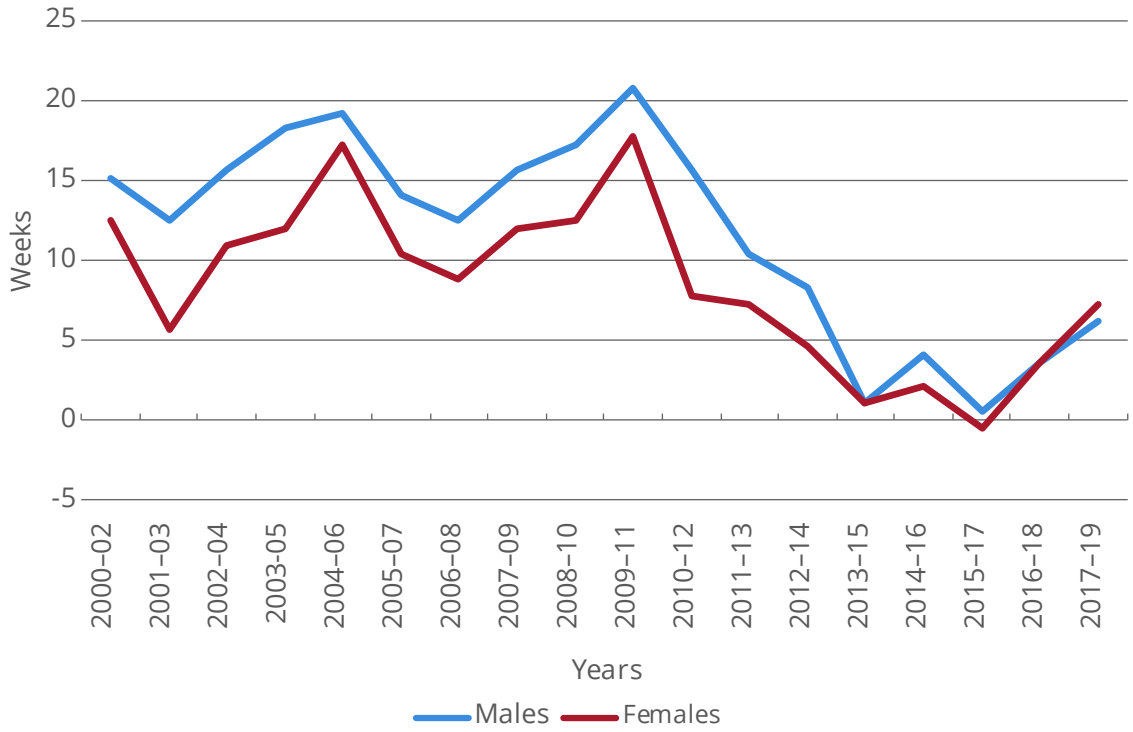
14. Life expectancy is a "population based statistical measure of the average number of years a person has before death."[15] Life expectancy at birth[16] in the UK in 2017–19 was 83.1 years for women and 79.4 years for men.[17] These

13 Q 2 (Professor Chris Whitty)
14 *Ibid.*
15 Office for National Statistics, *Life Expectancy releases and their different uses* (21 December 2018): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/articles/lifeexpectancyreleasesandtheirdifferentuses/2018–12-17 [accessed 28 September 2020]
16 This report uses period life expectancies, which take mortality rates from a single year (or group of years) and assume that those rates apply throughout the remainder of a person's life. Period life expectancies are therefore a measure of mortality rates at a given time. Cohort life expectancies take into account both observed and projected changes in mortality rate, and so tend to be higher than period life expectancies. The cohort life expectancy was 87.6 for males born in 2018, and 90.2 for females. The Office for National Statistics explains the difference in: *Period and cohort life expectancy explained: December 2019* (2 December 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/methodologies/periodandcohortlifeexpectancyexplained [accessed 28 September 2020]
17 Office for National Statistics, *National life tables—life expectancy in the UK: 2017 to 2019* (28 September 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/nationallifetablesunitedkingdom/2017to2019 [accessed 28 September 2020]

values represent a slight increase from the period 2016–18 of 6.3 weeks for males and 7.3 weeks for females. Since the start of the 20th century, life expectancy has increased by over 30 years; in 1901 life expectancy in England and Wales was 48.5 years for males and 52.4 years for females.[18]

15. Although life expectancy has continued to rise, since 2011 the rate of annual life expectancy increases in the UK has slowed compared with the previous decade.[19] Between the periods 2002–04 and 2009–11, life expectancy at birth in the UK increased by an average of 16.7 weeks for males and 12.7 weeks for females each year; between the periods 2010–12 and 2017–19, the rate of improvements decreased to an average of 6.3 weeks for males and 4.2 weeks for females per year (see Figure 3).

Figure 3: Annual change in life expectancy at birth in weeks, for males and females in the UK, between the periods 2002–04 and 2017–19



Source: Office for National Statistics (2020) National life tables, UK: 2017 to 2019: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/nationallifetablesunitedkingdom/2017to2019 [accessed 28 September 2020]

16. Reasons for this slowdown are under investigation. On 25 February 2020, the UCL Institute of Health Equity published the report *Health Equity in England: The Marmot Review 10 Years On* ("Marmot 2020")[20], a follow-up

18 Office for National Statistics, *How has life expectancy changed over time?* (9 September 2015): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/howhaslifeexpectancychangedovertime/2015–09-09 [accessed 28 September 2020]

19 Office for National Statistics, *National life tables—life expectancy in the UK: 2017 to 2019* (24 September 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/bulletins/nationallifetablesunitedkingdom/2017to2019 [accessed 28 September 2020]

20 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020): http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]

to a 2010 report by the same authors (the "Marmot Review").[21] The report found that the slowing of life expectancy improvements since 2011 "cannot for the most part be attributed to severe winters", as "more than 80 percent of the slowdown, between 2011 and 2019, results from influences other than winter-associated mortality." Some studies have linked the slowdown to austerity policies and their impact on public services.[22] Marmot 2020 was "reluctant to attribute the slowdown in health improvement to years of austerity because of difficulty in establishing cause and effect", but said that "the link is entirely plausible, given what has happened to the determinants of health" over this period.[23]

17. Life expectancy is not even across the UK. There is a strong link between life expectancy and deprivation, resulting in a gap in life expectancy between the most and least deprived areas (see Figure 4). In England in 2016–18, males in the least deprived areas could expect to live on average 9.5 years longer than males in the most deprived areas, while for females the gap was 7.7 years.[24] This gap has widened since 2013–15, when it was 9.2 years for males and 7.2 years for females.[25] This is in part a consequence of different rates of improvement of life expectancy by levels of deprivation; for example, Marmot 2020 found that in the most deprived 10% of neighbourhoods female life expectancy declined between 2010–12 and 2016–18, while in the six least deprived deciles female life expectancy increased by around 0.5 years.[26]

21 Institute of Health Equity, *Fair Society, Healthy Lives (The Marmot Review)* (February 2010): http://www.instituteofhealthequity.org/resources-reports/fair-society-healthy-lives-the-marmot-review/fair-society-healthy-lives-full-report-pdf.pdf [accessed 7 September 2020]

22 The King's Fund, 'What is happening to life expectancy in the UK?' (26 June 2020): https://www.kingsfund.org.uk/publications/whats-happening-life-expectancy-uk [accessed 7 September 2020]

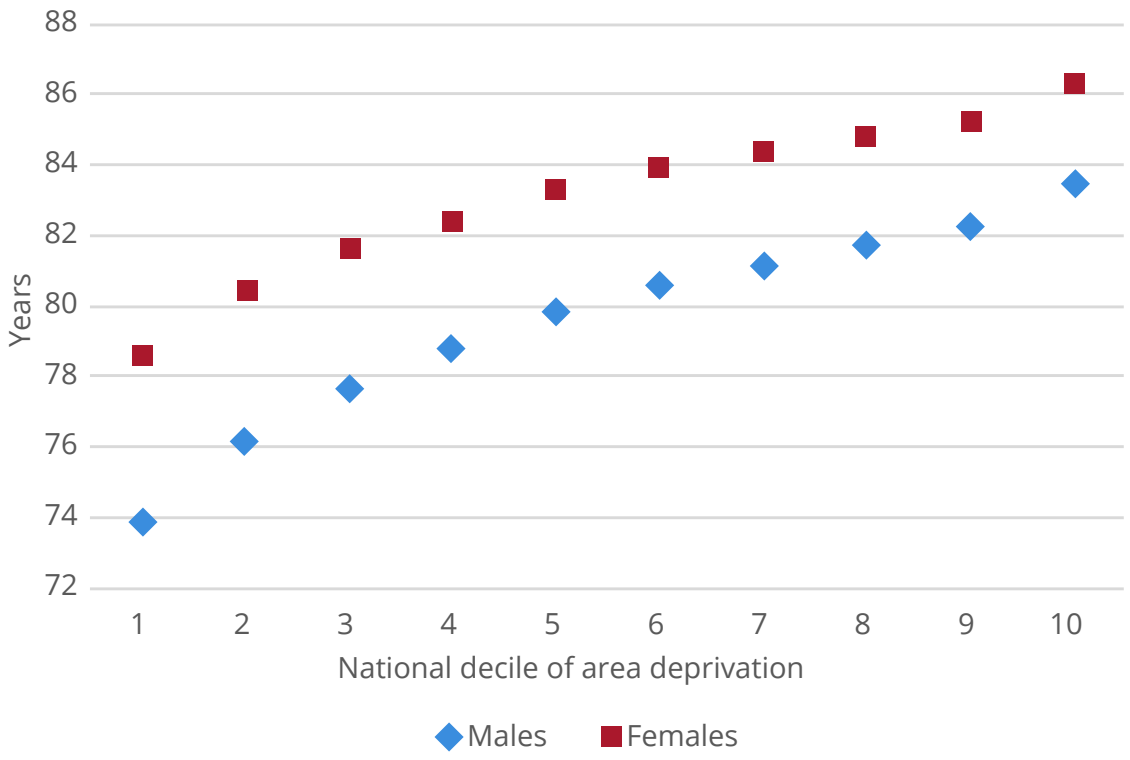
23 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020), p 5: http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]

24 Office for National Statistics, *Health state life expectancies by national deprivation deciles, England: 2016 to 2018* (27 March 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 [accessed 28 September 2020]

25 *Ibid.*

26 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020): http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]

Figure 4: Life expectancy for males and females in England by national deciles of area deprivation (1 = most deprived, 10 = least deprived)



Source: Office for National Statistics (2020) Health state life expectancies by national deprivation deciles, England: 2016 to 2018: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 [accessed 28 September 2020]

18. As with the slowdown in life expectancy improvements, reasons for widening differences in life expectancy are unclear. *Marmot 2020* noted that it was impossible to establish precise reasons at this stage, but that "the health situation is somewhat similar to other countries that have experienced political, social and economic disruption and widening social and economic inequalities." The report also noted that "in some of the key social determinants, inequalities are widening in England".[27]

19. The most common cause of death in 2017 in England was heart disease for males (13.6% of deaths) and dementia and Alzheimer's disease for females (16.6% of deaths) (see Table 1).[28] The mortality rate from dementia and Alzheimer's disease has been rising steadily in both sexes since 2006, which may in part be due to better diagnosis and recording. Conversely, mortality rates from heart disease have been falling; this was the biggest cause of increased life expectancy between 2001 and 2016. However, the rising mortality from dementia offset gains in life expectancy between 2011 and 2016 by 0.2 years in males and 0.3 years in females.[29]

27 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020): http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]

28 Public Health England, *Health Profile for England: 2019*, Chapter 2: Trends in Mortality (24 September 2019): https://www.gov.uk/government/publications/health-profile-for-england-2019 [accessed 28 September 2020]

29 *Ibid.*

Table 1: Leading causes of death in 2017 for males and females in England

Rank	Cause	% of all deaths (males)	Cause	% of all deaths (females)
1	Heart disease	13.6%	Dementia and Alzheimer's disease	16.6%
2	Dementia and Alzheimer's disease	8.9%	Heart disease	8.1%
3	Lung cancer	6.2%	Stroke	6.7%
4	Chronic lower respiratory diseases	6.1%	Chronic lower respiratory diseases	5.9%
5	Stroke	5.2%	Influenza and pneumonia	5.5%
6	Influenza and pneumonia	4.7%	Lung cancer	5.1%
7	Prostate cancer	4.1%	Breast cancer	3.7%
8	Colorectal and anal cancer	3.1%	Colorectal and anal cancer	2.5%
9	Leukaemia and lymphomas	2.6%	Leukaemia and lymphomas	1.9%
10	Cirrhosis and other diseases of liver	2.0%	Kidney disease and other diseases of the urinary system	1.8%

Source: Public Health England (2019) Health Profile for England: 2019, Chapter 2: Trends in Mortality: https://www.gov.uk/government/publications/health-profile-for-england-2019 [accessed 28 September 2020]

Healthy life expectancy

Definitions

20. Healthy life expectancy is defined by the Office for National Statistics as "an estimate of the number of years lived in "Very good" or "Good" general health, based on how individuals perceive their general health."[30] For the period 2016–18 males in the UK had a healthy life expectancy of 63.1 years; for females it was 63.6 years. Males will then on average live a further 16.2 years in poorer health, equating to 20.5% of their lifespan. Females can expect to live a further 19.4 years (23.3% of their lifespan) in poorer health.[31]

21. Another similar measure is disability-free life expectancy, "an estimate of the number of years lived without a long-lasting physical or mental health

30 Office for National Statistics, *Health state life expectancies, UK: 2015 to 2017* (12 December 2018): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2015to2017 [accessed 28 September 2020]

31 Office for National Statistics, *Health state life expectancies, UK: 2016 to 2018* (11 December 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2016to2018#healthy-and-disability-free-life-expectancy-in-the-uk [accessed 28 September 2020]

condition that limits daily activities."[32] Disability-free life expectancy was slightly lower than healthy life expectancy for men (62.6) and women (61.6) for the period 2016–18.

22. Our evidence suggested that collecting information on both self-perceived health and more objective measures of disability is important. Professor Whitty told us that "there is no objective measure of health" and it is "very useful" to ask people whether they feel healthy. He explained:

> "You can have a very good life and have multiple disabilities, and some people can have no disabilities objectively but feel that they have a rotten life and indeed feel that their health is impaired. That is particularly true with some mental health issues."[33]

However, Professor Michael Marmot, Director of the University College London Institute of Health Equity, noted that cultural differences can result in different perceptions of health, and so subjective measures of healthy life expectancy are not directly comparable between countries.[34]

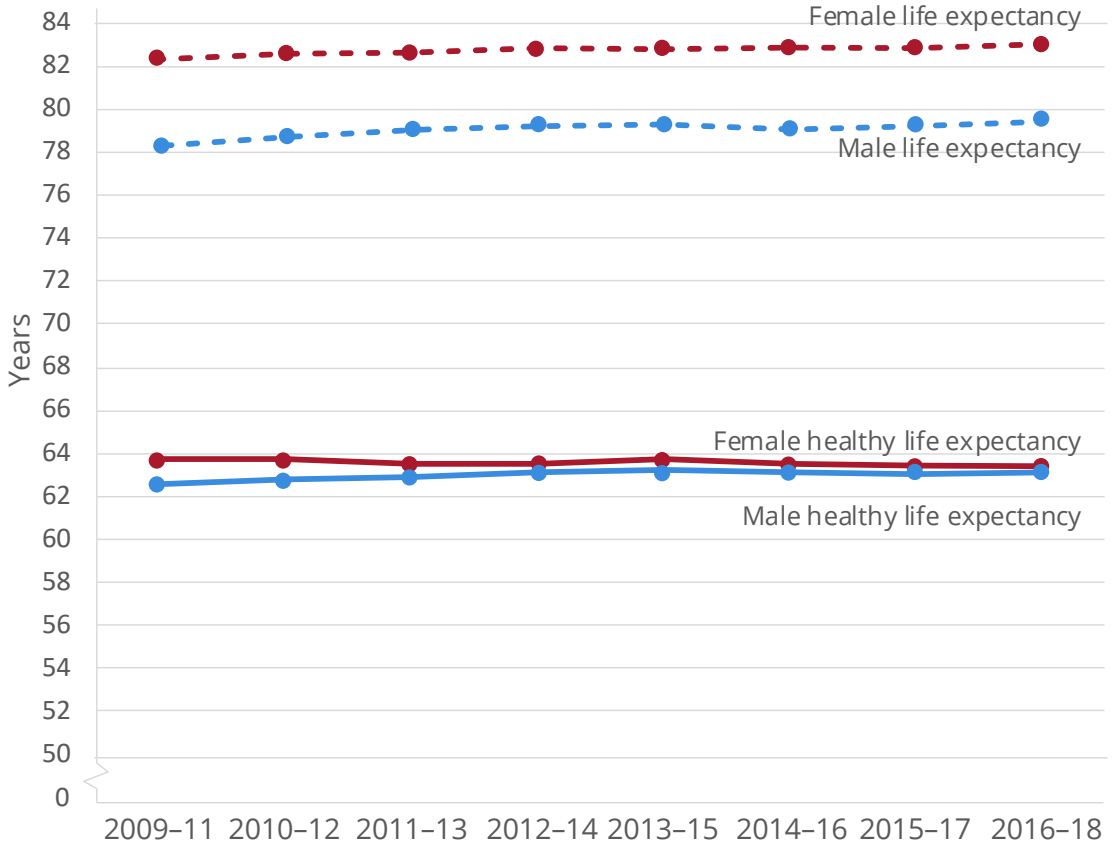
23. The Ageing Society Grand Challenge mission of five extra years of healthy, independent life by 2035 is based on disability-free life expectancy at birth for the period 2033–35, compared with the UK 2014–16 baseline of 62.5 years for males and 62.1 years for females.[35] There was consensus across our evidence that improving healthy life expectancy—and reducing the gap between healthy life expectancy and life expectancy—is a greater priority than improving life expectancy itself.

Trends

24. Increases in healthy life expectancy at birth have generally not kept pace with increases in life expectancy. In 2009–11 in the UK, males could expect to live to 62.7 in good health, compared with 63.1 in the period 2016–18. Over the same period, life expectancy increased by twice the amount (0.8 years), meaning the proportion of life spent in good health for males has decreased from 79.9% to 79.5%.[36] For females, healthy life expectancy at birth decreased by 0.2 years between 2009–11 and 2016–18, while life expectancy increased by 0.6 years, resulting in a decrease in the proportion of life spent in good health from 77.4% to 76.7% (see Figure 5). However, healthy life expectancy at age 65 has increased at a faster rate than life expectancy since 2009–11 in England and Wales for both females and males, and in Northern Ireland for females.

32 Office for National Statistics, *Health state life expectancies, UK: 2015 to 2017* (12 December 2018): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2015to2017 [accessed 28 September 2020]
33 Q 4 (Professor Chris Whitty)
34 Q 192 (Professor Sir Michael Marmot)
35 Written evidence from HM Government (INQ0023)
36 Office for National Statistics, *Health state life expectancies, UK: 2016 to 2018* (11 December 2019): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2016to2018 [accessed 28 September 2020]

Figure 5: Change in life expectancy and healthy life expectancy between 2009–11 and 2016–18, for males and females, in the UK



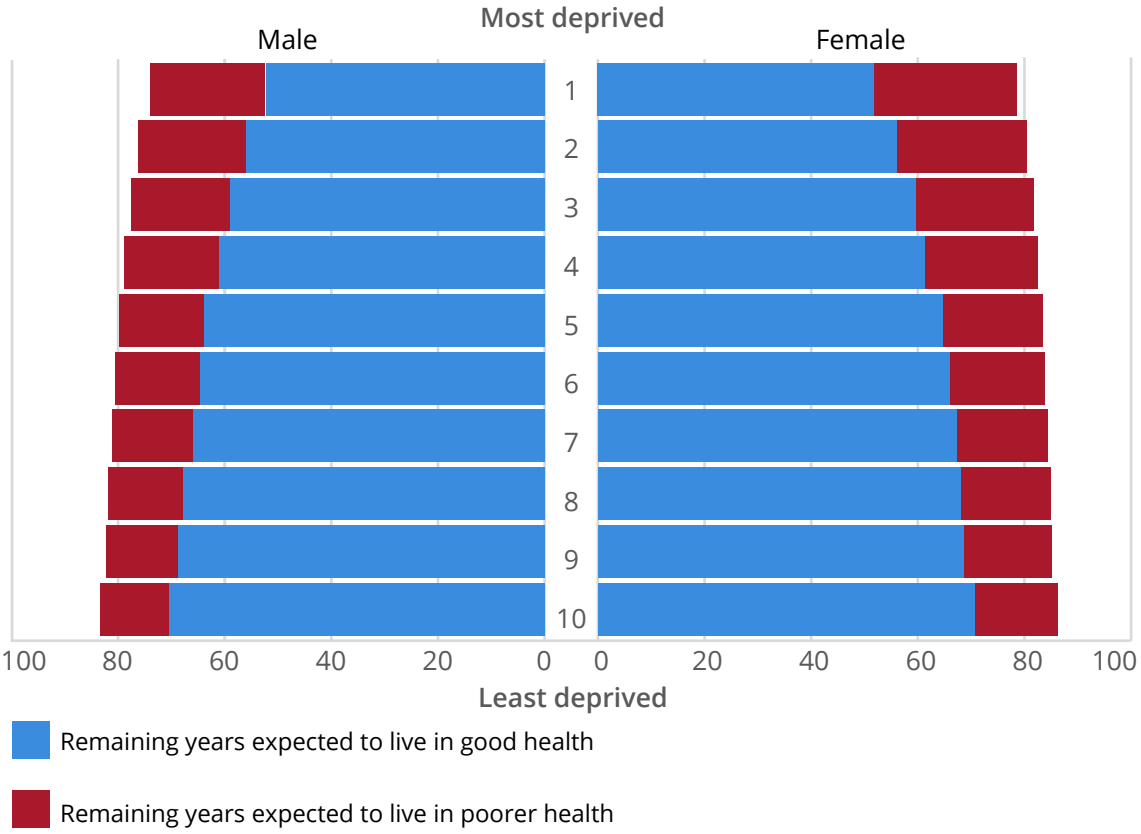
Source: Office for National Statistics (2019) Health state life expectancies, UK: 2016 to 2018: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/healthstatelifeexpectanciesuk/2016to2018 [accessed 28 September 2020]

25. Inequalities in healthy life expectancy are greater than for life expectancy. In England for the period 2016–18, men in the least deprived decile could expect to live in good health to 70.6, whereas men in the most deprived decile could expect to reach only 52.3 in good health. This difference of 18.3 years is almost twice the difference in life expectancy between the most and least deprived deciles (9.5 years).[37] For women, the difference in healthy life expectancy at birth was 18.9 years, more than twice the difference in life expectancy (7.7 years).[38] Figure 6 shows the life expectancy and healthy life expectancy of males and females by level of deprivation.

37 Office for National Statistics, *Health state life expectancies by national deprivation deciles, England: 2016 to 2018* (27 March 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 [accessed 28 September 2020]

38 This report uses the difference between the average value for the most and least deprived deciles. Another measure, the Slope Index of Inequality, can be interpreted in the same way as the difference between the most and least deprived deciles, but also takes into account inequality across the whole distribution and gives greater weight to larger populations. Using this measure, males in the least deprived decile can expect to live 18.9 years longer than males in the most deprived decile; the gap for females is 19.4 years. Both types of measure are used by the Office for National Statistics; see: Office for National Statistics, *Health state life expectancies by national deprivation deciles, England: 2016 to 2018* (27 March 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 [accessed 28 September 2020]

Figure 6: Life expectancy and healthy life expectancy of males and females in the UK, by national deciles of area deprivation (1 = most deprived, 10 = least deprived), 2016–18



Source: Office for National Statistics (2020) Health state life expectancies by national deprivation deciles, England: 2016 to 2018: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthinequalities/bulletins/healthstatelifeexpectanciesbyindexofmultipledeprivationimd/2016to2018 *[accessed 28 September 2020]*

26. Inequalities also exist in healthy life expectancy between different ethnic groups, which exceed inequalities in life expectancy in those groups. Professor Whitty told us that there are "clear patterns … in both mortality and healthy life expectancy in ethnicity", but these "co-locate to a large degree with deprivation".[39] People from ethnic minorities are more likely to live in poverty in older age; 29% of Asian or Asian British people and 33% of Black or Black British people over the age of 65 live in poverty, compared with 14% of White people.[40] The Government told us that inequalities exist across a range of dimensions, including "ethnicity, gender, sexuality and having a disability", and that the "underlying causes of these inequalities often cluster together, with people experiencing 'multiple disadvantage'."[41]

27. Other factors which may account for the differences in healthy life expectancy (and disability-free life expectancy) by ethnicity include: a higher prevalence of chronic disabling conditions in some groups (for example, Indian, Pakistani and Bangladeshi populations have a higher prevalence of cardiovascular

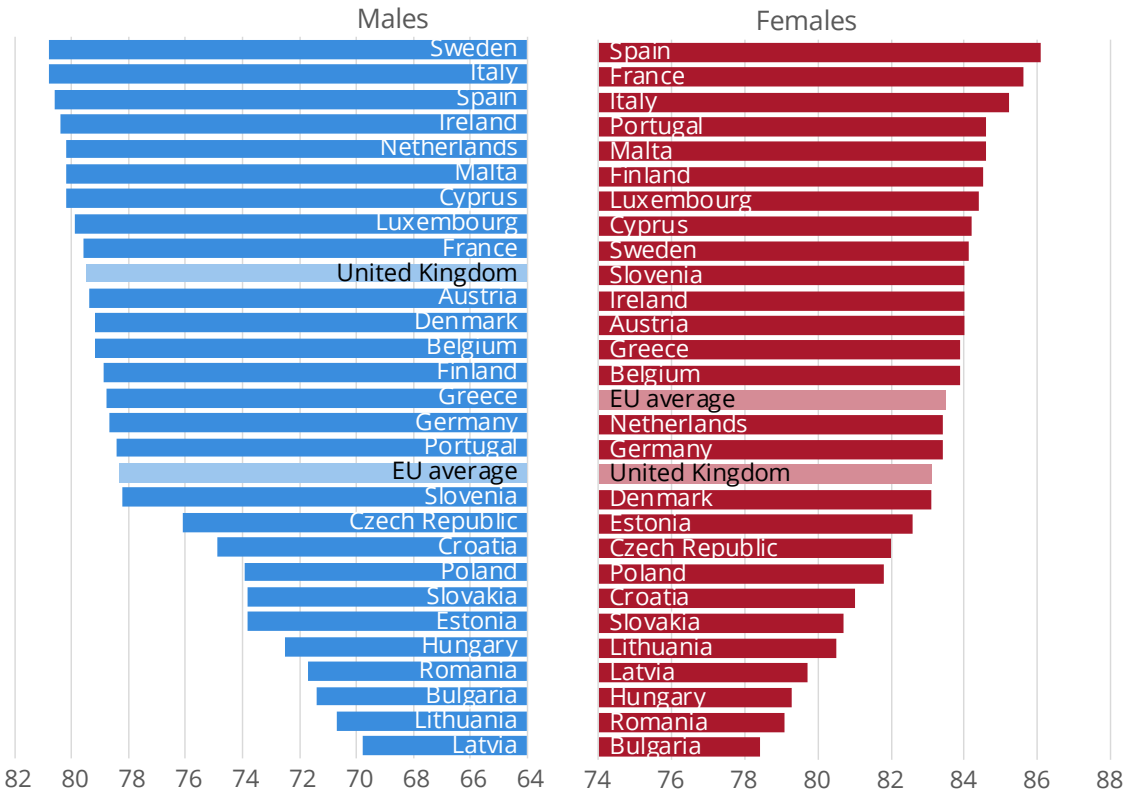
39 Q 4 (Professor Chris Whitty)
40 Centre for Ageing Better, *The State of Ageing in 2019, Adding life to our years* (2019): https://www.ageing-better.org.uk/sites/default/files/2019–04/The-State-of-Ageing-in-2019.pdf [accessed 7 September 2020]
41 Written evidence from HM Government (INQ0023)

disease than other groups); whether large numbers of the group are recent immigrants, and the reasons for such immigration (e.g. for work or fleeing a crisis); and differences in behaviours amongst groups (e.g. prevalence of smoking or levels of physical inactivity). [42]

International comparisons

28. Professor Whitty told us that the UK is "pretty well mid table" compared with EU and other OECD countries, for both healthy life expectancy and life expectancy, though he noted that different countries calculate healthy life expectancy in different ways.[43] For male life expectancy, the UK (79.5) ranked higher than the EU average (78.3) in 2017 (see Figure 7), though its position in the ranking has shifted downwards since 2006 (6th to 10th highest). For females the UK ranked lower than the EU average life expectancy in 2017 (83.1 and 83.5 respectively), and had the same ranking (17th) as in 2006.[44]

Figure 7: Life expectancy at birth for males and females in EU countries, 2017



Source: Public Health England, Health Profile for England: 2019, Chapter 1: Population, deaths, life expectancy and health life expectancy (September 2019): https://www.gov.uk/government/publications/health-profile-for-england-2019 *[accessed 2 November 2020]*

42 Wohland *et al.*, 'Inequalities in healthy life expectancy between ethnic groups in England and Wales in 2001', *Ethnicity & Health*, vol. 20 (2014), pp 341–353: https://doi.org/10.1080/13557858.2014.921892 [accessed 7 September 2020]

43 Q 3 (Professor Chris Whitty)

44 Public Health England, *Health Profile for England: 2019*, Chapter 1: Population, deaths, life expectancy and health life expectancy (24 September 2019): https://www.gov.uk/government/publications/health-profile-for-england-2019 [accessed 28 September 2020]

29. On improvements in life expectancy, Marmot 2020 found that "the UK has seen low rates of life expectancy increases compared with most European and other high-income countries."[45] As of 2016 data, the rate of improvement in life expectancy in the UK was slower than the EU rate for both sexes, although four of the other five largest EU states also experienced a reduced rate of improvement.[46] In a 2016 analysis of 20 countries, females in the UK had the lowest rate of improvement in life expectancy, followed by those in the USA. For males, the UK had the second-lowest rate of improvement, after the USA.[47]

30. **Life expectancy in the UK continues to rise, but since 2011 it has risen at a slower rate. Healthy life expectancy is not keeping pace with increases in life expectancy, resulting in a growing period of poor health towards the end of life. Inequalities in healthy life expectancy are stark, with people in the least deprived groups living more than 18 years longer in good health than those in the most deprived groups.**

31. ***We recommend that the Government, along with NHS England, Public Health England, and other agencies, prioritise reducing health inequalities. In its response to this report we request that the Government sets out a plan for reducing health inequalities over the next Parliament.***

Age-related diseases

32. We heard that ageing is the primary risk factor for a wide range of diseases, often referred to as age-related diseases.[48] Age-related diseases include cardiovascular disease, diabetes, hypertension, neurological diseases, cancer and arthritis.[49] In 2017, the leading cause of morbidity in England for males aged 70 and over was low back pain, followed by age-related hearing loss[50] and diabetes.[51] For females aged 70 and over, the two leading causes were also low back pain and age-related hearing loss, followed by chronic obstructive pulmonary disease.[52]

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45 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020): http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]

46 Public Health England, *Health Profile for England: 2018, Research and analysis*, Chapter 1: population change and trends in life expectancy (11 September 2018): https://www.gov.uk/government/publications/health-profile-for-england-2018/chapter-1-population-change-and-trends-in-life-expectancy [accessed 2 November 2020]

47 Office for National Statistics, *Changing trends in mortality: an international comparison: 2000 to 2016* (7 August 2018): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/lifeexpectancies/articles/changingtrendsinmortalityaninternationalcomparison/2000to2016 [accessed 28 September 2020]

48 Q 36 (Professor Dame Linda Partridge). See also: Carlos López-Otín *et al.*, 'The Hallmarks of Aging', *Cell*, vol. 153 (June 2013) pp 1194–1217: https://www.sciencedirect.com/science/article/pii/S0092867413006454?via%3Dihub [accessed 7 September 2020]

49 Efraim Jaul and Jeremy Barron, *'Age-Related Diseases and Clinical and Public Health Implications for the 85 Years Old and Over Population', Frontiers in Public Health* (2017): https://doi.org/10.3389/fpubh.2017.00335 [accessed 7 September 2020]

50 In written evidence, Action on Hearing Loss (INQ0013) told us that over 70% of people aged 70 and over experience hearing loss, which can impact quality of life and productivity, and has been linked to an increased risk of dementia.

51 Public Health England, *Health Profile for England: 2019* (24 September 2019): https://www.gov.uk/government/publications/health-profile-for-england-2019 [accessed 7 September 2020]

52 *Ibid.*

33. Alongside physical conditions, mental health conditions are a leading cause of years lived with disability.[53] The most common mental health conditions in England are depression and anxiety, with nearly half of adults over the age of 55 saying they have experienced depression, and a similar number for anxiety.[54] Dr Chris Blackmore, Lecturer in Mental Health at the University of Sheffield, told us that data from the Adult Psychiatric Morbidity Survey show that "older people suffer much lower rates of mental disorder than their younger counterparts in their lifespan", which might suggest that "there is something protective about older adulthood".[55] However, he highlighted that living alone, which is more prevalent for older people, "seems to double your chance of experiencing a common mental health issue".[56]

34. We heard that loneliness is a risk factor for mental health and physical health conditions. Dr Blackmore told us:

> "The research shows that being chronically lonely puts you at much greater risk of many physical and mental health conditions. For example, you are twice as likely to develop frailty or dementia. You are nearly three times as likely if you are chronically lonely to be physically inactive, which puts you at greater risk of developing other health conditions such as diabetes, heart disease and having a stroke, and you are more than three times more likely to suffer depression."[57]

35. While the Centre for Ageing Better told us that "overall, older people are no more likely to report feeling lonely than younger people",[58] the NHS and Age UK have suggested that older people may be particularly vulnerable to loneliness, due to factors such as increased frailty, disability, and the deaths of spouses and friends.[59]

Frailty

36. Alongside an enhanced prevalence of age-related diseases, older people are more likely to experience frailty, which can exacerbate their response to conditions and other stressors. Professor Simon Conroy, Professor of Geriatric Medicine at the University of Leicester, explained:

> "Frailty describes a decline in function across multiple organ systems, linked to ageing but progressing at different rates in different people. It is characterised by vulnerability to poor outcomes in individuals exposed to an apparently innocuous stressor, such as a minor infection."[60]

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53 HM Government, *Advancing our health: prevention in the 2020s*, CP 110, July 2019: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/819766/advancing-our-health-prevention-in-the-2020s-accessible.pdf [accessed 7 September 2020]

54 Age UK, *'Half of adults aged 55 and over have experienced mental health problems'* (6 October 2017): https://www.ageuk.org.uk/latest-news/articles/2017/october/half-aged-55-have-had-mental-health-problems/ [accessed 7 September 2020]

55 Q 125 (Dr Chris Blackmore)

56 Q 126 (Dr Chris Blackmore)

57 Q 125 (Dr Chris Blackmore)

58 Written evidence from the Centre for Ageing Better (INQ0016)

59 NHS, *'Loneliness in older people'* (4 September 2018): https://www.nhs.uk/conditions/stress-anxiety-depression/loneliness-in-older-people/ [accessed 7 September 2020]. See also Age UK, *All the Lonely People: Loneliness in Later Life* (September 2018): https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/reports-and-briefings/loneliness/loneliness-report_final_2409.pdf [accessed 7 September 2020]

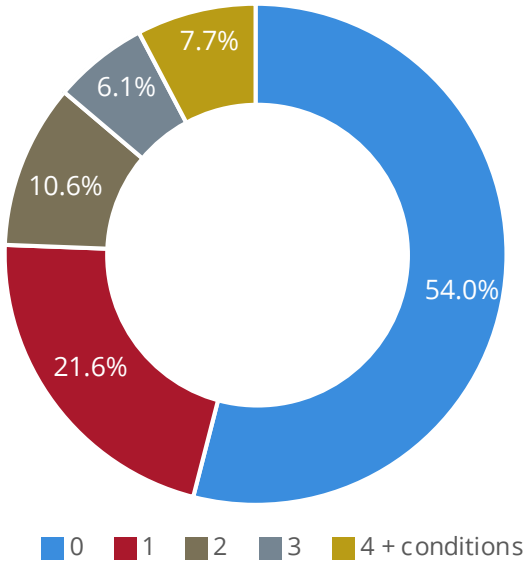
60 Written evidence from Professor Simon Conroy (INQ0003)

37. The British Geriatrics Society states that, as of 2014, around 10% of people over the age of 65 had frailty, increasing to between a quarter and a half of people aged 85 or over.[61] Professor Conroy told us that frailty "predicts the risk of falls, delirium, disability, [hospital] readmission and care home admission."[62]

Multimorbidity

38. Multimorbidity is the state of having two or more long-term conditions.[63] A study by the Health Foundation using data from 2014 found that one in four people sampled had two or more conditions (see Figure 8). They estimated that this equated to around 14.2 million people in England as of September 2018.[64] One in 12 people had four or more conditions, equivalent to 4.7 million people in England. The most common conditions included hypertension, a painful condition, depression or anxiety, and hearing loss.[65]

Figure 8: Estimated percentage of people in England with 0, 1, 2, 3 or 4+ conditions, 2014. Based on analysis by the Health Foundation of data from the Clinical Practice Research Datalink.



Source: The Health Foundation (2018), Understanding the health care needs of people with multiple health conditions: https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 2 November 2020]

61 British Geriatrics Society in association with the Royal College of General Practitioners and Age UK, *'Introduction to Frailty: Fit for Frailty Part 1'* (11 June 2014): https://www.bgs.org.uk/resources/introduction-to-frailty [accessed 7 September 2020]

62 Written evidence from Professor Simon Conroy (INQ0003)

63 The Richmond Group of Charities, *Multimorbidity: Understanding the Challenge* (January 2018): https://richmondgroupofcharities.org.uk/sites/default/files/multimorbidity_-_understanding_the_challenge.pdf [accessed 7 September 2020]

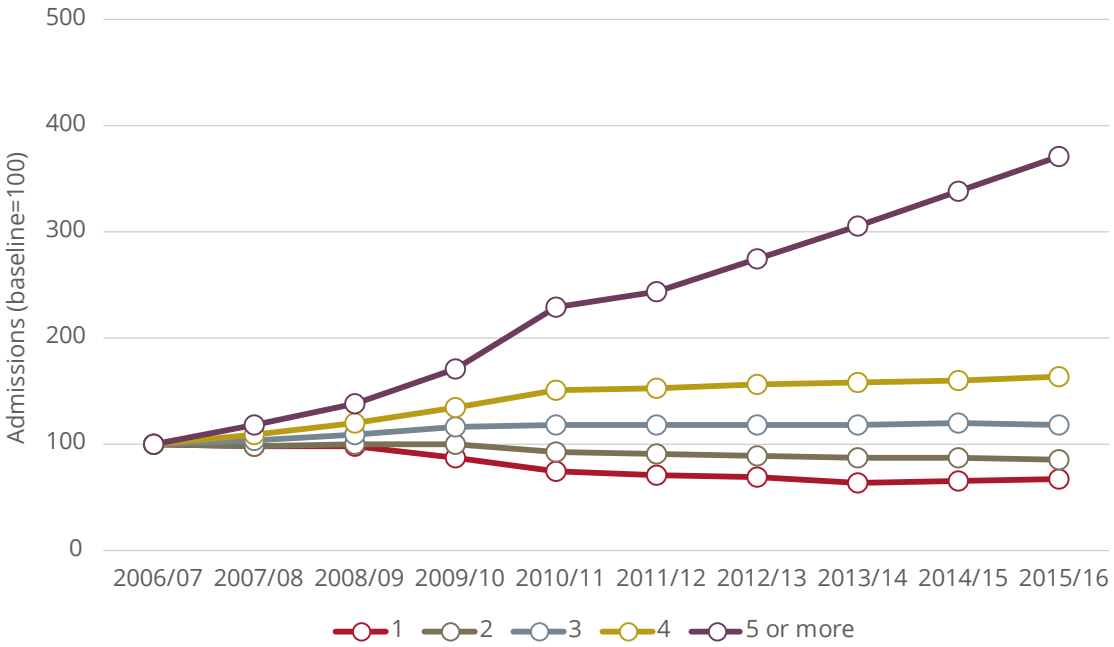
64 According to the Health Foundation, this is an estimate based on September 2018 figures of 59,297,331 patients registered at a GP practice in England: The Health Foundation, *Understanding the health care needs of people with multiple health conditions* (November 2018): https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 2 November 2020]

65 The Health Foundation, *Understanding the health care needs of people with multiple health conditions* (November 2018): https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 2 November 2020]

39. Multimorbidity is more common in older age groups. Professor Marcus Richards, Programme Leader at the MRC Unit for Lifelong Health and Ageing at University College London, told us that "the risk of multimorbidity strongly increases with age".[66] The Government told us that "multimorbidity is now the norm among older people in the UK".[67] A 2012 study based on patient data from 314 medical practices in Scotland (covering over 1.7 million patients) found that, by age 50, half of the population had at least one condition and by age 65 most people had multimorbidity.[68]

40. Evidence suggests that the prevalence of multimorbidity is increasing and will continue to do so. The number of patients admitted to hospital as an emergency in England with three or more conditions increased between 2006–07 and 2015–16 (see Figure 9). In 2006–07, one in 10 patients admitted to hospital as an emergency in England had five or more conditions; by 2015–16, it was one in three.[69] A 2018 study projected that, between 2015 and 2035, the proportion of people with four or more conditions is expected almost to double, and for two-thirds of those people one of the conditions will be related to mental or cognitive health.[70]

Figure 9: Trends in emergency hospital admissions in England by number of conditions, compared with 2006–07 baseline. Based on analysis by the Health Foundation of Hospital Episodes Statistics data.



Source: The Health Foundation, Emergency Hospital Admissions in England: Which May be Avoidable and How? (November 2018): https://www.health.org.uk/publications/emergency-hospital-admissions-in-england-which-may-be-avoidable-and-how?gclid=Cj0KCQjwsYb0BRCOARIsAHbLPhFdZyal4uj2ZwmY4gx7ZC9UX4fyF76BVc2adG4pzg63WJGUMHXy4KQaAsTbEALw_wcB [accessed 2 November 2020]

66 Q 15 (Professor Marcus Richards)
67 Written evidence from HM Government (INQ0023)
68 Karen Barnett *et al.*, 'Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study', *The Lancet*, vol 380, (July 2012), pp 37–43 : https://www.thelancet.com/journals/lancet/article/PIIS0140–6736(12)60240-2/fulltext [accessed 7 September 2020]
69 The Health Foundation, *Emergency Hospital Admissions in England: Which May be Avoidable and How?*, (November 2018) https://www.health.org.uk/sites/default/files/Briefing_Emergency%2520admissions_web_final.pdf [accessed 2 November 2020]
70 Andrew Kingston *et al.*, 'Projections of multi-morbidity in the older population in England to 2035: estimates from the Population Ageing and Care Simulation (PACSim) model', *Age and Ageing*, vol. 47 (May 2018), pp 374–380: https://academic.oup.com/ageing/article/47/3/374/4815738 [accessed 7 September 2020]

41. Data from longitudinal studies can indicate the incidence of multimorbidity in cohorts of people and how they have changed over time. Professor Richards explained some of the trends seen in the 1946 birth cohort:[71]

> "on average, at age 60 to 64, people had two conditions. Only about 15% were disorder-free, about 20% had four or more disorders, and about 10% had five or more disorders: the most common were hypertension, obesity, raised cholesterol and diabetes or impaired fasting glucose. There is a small cluster with a very high probability of those conditions; another key factor was that they were in the poorest health in their mid-30s."[72]

Professor Richards noted that this finding was particularly surprising as, like in most cohort studies, "there is a retention of the more socially advantaged and the healthier, and a selective dropout over time of people who are less healthy".[73]

42. We heard that the onset of multimorbidity is occurring earlier in life in more recent cohorts. Professor Richards told us:

> "One of the key differences across the cohorts is in the growth of obesity … Since 1946, every generation has been heavier than the previous one, and people are becoming overweight at an earlier stage. In the 1946 generation, people reached overweight around the mid-40s. In the cohort of people born in 1970, that has dropped down to about 35. That means that people are living longer with these conditions, which will almost certainly impact on coronary heart disease, diabetes and arthritis, and that is projected to cost the NHS about £23 billion per year."[74]

43. Professor James Nazroo, Professor of Sociology at the University of Manchester, concurred, explaining that in the English Longitudinal Study of Ageing:

> "something like two-fifths of the 50-and-older population are classified as multimorbidity in their diagnosis. This is increasing to about 50% in more recent cohorts. Something like 15% of the 50-and-older population have more than one body system involved in disease. This is increasing to about 20% in more recent cohorts".[75]

44. There is evidence that certain morbidities tend to cluster together, and the prevalence of certain conditions can affect the likelihood of others. For example, the Health Foundation found that if a person had hypertension they would have, on average, an additional 2.1 conditions, while people with depression or anxiety typically had a further 2.0 conditions (see Figure 10). The report found that "82% of people with cancer, 92% with cardiovascular disease, 92% with chronic obstructive pulmonary disease (COPD), and

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71 Medical Research Council, '*MRC National Survey of Health and Development Cohort/1946 Birth Cohort (NSHD/1946BC)*', (March 2015): https://mrc.ukri.org/research/facilities-and-resources-for-researchers/cohort-directory/mrc-national-survey-of-health-and-development-cohort-1946-birth-cohort-nshd-1946bc/ [accessed 7 September 2020]

72 Q 14 (Professor Marcus Richards). See also the footnote in the transcript, in which Professor Richards provided more detail about this cluster: "A cluster of one in five individuals had a high probability of cardio-metabolic disorders and were twice as likely than others to have been in the poorest health at 36 years."

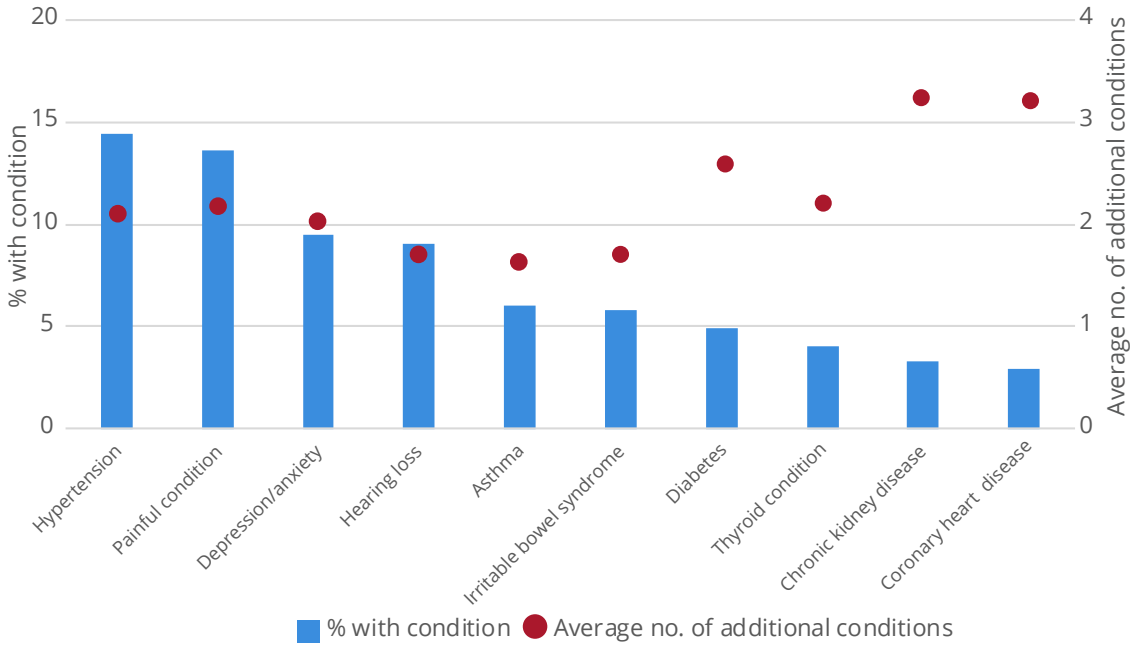
73 Q 14 (Professor Marcus Richards)

74 *Ibid.*

75 Q 15 (Professor James Nazroo)

70% with a mental health condition had at least one additional condition", meaning that for people with those conditions multimorbidity "is now the norm".

Figure 10: Common conditions and the average number of additional conditions, 2014. Based on analysis by the Health Foundation of data from the Clinical Practice Research Datalink.



Source: The Health Foundation , Understanding the health care needs of people with multiple health conditions (November 2018): https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 2 November 2020]

45. There is evidence that patterns in, and clustering of, multimorbidities are linked to socioeconomic deprivation. The 2012 analysis of medical practice data in Scotland found that the onset of multimorbidity occurred "10–15 years earlier in people living in the most deprived areas compared with the most affluent".[76] Of people in the least deprived decile, 19.5% had multimorbidity, compared with 24.5% of people in the most deprived decile. They noted that, while in general the presence of a mental health condition increased as the number of physical conditions increased, this relationship was stronger for people in the most deprived deciles (11% of whom had physical and mental health co-morbidities) compared with the least deprived decile (5.9%).

46. A 2018 report by the Academy of Medical Sciences argued that further evidence is needed on the clustering of multimorbidities, including how they change over time and whether particular clusters of conditions are more prevalent in particular communities or subgroups of the population, as with some individual chronic conditions.[77] The report noted that much of the

76 Karen Barnett *et al.*, 'Epidemiology of multimorbidity and implications for health care, research, and medical education: a cross-sectional study', *The Lancet*, vol 380, (July 2012), pp 37–43: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(12)60240-2/fulltext [accessed 7 September 2020]

77 Academy of Medical Sciences, *Multimorbidity: a priority for global health research* (April 2018): https://acmedsci.ac.uk/file-download/82222577 [accessed 7 September 2020]

research into multimorbidity clusters has been "largely descriptive and has not extended to the investigation of common causal factors or pathological processes" of clustering conditions.[78]

47. **Multimorbidity—the state of having two or more long-term conditions—is more common in old age. There is evidence that the rate of multimorbidity is increasing, so it will become an increasing issue for the NHS. The environmental and biological factors driving the development of multimorbidity are not fully understood.**

Coordination of healthcare for older people

48. With the rising prevalence of multimorbidity, particularly among older people, a major challenge is the coordination of care and treatment for people who have multiple conditions. Several witnesses told us that in the current system healthcare is provided on a condition-by-condition basis. Professor Miles Witham, Professor of Trials for Older People at Newcastle University, explained:

> "Historically the NHS was designed, or has evolved, to deal with single problems in single-organ systems. It has evolved to deal with episodic care. It is less good and less well designed to deal with chronic care. It is particularly poorly equipped to deal with multiple problems affecting a single person."[79]

49. Dr Maggie Keeble, a GP and co-founder of the British Geriatric Society's GeriGPs Group, explained that most long-term monitoring of conditions happens within primary care. However, because GPs and district nurses often have particular interest areas, face-to-face reviews are usually "disease specific" and conducted by different clinicians depending on the condition. This means that "patients with multiple conditions will need to see a number of different people within the practice for a certain disease review."[80]

50. We heard that patients may not be able to see the same clinicians each time they visit. The Northern Health Science Alliance told us that treating people in "condition silos" means that "there is no health professional who can address the needs of that *person* (as opposed to their conditions)."[81] Dr Keeble told us: "Increasingly patients are unable to see the same clinician for interval problems"; this "lack of continuity results in increased investigations and referrals."[82] In 2013, the then-Secretary of State for Health proposed that vulnerable older people being treated in the NHS should have a named primary care clinician to oversee their care outside of hospital.[83] However, this proposal does not appear to have been implemented.

51. Dr Keeble also thought there is a "lack of coordination between reviews for different conditions".[84] This means that often multiple sets of blood tests and face-to-face appointments are needed for a single patient. Analysis by the

78 *Ibid.*, p32
79 Q 37 (Professor Miles Witham)
80 Written evidence from Dr Maggie Keeble (INQ0100)
81 Written evidence from Northern Health Science Alliance (INQ0053)
82 Written evidence from Dr Maggie Keeble (INQ0100)
83 *Department of Health and Social Care*, 'New proposals to improve care for vulnerable older people' (5 July 2013): https://www.gov.uk/government/news/new-proposals-to-improve-care-for-vulnerable-older-people [accessed 5 October 2020]
84 Written evidence from Dr Maggie Keeble (INQ0100)

Health Foundation found that the average number of appointments attended in England is considerably higher for a person with multimorbidity:

> "patients with 4+ conditions had an average of 8.9 outpatient visits across 2.8 different medical specialties. Over the study period,[85] they visited their general practice 24.6 times (or once a month on average) and were prescribed 20.6 different medications. This compares with the 2.8 outpatient visits, 8.8 visits to the general practice, and 5.6 different medications for patients with one condition."[86]

The report found that those with multiple conditions did not on average spend significantly longer with their GP on each visit, despite having more complex needs.

52. This lack of coordination across the health system places a burden on people with multimorbidity, and can be confusing for them.[87] A 2018 report by the Richmond Group of Charities on multimorbidity noted that "as a result of having to engage with a fragmented and siloed system, people living with multiple conditions are often in contact with multiple health professionals, and are more likely to report care coordination problems". It found that "patients with three or more long-term conditions are 25–40 per cent more likely to report care coordination problems than those with a single condition."[88] The report noted that people with multiple conditions are likely to be particularly vulnerable to adverse consequences arising during transitions in care, which are "further complicated by poor communication and inadequate data flow across the health and care system."[89]

53. A particular care coordination challenge is that patients with multimorbidity can end up following several different, possibly contradictory, care pathways. Professor Whitty told us that "we do not have the science of properly linking up different diseases, which may well have a common pathway", meaning that a person with multiple conditions may attend "six different clinics and follow six different NICE [National Institute for Health and Care Excellence] pathways."[90] The Health Foundation explained that "specialists in outpatient departments are not set up to provide joined-up treatment", and so "those specialists might be treating the patient according to condition-specific guidelines, rather than considering what other conditions the patient has

85 The study period was 2014–16.

86 The Health Foundation, *Understanding the health care needs of people with multiple health conditions*, (November 2018), p 2: https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 5 October 2020]

87 The Taskforce on Multiple Conditions, *"Just one thing after another": living with multiple conditions* (October 2018): https://richmondgroupofcharities.org.uk/sites/default/files/final_just_one_thing_after_another_report_-_singles.pdf [accessed 5 October 2020]. See also Elizabeth Bayliss *et al.*, 'Processes of care desired by elderly patients with multimorbidities', *Family Practice*, vol. 25 (2008), pp 287–293: https://academic.oup.com/fampra/article/25/4/287/606449 [accessed 5 October 2020]

88 The Richmond Group of Charities, *Multimorbidity: Understanding the Challenge* (January 2018), p 19: https://richmondgroupofcharities.org.uk/sites/default/files/multimorbidity_-_understanding_the_challenge.pdf [accessed 5 October 2020]

89 The Richmond Group of Charities, *Multimorbidity: Understanding the Challenge* (January 2018), p 4: https://richmondgroupofcharities.org.uk/sites/default/files/multimorbidity_-_understanding_the_challenge.pdf [accessed 5 October 2020]

90 Q 9 (Professor Chris Whitty)

and coordinating their advice and treatment."[91] The Richmond Group of Charities argued that "existing clinical guidelines and quality standards are not based on, and do not reflect, the lived experiences of people with multiple health conditions", and while "efforts are currently underway to increase the applicability of NICE clinical guidelines and quality standards to people living with multimorbidity", the uptake of updated guidelines is currently uncertain.[92]

54. Dr Keeble told us that condition-specific pathways are a particular challenge when treating people who also have frailty. She explained that it is important that clinicians adopt a "Frailty Sensitive Approach" to care, ensuring that "individual's wishes and preferences are discussed with them". However, she told us:

> "At the moment all systems are disease orientated, protocol driven and pathway aligned. We need to shift the focus to being person orientated, choice driven and priorities aligned. We are living in a system which is entirely based on clinical algorithms and pathways which does not support a personalised approach to care. Adopting a Frailty Sensitive Approach means departing from guidelines and accepting uncertainty and risk."[93]

55. Professor Russell Foster, Professor of Circadian Neuroscience at the University of Oxford, gave an example of how a lack of coordination between departments can result in additional negative health outcomes for older people.[94] He explained that older people are frequently prescribed sleeping tablets for insomnia, which can also cause daytime sleepiness, which may in turn contribute to increased falls in older people. A more co-ordinated approach to care for people with multi-morbidities would aim to avoid such indirect adverse effects.

56. We heard several suggestions for how care for older patients with multimorbidity could be better coordinated. Several witnesses suggested that GPs need access to more training in how to provide holistic care to older patients and those with multimorbidity, given that most care takes place in primary care settings rather than hospitals. The British Geriatrics Society told us:

> "General practice is the cornerstone of the NHS … However the GP contractual system has historically incentivised recognising and responding to individual conditions and very few GPs have had specific training in caring for older people living with frailty."[95]

57. We heard that better coordination between primary and secondary care will be vital for ensuring more coordinated care for older patients and those with multimorbidity. Dr Keeble told us that "there remains very

91 The Health Foundation, *Understanding the health care needs of people with multiple health conditions*, (November 2018), p 10: https://www.health.org.uk/sites/default/files/upload/publications/2018/Understanding%20the%20health%20care%20needs%20of%20people%20with%20multiple%20health%20conditions.pdf [accessed 5 October 2020]

92 The Richmond Group of Charities, *Multimorbidity: Understanding the Challenge* (January 2018), p 19: https://richmondgroupofcharities.org.uk/sites/default/files/multimorbidity_-_understanding_the_challenge.pdf [accessed 5 October 2020]

93 Written evidence from Dr Maggie Keeble (INQ0100)

94 Q 118 (Professor Russell Foster)

95 Written evidence from the British Geriatrics Society (INQ0101). See also written evidence from Dr Maggie Keeble (INQ0100).

poor coordination between Primary and Secondary Care with very limited sharing of information".[96] The British Geriatrics Society agreed, telling us that healthcare professionals working in different settings often use different IT systems, "making seemingly simple things like sharing patient records difficult".[97]

58. NHS England and NHS Improvement told us that they have been "introducing improvements in coordination and collaboration across primary and secondary care", including via the "New GP contract", which "paves the way for thousands of pharmacists and pharmacy technicians to … create new multidisciplinary teams across primary care in England over the next four years".[98]

59. Another suggestion for improving care was better and more regular use of Comprehensive Geriatric Assessments (CGAs). According to the British Geriatrics Society, CGAs consist of a "multidimensional holistic assessment of an older person [which] considers health and wellbeing and leads to the formulation of a plan to address issues which are of concern to the older person (and their family and carers when relevant)." [99] NHS England and NHS Improvement told us that the aim of CGAs is to "develop a coordinated, integrated plan for treatment and long-term support and reduce impact and extend healthy life."[100]

60. Once in place, interventions are arranged in support of the CGA. Birmingham Health Partners wrote, "we know CGA works; [they] reduce the time people spend in hospitals, and increase their chances of being alive, and living in their own home."[101] CGAs are mentioned in the NHS Long Term Plan as a method for reducing avoidable hospital admissions.[102]

61. However, we heard that CGAs are mostly undertaken in hospital settings, by geriatricians, and the extent to which they are used in primary care settings is not known.[103] Dr Keeble told us:

> "Until very recently the CGA has been the domain of Geriatricians. GPs were not and many are still not aware of or use it … Short appointments and home visiting only when requested by the patient or carer as a result of a deterioration doesn't allow for the time required to undertake a lengthy intervention in a planned proactive manner."[104]

62. Birmingham Health Partners thought that application of CGAs outside of hospitals is "hampered by the resource requirement to deliver it—we need

96 Written evidence from Dr Maggie Keeble (INQ0100)
97 Written evidence from the British Geriatrics Society (INQ0101)
98 Written evidence from NHS England and NHS Improvement (INQ0102)
99 British Geriatrics Society, *Comprehensive Geriatric Assessment Toolkit for Primary Care Practitioners* (2019) p 3: https://www.bgs.org.uk/sites/default/files/content/resources/files/2019–02-08/BGS%20Toolkit%20-%20FINAL%20FOR%20WEB_0.pdf [accessed 5 October 2020]
100 Written evidence from NHS England and NHS Improvement (INQ0102)
101 Written evidence from Birmingham Health Partners (BHP) (INQ0051)
102 NHS England, *The NHS Long Term Plan* (January 2019), p 22: https://www.longtermplan.nhs.uk/wp-content/uploads/2019/08/nhs-long-term-plan-version-1.2.pdf [accessed 5 October 2020]
103 Written evidence from Birmingham Health Partners (BHP) (INQ0051)
104 Written evidence from Dr Maggie Keeble (INQ0100)

more geriatricians, and more therapists trained to deliver CGA".[105] Dr Keeble agreed:

> "Training of medical students and for GPs doesn't to my knowledge include training on the use of CGA … Another barrier to completion of a CGA is a lack of integrated computer systems enabling the compilation of information already held by different professionals working in different parts of the system. Primary, secondary, community and social care usually work of different systems which differ again from emergency and out of hours services."[106]

However, we heard that once the resources and expertise to conduct CGAs are in place, it is a "cheap intervention."[107]

63. We also heard that it is important that multidisciplinary teams are involved in compiling a CGA. Dr Keeble told us: "The elements of the CGA can be compiled by a single individual but it is more efficient and likely to be more detailed if contributed to by all members of a multidisciplinary team including social workers."[108] However, we heard from both Dr Keeble and the British Geriatrics Society that social workers are often not involved in these discussions, as health care and social care are highly "siloed".[109]

64. Finally, witnesses told us that there is a need for more geriatricians, in both hospital and community settings. The British Geriatrics Society told us that:

> "More geriatricians are always needed—the 2018–19 [Royal College of Physicians of London] census found that 72% of Higher Specialty Trainees and 59% of consultants in geriatric medicine reported that a gap in the rota occurred daily or weekly … However, while we will always need hospital-based doctors, the NHS is moving towards a model of providing more care in the community and this is often preferred by patients. As such, we need more geriatricians to work in the community as well as in a hospital setting."[110]

65. NHS England and NHS Improvement told us: "Geriatricians should be a part of the local population health team", and "The role of oversight should be that of the local system."[111]

66. **Care pathways are not well coordinated or integrated for older people, particularly those with multimorbidity. Patients often have to see multiple doctors, with multiple specialisms, with little coordination between specialists to reduce the burden on patients.**

67. ***We recommend that, as was proposed in 2013, the NHS ensures that all older patients have a designated clinician. This clinician would have oversight of the patient's care as a whole, and should coordinate activity across multidisciplinary teams, which should include members from across the health and social care sectors. The***

105 Written evidence from Birmingham Health Partners (BHP) (INQ0051)
106 Written evidence from Dr Maggie Keeble (INQ0100)
107 Written evidence from Birmingham Health Partners (INQ0051)
108 Written evidence from Dr Maggie Keeble (INQ0100)
109 Written evidence from Dr Maggie Keeble (INQ0100) and British Geriatrics Society (INQ0101)
110 Written evidence from the British Geriatrics Society (INQ0101)
111 Written evidence from NHS England and NHS Improvement (INQ0102)

clinician could be from either primary or secondary care, depending on the patient's needs.

68. ***We recommend that designated clinicians for older people ensure that Comprehensive Geriatric Assessments are used regularly for older patients, particularly for those with multimorbidity. The Government should ensure that training in how to conduct Comprehensive Geriatric Assessments is a core part of medical training, and that training is provided on an ongoing basis, in particular to GPs.***

Polypharmacy

69. The treatment of conditions in silos, via multiple appointments with different clinicians, has led to increased polypharmacy (the prescription of multiple drugs). Professor Sir Munir Pirmohamed, Professor of Molecular and Clinical Pharmacology at the University of Liverpool and President-elect of the British Pharmacological Society, told us that polypharmacy is a "major problem".[112] According to the British Pharmacological Society, "over 1 million people in the UK take eight or more medicines per day".[113]

70. Polypharmacy creates several problems. First, it is burdensome for patients and can lead to confusion and frustration. Professor Witham explained:

> "If you are a patient and you are having to attend appointments in six clinics, take 20 medications a day and undertake multiple, different self-care behaviours that have been recommended by your physicians, the number of hours in a month that that takes is truly enormous. A study in 2015 suggested that if you have six conditions and you adhere to all the guidelines, you will be looking after yourself—self-care appointments—for 80 hours a month. That is not uncommon and is a huge burden."[114]

71. Polypharmacy heightens the risk of adverse drug reactions. Research suggests that older adults are more susceptible to adverse drug reactions than younger adults, and polypharmacy can compound this.[115] Dr Keeble explained:

> "As people age, they are more likely to suffer adverse effects from medication prescribed for a number of conditions. The causes of this are multiple: older people may have liver and kidney problems meaning drugs are not excreted as efficiently causing a build-up in the system. They may lose weight over time meaning that the amount of drug available to the body increases."[116]

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112 Q 38 (Professor Sir Munir Pirmohamed)
113 Written evidence from the British Pharmacological Society (INQ0031)
114 Q 37 (Professor Miles Witham)
115 E A Davies and M S O'Mahony, 'Adverse drug reactions in special populations—the elderly', *British Journal of Clinical Pharmacology*, vol. 80 (October 2015), pp 796–807: https://doi.org/10.1111/bcp.12596 [accessed 5 October 2020]. See also Kristina Johnell and Inga Klarin, 'The relationship between number of drugs and potential drug-drug interactions in the elderly', *Drug Safety*, vol. 30 (October 2007), pp 911–918: https://doi.org/10.2165/00002018–200730100-00009 [accessed 5 October 2020]; and Maryann Fulton and Elizabeth Allen, 'Polypharmacy in the elderly: a literature review', *Journal of the American Academy of Nurse Practitioners*, vol. 17 (April 2005), pp 123–132: https://doi.org/10.1111/j.1041–2972.2005.0020.x [accessed 5 October 2020]
116 Written evidence from Dr Maggie Keeble (INQ0100)

72. Professor Pirmohamed told us that drug-drug interactions are usually considered binary—"one drug, a victim, interacting with a perpetrator"—but:

> "Actually, when you have 15 drugs, there are three, four or five-way interactions going on, together with your renal and hepatic functions, which compounds the problem and leads to the adverse drug reactions that are common in this age group and often not picked up in routine clinical care."[117]

These side effects may cause patients to stop taking some of the drugs, leading to a "vicious cycle".[118]

73. Adverse drug reactions are a significant cause of hospital admissions. Professor Pirmohamed told us that "of the general population coming into hospital, 6.5% of patients are admitted because of adverse drug reactions, and 15% of patients develop adverse drug reactions while in hospital" equating to 8,000 hospital beds in use by patients with adverse drug reactions.[119]

74. Polypharmacy can increase the risk of other negative health outcomes. Professor Witham explained:

> "typically, over half the number of people we see in a falls clinic will be on a medication that we know contributes to their risk of falls. Typically half of people in hospital who have delirium, a confusional state, have medications that are contributing to that delirium state. We know that that is a very dangerous state. It makes dementia more likely and means that people are likely to stay longer in hospital."[120]

75. Polypharmacy is costly for the NHS. The British Pharmacological Society told us that "total NHS expenditure on drugs was estimated to be £17.4 billion in 2016/17 and is growing at an average of around 5% per year."[121] Professor Pirmohamed said that a recent report commissioned by NHS England estimated that the cost to the NHS of medication errors (including adverse drug reactions) is £1.6 billion per year.[122]

76. We heard that solving the problems of polypharmacy will require "regular structured medication reviews", and a coordinated approach across different specialisms.[123] Professor Pirmohamed told us that while the current system of medicine reviews conducted by pharmacists can help reduce some of the issues of polypharmacy, "when you have a very complicated patient with seven diseases and on 15 drugs, deciding which one to stop and having that conversation with the patient is quite complicated".[124] He told us that multidisciplinary teams covering "care of the elderly, clinical pharmacology,

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117 Q 38 (Professor Sir Munir Pirmohamed)
118 *Ibid.*
119 *Ibid.*
120 Q 38 (Professor Miles Witham)
121 Written evidence from the British Pharmacological Society (INQ0031)
122 Q 38 (Professor Sir Munir Pirmohamed). See also: Policy Research Unit in Economic Evaluation of Health & Care Interventions (EEPRU), *Prevalence and Economic Burden of Medication Errors in The NHS in England* (22 February 2018): https://test.bpsassessment.com/wp-content/uploads/2018/07/1.-Prevalence-and-economic-burden-of-medication-errors-in-the-NHS-in-England.pdf [accessed 5 October 2020].
123 Written evidence from the British Geriatrics Society (INQ0101). See also written evidence from Dr Maggie Keeble (INQ0100).
124 Q 38 (Professor Sir Munir Pirmohamed)

pharmacy and general practice" would be required to solve the problems of polypharmacy, but "we do not have a model of care like that at the moment".[125]

77. We heard that more effective medicine reviews will require greater involvement and awareness by pharmacists. Dr Keeble told us that "Clinical pharmacists are becoming more common in the system", but "there is a range in expertise with some colleagues being very aware of older people's needs and others being less well informed".[126] She added that there tends to be "insufficient interaction, coordination and communication" between pharmacists working in different care settings, which results in errors.[127]

78. We were told that there is also a need for more pharmacologists (scientists who study drugs and how they affect the body) in the UK.[128] Dr Lauren Walker of the University of Liverpool and Chair of the Specialty Training Registrars Committee at the British Pharmacological Society, explained that clinical pharmacologists are not single-organ specialists; their job "is to look at medicines across all therapeutic areas". She said that:

> "super-specialisation" has "changed the way that we manage many diseases … but the cost of that is that we are less familiar with prescribing in somebody else's specialty, and we end up with five different prescribers all prescribing in their area of expertise but with limited knowledge of how that affects the others."[129]

79. In December 2018 the Secretary of State for Health and Social Care launched a review into overprescribing, to be led by Chief Pharmaceutical Officer Dr Keith Ridge.[130] The aims of the review included "addressing 'problematic polypharmacy'", "creating a more efficient handover between primary and secondary care", and "improving management of non-reviewed repeat prescriptions".[131] We heard that this review is due to report to the Secretary of State in late 2020.[132] We also heard from NHS England and NHS Improvement that in 2019 the English Deprescribing Network was launched, to "promote appropriate prescribing to avoid severe and avoidable harm from medicines."[133]

80. **Medicine reviews are a core component of Comprehensive Geriatric Assessments, and if these are used more widely, with the involvement of multidisciplinary teams, the incidence of polypharmacy and the risk of adverse drug reactions should reduce.**

81. ***We recommend that the review into overprescribing—which is due to report to the Secretary of State for Health and Social Care in late 2020—should be published as soon as possible.***

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125 *Ibid.* See also Q 183 (Dr Lauren Walker).
126 Written evidence from Dr Maggie Keeble (INQ0100)
127 *Ibid.*
128 Q 38 (Professor Sir Munir Pirmohamed)
129 Q 186 (Dr Lauren Walker)
130 *Department of Health and Social Care*, 'Matt Hancock orders review into overprescribing in the NHS', (8 December 2018): https://www.gov.uk/government/news/matt-hancock-orders-review-into-over-prescribing-in-the-nhs [accessed 5 October 2020]
131 *Ibid.*
132 Supplementary written evidence from the Department for Health and Social Care (INQ0103)
133 Written evidence from NHS England and NHS Improvement (INQ0102)

NHS Long Term Plan

82. We asked witnesses whether the NHS Long Term Plan, which sets out the key ambitions for the service between 2019 and 2029, adequately addresses the changes required to provide better care and support for older people, particularly those with multimorbidity.[134] Responses were positive but cautious. The British Geriatrics Society told us that some of the commitments under the "Ageing Well" component of the plan, such as "enhanced health in care homes, anticipatory care and urgent community care, have the potential to transform services for older people in England."[135]

83. The British Geriatrics Society saw "much promise" in the development of Primary Care Networks—which will bring general practices together to work at scale—telling us: "The introduction of [Primary Care Networks] and joined-up working with community services marks a turning point in aligning and delivering services that support older people to lead happy, healthy, and independent lives."[136]

84. However, they warned that the commitments made in the plan should not be "watered down".[137] For example, they raised concerns that the scope of the Ageing Well component had been widened to include more care groups since publication of the plan. They told us that: "We do not believe that this would be in the best interest of older people and recommend that the Ageing Well programme is firmly focused on older people."[138]

85. Dr Keeble told us that the plan is "laudable in its aims to improve primary and community services with a focus on community based care with anticipatory care and personalised care and support planning at its heart".[139] However, there "needs to be an appropriate allocation of funds in community services" to support the implementation of this part of the plan and this is "yet to be seen".[140] The British Geriatrics Society agreed about the importance of the community-based care components: "We would like to see greater pace around the urgent community response component as well as clarity about recurrent funding to allow recruitment of staff to reach the required community capacity."[141]

86. Dr Keeble expressed concern about a lack of focus in the plan on healthy ageing activities and public health communication. The message that "the onset of frailty is not predetermined and can be either prevented, reversed or reduced if appropriate measures are taken" should be "promoted at all ages", including in schools. She suggested that the Government sends a strong message that "people will end up spending far less on their health and social care needs if they adopt an age positive lifestyle."[142]

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134 NHS England, *The NHS Long Term Plan* (January 2019): https://www.longtermplan.nhs.uk/wp-content/uploads/2019/08/nhs-long-term-plan-version-1.2.pdf [accessed 5 October 2020]
135 Written evidence from the British Geriatrics Society (INQ0101)
136 *Ibid.*
137 *Ibid.*
138 *Ibid.*
139 Written evidence from Dr Maggie Keeble (INQ0100)
140 *Ibid.*
141 Written evidence from the British Geriatrics Society (INQ0101)
142 Written evidence from Dr Maggie Keeble (INQ0100)

CHAPTER 3: THE SCIENCE OF AGEING

Why do humans age?

87. From a biological perspective, ageing is the result of an "accumulation of a wide variety of molecular and cellular damage over time."[143] This damage leads to decreased physical and cognitive capacity, and increasing risk of illness and death.[144]

88. Professor Dame Linda Partridge, Managing Director of the Max Planck Institute for Biology of Ageing, stressed that ageing is different from development, which is a "controlled, evolved process" which continues until the end of puberty. In contrast, ageing is a "process of rather random things going wrong that have never been corrected during evolution."[145] Several evolutionary reasons have been proposed for this accumulation of cellular and molecular damage over an organism's lifetime. The main theories (which are not mutually exclusive) are:[146]

- The "mutation accumulation" theory, which suggests that because the force of natural selection reduces after reproductive age, mutations to genes which have deleterious effects in later life can accumulate without being selected out.[147]

- The "antagonistic pleiotropy" theory, which suggests that that there is an evolutionary trade-off between fitness in early life and health and longevity in later life. This means that natural selection will favour genes which confer beneficial traits in early life, even if they have deleterious effects later, because the force for selection declines with age.[148] For example, a mechanism called cellular senescence protects against the development of cancer during adulthood but as we age it has negative effects, such as increased inflammation.

- The "disposable soma" theory, which suggests that there is an evolutionary trade-off between allocating energy to reproduction, and to the repair and maintenance of non-reproductive (somatic) tissues.[149] When resources are scarce, organisms tend to invest energy in reproductive (germ) cells and tissues, which is how genetic information is passed on through generations, rather than maintaining somatic cells and tissues, which need to survive for only one generation. As a consequence, the organism accumulates unrepaired cellular and molecular damage

143 *World Health Organisation,* 'Ageing and Health' (5 February 2018): https://www.who.int/news-room/fact-sheets/detail/ageing-and-health [accessed 7 September 2020]

144 Q 23 (Professor Richard Faragher)

145 Q 36 (Professor Dame Linda Partridge)

146 Thomas Flatt and Linda Partridge, 'Horizons in the evolution of aging', *BMC Biology,* vol 16, (August 2018): https://bmcbiol.biomedcentral.com/articles/10.1186/s12915–018-0562-z [accessed 7 September 2020]. See also Leonid Gavrilov and Natalia Gavrilova, 'Evolutionary theories of aging and longevity', *Scientific World Journal,* vol 2, (2002), pp 339–356: https://www.hindawi.com/journals/tswj/2002/704240/ [accessed 7 September 2020].

147 Peter Brian Medawar, *An unsolved problem of biology*, (London: H.K. Lewis and company, 1952). See also Leonid Gavrilov and Natalia Gavrilova, 'Evolutionary theories of aging and longevity', *Scientific World Journal,* vol 2, (2002), pp 339–356: https://www.hindawi.com/journals/tswj/2002/704240/ [accessed 7 September 2020]

148 George C. Williams, 'Pleiotropy, Natural Selection, and the Evolution of Senescence', *Society for the study of Evolution*, vol. 11 (1957), pp 398-411: https://www.jstor.org/stable/2406060?origin=crossref&seq=1 [accessed 7 September 2020]

149 T B L Kirkwood, 'Evolution of ageing', *Nature*, vol. 270 (1977), pp 301–304: https://www.nature.com/articles/270301a0 [accessed 7 September 2020]

over its lifetime, resulting in the observable characteristics of ageing (sometimes referred to as the "ageing phenotype").[150]

89. The molecular damage that accumulates with age leads to an increased prevalence of disease in later life. Witnesses stressed that the timing of these effects is not fixed. Professor Sir Michael Ferguson, Professor of Life Sciences at the University of Dundee, explained that while the "ultimate programme is inevitable", the "trajectory and speed with which an individual progresses through these biochemical and cell biological insults that lead to multimorbidities can be modulated."[151] Professor Pirmohamed noted that the exact reasons why the trajectory varies between individuals are not fully understood, but genetics, lifestyle and environmental factors all play a role.[152]

90. We heard that while genetic factors can increase or decrease the risk of contracting some individual age-related diseases significantly, they account for much less of the variation in longevity as a whole between individuals.[153] Data from twin studies suggest that around 25% of variation between individuals is due to genetics, with the remainder attributable to environmental factors.[154]

Measuring biological ageing

91. Given that people accumulate damage at different rates, the speed at which individuals age can vary significantly. A person's 'biological age' can therefore be out of step with their chronological age. This leads to some people ageing more slowly and reaching old age in better health.[155] Increasingly, researchers and clinicians are seeking to identify biological indicators that can help determine a person's biological age. These 'biomarkers' of ageing can be assessed over time to determine an individual's rate of ageing, and to establish whether interventions, drugs or lifestyle changes can help alter that rate.

92. Biomarkers are often biochemical measurements taken from samples of blood, saliva or tissues; for example, measuring blood lipids, levels of inflammation or fasting glucose levels. Biomarkers can also include measurements taken from non-invasive tests, such as measures of physical capability (e.g. grip strength and gait speed), and cognitive function (e.g. processing speed).[156] Dr Riccardo Marioni of the University of Edinburgh told us that, ideally, biomarkers should be inexpensive, so they can be used at the population level, and as minimally invasive as possible.[157]

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150 T B L Kirkwood, 'Understanding ageing from an evolutionary perspective', *Journal of Internal Medicine*, vol 263, (February 2008), pp 117–127: https://doi.org/10.1111/j.1365–2796.2007.01901.x [accessed 7 September 2020]

151 Q 36 (Professor Sir Michael Ferguson)

152 Q 36 (Professor Sir Munir Pirmohamed)

153 Q 26 (Professor David Melzer)

154 Giuseppe Passarino *et al.*, 'Human longevity: Genetics or Lifestyle? It takes two to tango', *Immunity and Ageing*, vol 13, (2016): https://doi.org/10.1186/s12979–016-0066-z [accessed 7 September 2020]. See also: Alireza Moayyeri *et al.*, 'Ageing trajectories in different body systems share common environmental etiology: The healthy ageing twin study', *Twin Research and Human Genetics*, vol. 19 (January 2016): https://doi.org/10.1017/thg.2015.100 [accessed 7 September 2020]

155 American Federation for Aging Research (AFAR), *Biomarkers of Aging* (2016): https://www.afar.org/imported/AFAR_BIOMARKERS_OF_AGING_2016.pdf [accessed 7 September 2020]

156 Q 29 (Professor Graham Kemp)

157 Q 29 (Dr Riccardo Marioni)

93. There is no single biomarker that can be used to assess how 'well' a person is ageing. Various 'toolkits' have been developed which identify key biomarkers for a range of functions associated with the ageing process.[158] Professor Graham Kemp of Liverpool University told us that developing these toolkits is challenging, as often "the data simply was not there" to identify reliable markers for ageing in general, rather than for individual diseases.[159]

94. Considerable attention is being paid to underlying biological processes which affect multiple aspects of ageing, some of which may be able to provide more holistic measures of how well a person is ageing and offer routes to intervene in the ageing process. For example, measurements of certain molecules that attach to an individual's DNA (known as epigenetic markers) have shown a strong correlation with chronological age.[160] This process and others are discussed in the following section.

Biological processes underlying ageing

95. As in the healthcare system, medical research has focused historically on the diagnosis and treatment of age-related diseases, such as cancer, cardiovascular disease and diabetes, on an individual basis. Indeed, this Committee's 2005 report on ageing focused predominantly on the state of research into individual conditions.[161] But we heard that in recent years there has been an increased focus by biogerontologists (scientists who specialise in the biological processes of ageing) on identifying and understanding the common, underlying biological mechanisms which drive ageing and increase the risk of multiple age-related diseases.

96. Professor Lynne Cox of the University of Oxford explained that the idea that basic biological processes underly many diseases of older age is now "mainstream" thinking.[162] We were told that since the publication of this Committee's report in 2005 there has been "rapid progress" in understanding these mechanisms.[163] Professor Richard Faragher, Professor of Biogerontology at Brighton University, said that in recent years scientists have honed in on a small number of ageing mechanisms which have "firm evidence that they are relevant to humans as well as experimental animals". These are known as the 'Hallmarks of Ageing'.[164] He explained:

> "To qualify as a hallmark, any biological process has to meet three criteria. First, it must be present in an ageing body. If it is not, it cannot cause ageing. Secondly, accelerating it should accelerate ageing. Lastly, slowing it down or getting rid of it should slow ageing down and improve health."[165]

158 Jose Lara *et al.*, 'A proposed panel of biomarkers of healthy ageing', *BMC Medicine*, vol 13, (2015): https://doi.org/10.1186/s12916–015-0470-9 [accessed 7 September 2020]. See also Graham Kemp *et al.*, 'Developing a toolkit for the assessment and monitoring of musculoskeletal ageing', *Age and Ageing*, vol 47, (September 2018), pp 1–19: https://doi.org/10.1093/ageing/afy143 [accessed 7 September 2020]

159 Q 30 (Professor Graham Kemp)

160 Christopher Bell *et al.*, 'DNA methylation aging clocks: challenges and recommendations', *Genome Biol,* vol. 20 (November 2019): https://doi.org/10.1186/s13059–019-1824-y [accessed 7 September 2020]

161 Science and Technology Committee, *Ageing: Scientific Aspects* (1st Report, Session 2005–06, HL Paper 20-I)

162 Written evidence from Professor Lynne Cox (INQ0034)

163 Q 24 (Professor Richard Faragher)

164 Q 24 (Professor Richard Faragher). See also Carlos López-Otín *et al.*, 'The Hallmarks of Aging', *Cell*, vol. 153 (June 2013): https://doi.org/10.1016/j.cell.2013.05.039 [accessed 7 September 2020]

165 Q 24 (Professor Richard Faragher)

97. The nine identified hallmarks of ageing are:[166]

    (1) Genomic instability[167]

    (2) Telomere attrition[168]

    (3) Epigenetic alterations[169]

    (4) Loss of proteostasis[170]

    (5) Deregulated nutrient-sensing[171]

    (6) Mitochondrial dysfunction[172]

    (7) Cellular senescence[173]

    (8) Stem cell exhaustion[174]

    (9) Altered intercellular communication.[175]

    Professor Faragher added that more hallmarks will likely be identified in future.[176]

98. Some hallmarks have been the subject of more scientific attention than others. The Medical Research Council Unit and Institute of Healthy Ageing at University College London told us that the role of many of these mechanisms has "wide support from animal studies". They explained that although their role in human ageing is less well documented, they clearly have a causal role in "multiple age-related diseases".[177] Cellular senescence and deregulated nutrient sensing were identified by witnesses as two of the most well-understood hallmarks of human ageing.[178]

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166 Carlos López-Otín *et al*., 'The Hallmarks of Aging', *Cell*, vol. 153 (June 2013): https://doi.org/10.1016/j.cell.2013.05.039 [accessed 7 September 2020]

167 Genomic instability will be considered later in this section.

168 Telomere attrition will be considered later in this section.

169 Epigenetic alterations will be considered later in this section.

170 Loss of proteostasis refers to the failure of the mechanisms in cells which normally remove damaged proteins, allowing them to build up. For further information, see, for example: *Lifespan*, 'Hallmarks of Aging: Loss of Proteostasis' (23 May 2018): https://www.lifespan.io/news/hallmarks-of-aging-loss-of-proteostasis/ [accessed 7 September 2020]

171 Deregulated nutrient-sensing will be considered later in this section.

172 Mitochondria are the 'powerhouses' of cells, converting food into energy. As they age, their ability to provide energy to cells is reduced and they release damaging chemicals. For further information, see, for example, Lifespan, 'Hallmarks of Aging: Mitochondrial Dysfunction', (27 September 2018): https://www.lifespan.io/news/hallmarks-of-aging-mitochondrial-dysfunction/ [accessed 7 September 2020]

173 Cellular senescence will be considered later in this section.

174 Stem cell exhaustion is the reduction in activity of stem cells, which are important for replacement of worn out cells and tissues. For further information, see, for example, Lifespan, 'Hallmarks of Aging—Stem Cell Exhaustion', (18 September 2018): https://www.lifespan.io/news/hallmarks-of-aging-stem-cell-exhaustion/ [accessed 7 September 2020]

175 Altered intercellular communication refers to changes to the communication that occurs between cells that allows them to respond to their environment. For further information, see, for example, Lifespan, 'Hallmarks of Aging—Altered Intercellular Communication', (9 February 2019): https://www.lifespan.io/news/hallmarks-of-aging-altered-intercellular-communication/ [accessed 7 September 2020]

176 Q 24 (Professor Richard Faragher)

177 Written evidence from the Medical Research Council (MRC) Unit and Institute of Healthy Ageing (IHA), University College London (INQ0007)

178 Q 24 (Professor Richard Faragher). See also written evidence from Dr Andrew Steele (INQ0067).

99. Professor Cox stated that understanding the underlying biological mechanisms of ageing in humans opens up the potential for "new therapeutic options by treating the shared core process not symptoms", which could help slow, reverse or reduce biological ageing and, as a result, decrease the risk of multiple age-related diseases at once.[179] We heard that age-related diseases are currently treated individually, without intervening in their "fundamental pathology" (such as biological processes of ageing).[180] The Medical Research Council Unit and Institute of Healthy Ageing at University College London explained: "The big opportunity here is to intervene in the processes of ageing to prevent multiple age-related diseases and multimorbidity, rather than treating these diseases one at a time and as they arise."[181] They added that the current fragmentation of medical specialities, as discussed in Chapter 2, can make this more difficult.

100. The remainder of this section will consider the current understanding of the four ageing hallmarks we heard most about during our inquiry: genomic instability, deregulated nutrient sensing, cellular senescence and epigenetic alterations.

Genomic instability

101. Genomic instability can be understood as the accumulation of genetic damage, or mutations, throughout an organism's life. It has been described as a 'common denominator' of ageing.[182] Professor David Melzer, Professor of Epidemiology and Public Health at Exeter University, explained that the number of these mutations is "quite small in newborn babies but [rises] dramatically with age."[183] DNA damage can occur due to internal mechanisms (such as DNA replication errors) as well as activities external to the body (for example, smoking or exposure to UV light).

102. Damaged DNA can be repaired by a number of mechanisms. However, the effectiveness of DNA repair mechanisms declines with age, which allows damaged cells to accumulate. This in turn affects the functioning of these cells and those around them.[184] Professor Melzer told us that recent studies have shown "the accumulation of very large numbers of mutations" in somatic (non-reproductive) cells throughout life.[185] These accumulated mutations are a risk factor for various age-related diseases, in particular cancer. Animal studies suggests that genomic instability can contribute to ageing by promoting other hallmark processes, such as cellular senescence.[186]

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179 Written evidence from Professor Lynne Cox (INQ0034). See also written evidence from the Academy of Medical Sciences (INQ0078).

180 Written evidence from Michael Fossel MD, PhD (INQ0009)

181 Written evidence from the Medical Research Council (MRC) Unit and Institute of Healthy Ageing (IHA), University College London (INQ0007)

182 Carlos López-Otín *et al.*, 'The Hallmarks of Aging', *Cell*, vol. 153 (June 2013): https://doi.org/10.1016/j.cell.2013.05.039 [accessed 7 September 2020]

183 Q 26 (Professor David Melzer)

184 Shin-Ichi Moriwaki *et al.*, 'The effect of donor age on the processing of UV-damaged DNA by cultured human cells: reduced DNA repair capacity and increased DNA mutability', *Mutation Research / DNA Repair*, vol. 364 (1996) pp 117-123: https://doi.org/10.1016/0921–8777(96)00029-8 [accessed 7 September 2020] See also: Scott Maynard *et al.*, 'DNA Damage, DNA Repair, Aging, and Neurodegeneration', *Cold Spring Harbour Perspectives in Medicine*, vol. 5 (2015): http://perspectivesinmedicine.cshlp.org/content/5/10/a025130 [accessed 7 September 2020]

185 Q 24 (Professor David Melzer)

186 Carlos López-Otín *et al.*, 'The Hallmarks of Aging', *Cell*, vol. 153 (June 2013): https://doi.org/10.1016/j.cell.2013.05.039 [accessed 7 September 2020]

103. DNA damage occurs not only to DNA present in the nucleus but also in mitochondria, the cell structures that produce energy in the form of adenosine triphosphate (ATP). This results in mitochondrial dysfunction, another ageing hallmark, with reduced ATP production with age. Dysfunctional mitochondria also release damaging Reactive Oxygen Species (ROS) which may contribute to the ageing process by increasing inflammation. In youth such mitochondria are replaced, but the ability to remove damaged mitochondria (in a process called mitophagy) declines with age.[187]

Deregulated nutrient sensing pathways

104. Nutrient sensing pathways are how the body recognises and responds to fluctuations in the levels of available nutrients. It has been known for almost a century that the body's response to nutrient intake is related to ageing: a 1930s study which restricted the caloric intake of rats found they tended to live significantly longer than rats with more plentiful food.[188] This phenomenon has been studied widely by biogerontologists and shown to extend lifespan in many species, including primates.[189]

105. Recent research efforts have focused on identifying and understanding the mechanisms by which dietary restriction leads to enhanced longevity. One key pathway involves mTOR (the mechanistic target of rapamycin), a protein which regulates—among other things—cell growth and division, and the clearance of damaged cells.[190] When nutrition is plentiful, mTOR activity is increased, switching the body to a 'reproductive' or 'growth' mode. This increases cell and tissue production (and thereby also increasing the likelihood of DNA damage and mutations). When nutritional intake is restricted, mTOR activity decreases, switching the body to 'repair' mode and triggering increased autophagy (the removal of damaged and dysfunctional cells or their components). Selectively decreasing mTOR activity, either genetically or through drugs, and the resultant increase in autophagy, has been found to increase the lifespan of mice, worms and fruit flies.[191]

106. We heard that nutrient sensing pathways may be more sensitive to the intake of particular nutrients, rather than to total calorie intake. Professor Partridge explained: "It is clear that it is not just about calorie restriction; specific nutrients are important, especially protein and protein composition, which are beginning to look very important."[192] Professor Partridge's research has shown, for example, in species such as flies and worms, reduced intake of

187 Sarika Srivastava, 'The Mitochondrial Basis of Aging and Age-Related Disorders', *Genes* , vol. 8 (December 2017): https://doi.org/10.3390/genes8120398 [accessed 7 September 2020]

188 C M McCay *et al.*, 'The effect of retarded growth upon the length of life span and upon the ultimate body size', *Journal of Nutrition*, vol. 10 (July 1935): https://doi.org/10.1093/jn/10.1.63 [accessed 7 September 2020]. See also: Nicole Cummings and Dudley Lamming, 'Regulation of metabolic health and aging by nutrient-sensitive signaling pathways', *Molecular and Cellular Endocrinology*, vol. 455 (November 2017): https://doi.org/10.1016/j.mce.2016.11.014 [accessed 7 September 2020]

189 Ricki Colman *et al.*, 'Caloric Restriction Delays Disease Onset and Mortality in Rhesus Monkeys', *Science*, vol. 325 (July 2009) pp 201–204: https://science.sciencemag.org/content/325/5937/201 [accessed 7 September 2020]

190 Simon Johnson *et al.*, 'mTOR is a key modulator of ageing and age-related disease', *Nature*, vol. 493 (January 2013): https://doi.org/10.1038/nature11861 [accessed 7 September 2020]

191 Ibid., see also Roberto Zoncu *et al.*, 'mTOR: from growth signal integration to cancer, diabetes and ageing' *Nature reviews. Molecular cell biology*, vol. 12 (December 2010): https://doi.org/10.1038/nrm3025 [accessed 7 September 2020]

192 Q 42 (Professor Dame Linda Partridge)

essential amino acids contributes to extended lifespan.[193] Professor Kay-Tee Khaw, Professor of Clinical Gerontology at the University of Cambridge, highlighted that, of two long-term studies of caloric restriction in primates, only one study reported significant evidence of enhanced longevity, and concurred that it is therefore "not about the quantity of the calories but about the quality of the diet."[194]

107. Nutrient sensing pathways tend to become less well-regulated with age, which can lead to an increase in their pro-ageing activities and in turn an increased risk of age-related diseases, including type 2 diabetes.[195] Recent research has therefore focused on possible interventions that could restore nutrient sensing pathways in older people to improve health span and longevity.[196]

108. One option is dietary intervention, such as caloric restriction. However, while reducing the intake of calories has shown positive results in animals, there is less evidence for its effectiveness in humans. Professor Ferguson noted that humans find significantly reducing their dietary intake "very difficult to achieve", as our species evolved to eat whenever food is available.[197] Professor Partridge explained that more effective options may be to alter the intake of particular nutrients like protein, or to modify the time of day when people eat, which has been shown in mice to relate to health.[198] Another option is to identify pharmaceutical interventions which can mimic the effects of reduced dietary intake on nutrient sensing pathways. One such drug is metformin, which is used to treat type 2 diabetes.[199] These therapies are discussed in the following section.

Cellular senescence

109. Cellular senescence is a state in which cells can no longer divide. As such, it plays a key role in reducing the likelihood that genetic errors which occur when cells divide will persist, acting as an anti-tumour mechanism.[200] Cell senescence is a 'downstream' consequence of other ageing hallmarks which induce stress in cells, including telomere shortening, genomic instability and deregulated nutrient sensing. For example, selectively reducing mTOR

193 George Soultoukis and Linda Partridge, 'Dietary Protein, Metabolism, and Aging', *Annual Review of Biochemistry*, vol. 85 (2016): https://doi.org/10.1146/annurev-biochem-060815–014422 [accessed 7 September2020]

194 Q 56 (Professor Kay-Tee Khaw). See also: Ricki Colman *et al.*, 'Caloric Restriction Delays Disease Onset and Mortality in Rhesus Monkeys', *Science*, vol. 325 (July 2009) pp 201-204: https://science.sciencemag.org/content/325/5937/201 [accessed 7 September 2020]; Julie Mattison *et al.*, 'Impact of caloric restriction on health and survival in rhesus monkeys: the NIA study', *Nature*, vol. 489 (August 2012) pp 318–321: https://doi.org/10.1038/nature11432 [accessed 7 September 2020]; and Julie Mattison *et al.*, 'Caloric restriction improves health and survival of rhesus monkeys', *Nature Communications*, vol. 8 (January 2017): https://doi.org/10.1038/ncomms14063 [accessed 7 September 2020]

195 Q 42 (Professor Sir Michael Ferguson)

196 Victor Micó *et al.*, 'NutrimiRAging: Micromanaging Nutrient Sensing Pathways through Nutrition to Promote Healthy Aging', *International journal of molecular sciences*, vol. 18 (April 2017): https://doi.org/10.3390/ijms18050915 [accessed 7 September 2020]

197 Q 42 (Professor Sir Michael Ferguson)

198 Q 42 (Professor Dame Linda Partridge)

199 Q 37 (Professor Sir Michael Ferguson). See also written evidence from Dr Adam Dobson (INQ0069).

200 Q 23 (Professor Richard Faragher)

activity has been found to decrease senescent cell build up and suppress the secretion of pro-inflammatory molecules by senescent cells.[201]

110. Senescent cells are normally removed by the immune system, but as humans age the immune system becomes less effective and so senescent cells accumulate. Professor Faragher told us that the "accumulation of senescent cells appears to drive multiple aspects of the ageing process."[202] In particular, accumulated senescent cells secrete pro-inflammatory molecules called cytokines. These contribute to low-grade, persistent inflammation in blood and tissues, which causes damage and dysfunction throughout the body.[203] Cellular senescence is therefore likely to be one cause of 'inflammaging': chronic, low-level inflammation that is characteristic of human ageing and associated with increased risk of a broad range of age-related diseases.[204] In addition, despite acting as an anti-tumour mechanism in earlier life, as senescent cells accumulate in older age they release substances called growth factors which can promote tumour growth.[205]

111. Animal studies have indicated that removing or inserting senescent cells into tissues can have anti- or pro-ageing effects. Professor Cox told us that senescent cells "cause morbidity and decreased lifespan when transplanted into young animals", whereas removing senescent cells from mice "greatly improves their health and can extend lifespan by up to 30%".[206] Drugs that kill senescent cells (senolytics) or suppress their adverse effects (senomodifiers) are beginning to be developed. Dr Andrew Steele told us that "senescent cells are the ageing hallmark which is by far the best understood and where therapies are closest to clinical application".[207]

Telomere attrition

112. Telomeres are long sections of DNA at the end of chromosomes that support the correct replication of DNA during cell division. Each time a cell divides, the telomeres shorten ('telomere attrition'), which limits the number of times a cell can divide. Telomere attrition is considered one of the causes (hallmarks) of ageing because once telomeres are critically short the cell ceases to divide and becomes senescent.

113. Studies in animal models have indicated that there is a strong correlation between the telomere shortening rate and the lifespan of a species.[208] We

201 Thomas Weichhart, 'mTOR as regulator of lifespan, aging and cellular senescence', *Gerontology*, vol. 64 (February 2017): https://doi.org/10.1159/000484629 [accessed 7 September 2020]. See also Giovanni Stallone *et al.*, 'mTOR and Aging: An Old Fashioned Dress', *International journal of molecular sciences*, vol. 20 (June 2019): https://doi.org/10.3390/ijms20112774 [accessed 7 September 2020]

202 Q 24 (Professor Richard Faragher)

203 Irene Rea *et al.*,'Age and Age-Related Diseases: Role of Inflammation Triggers and Cytokines', *Frontiers in immunology*, vol. 9 (April 2018): https://doi.org/10.3389/fimmu.2018.00586 [accessed 7 September 2020]

204 Claudio Franceschi and Judith Campisi, 'Chronic Inflammation (Inflammaging) and Its Potential Contribution to Age-Associated Diseases', *The Journals of Gerontology*, Series A, vol. 69 (May 2014), pp S4-S9: https://academic.oup.com/biomedgerontology/article/69/Suppl_1/S4/587037 [accessed 7 September 2020]

205 Tamara Tchkonia *et al.*, 'Cellular senescence and the senescent secretory phenotype: therapeutic opportunities', *The Journal of Clinical Investigation*, vol 123(3) (March 2013): https://www.jci.org/articles/view/64098 [accessed 7 September 2020]

206 Written evidence from Professor Lynne Cox (INQ0034)

207 Written evidence from Dr Andrew Steele (INQ0067)

208 See for example: Mary Armanios *et al.*, 'Short telomeres are sufficient to cause the degenerative defects associated with aging', *American journal of human genetics*, vol. 85 (December 2009): https://doi.org/10.1016/j.ajhg.2009.10.028 [accessed 2 November 2020]

heard that, like the epigenetic clock, telomere shortening rate may be useful as a biomarker of ageing.[209]

Epigenetic alterations

114. Epigenetic alterations are the addition of molecules to the individual components (nucleotides) that make up DNA, or to the proteins that surround the DNA. They can modify the activity of genes but do not change the DNA sequence. Dr Jordana Bell, Head of Epigenomics Research Group at King's College London, told us that epigenetics can be thought of as "molecular information that guides the same piece of DNA sequence to act differently in different types of cells."[210] For example, the genes that create the proteins needed for bone growth are "switched off" by epigenetic modifications in non-bone cells. The total of all chemical compounds that have been added to the genome (an individual's entire DNA) is known as the epigenome. One example of an epigenetic modification is DNA methylation, whereby methyl 'tags' are attached to individual genes, which alters their function and expression.

115. Epigenetic modifications are not fixed in the way that DNA is, and there is strong evidence that the epigenome changes with age, and such changes may be reversible. Dr Bell told us there are three major types of epigenetic change that occur as humans get older:[211]

    (1) A loss of the overall number of methyl tags, which is thought to be related to genomic instability;

    (2) An increase in methylation at particular sites in the genome, which regulates or potentially silences the expression of particular genes;

    (3) An increase in variability of epigenetic changes in older people, which may indicate epigenetic dysregulation.

116. In addition to epigenetic changes that occur with age, environmental factors, such as smoking, diet and pollution, can induce epigenetic alterations. Dr Bell told us that smoking is "by far the one outlier that has major effects", but it has been more difficult to measure the impact of other environmental factors.[212]

117. Recent research has shown that measuring certain epigenetic markers which are known to change with age can be used to estimate an individual's biological age. These are known as epigenetic clocks. Horvath's clock, the first one described and most well-known, measures 353 different methyl tags.[213] Dr Adam Dobson from the University of Glasgow explained:

> "The ability to predict human age from a collection of epigenetic marks … underlines a correlation between epigenomic regulation and human ageing. Whether this relationship is causal remains to be established, but it is now apparent that an individual animal's epigenome can be

209 Q 33 (Dr Riccardo Marioni). See also: Sofie Bekaert *et al.*, 'Telomere attrition as ageing biomarker', *Anticancer Research*, vol. 25 (July 2005), pp 3011–3022: http://ar.iiarjournals.org/content/25/4/3011.full.pdf+html [accessed 2 November 2020]

210 Q 24 (Dr Jordana Bell)

211 *Ibid.*

212 Q 26 (Dr Jordana Bell)

213 Steve Horvarth, 'DNA methylation age of human tissues and cell types', *Genome Biology*, vol. 14 (December 2013): https://doi.org/10.1186/gb-2013–14-10-r115 [accessed 7 September 2020]

"programmed", e.g. by transient nutritional alterations, to modulate ageing."[214]

118. Given that the rate at which individuals age varies, predictions of age from epigenetic clocks may not match an individual's chronological age. Dr Bell explained: "You can look at the difference between the predicted age and your actual age and say that the person is ageing faster or slower than expected. That difference … has then been related to a lot of diseases, cancers and indeed the menopause."[215] Dr Marioni told us that "by far the most consistent finding [of epigenetic clocks] is that if your methylation age looks older than your chronological age, there is a higher risk of dying [earlier] than if your methylation age is the same as your chronological age."[216] Dr Bell told us that, in the past year, these predictors have been used to predict remaining lifespan or health span, "by taking into account time to death or lifespan as well as different phenotypes that capture healthy ageing."[217]

119. We heard that understanding of epigenetics is still in the early stages. Professor Cox told us: "Our knowledge of the effect of epigenetic changes as causative in ageing lags behind our knowledge that such changes occur and are important."[218] According to Dr Bell, the field is currently focused on using epigenetics as a marker of ageing and using that understanding to develop predictors of ageing.[219] She thought that modifying the epigenome for therapeutic options is "quite far in the future." Professor Cox agreed: "Effective intervention would need targeting to specific genetic loci but we don't know (a) what these loci are [and] (b) how to target some regions of the epigenome without having global (and potentially devastating) effects."[220]

Gaps in knowledge

120. There was consensus among witnesses that understanding of the biological processes which drive ageing in humans is incomplete. Professor Claire Stewart from Liverpool John Moores University told us that "We are currently scratching the surface in terms of our understanding of the biological process of ageing", and that "to think we understand the biology of ageing on a basal [basic] level is worrying."[221] This is likely to be due in part to the traditional focus in health research and clinical practice on individual age-related diseases, rather than the ageing process itself.[222] We heard that some hallmarks of ageing, such as cellular senescence, have received more attention than others, and consequently there is greater understanding of those processes.[223]

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214 Written evidence from Dr Adam Dobson (INQ0069)
215 Q 26 (Dr Jordana Bell)
216 Q 31 (Dr Riccardo Marioni)
217 Q 26 (Dr Jordana Bell)
218 Written evidence from Professor Lynne Cox (INQ0034)
219 Q 26 (Dr Jordana Bell)
220 Written evidence from Professor Lynne Cox (INQ0034)
221 Written evidence from Professor Claire Stewart (INQ0046)
222 Written evidence from Professor Claire Stewart (INQ0046). See also written evidence from: the Babraham Institute (INQ0070); Lifelong Health Research Theme, University of Surrey (INQ0017); Professor Avan Aihie Sayer (INQ0019); UK Research and Innovation (INQ0032); Birmingham Health Partners, University of Birmingham College of Medical and Dental Sciences (INQ0051); Northern Health Science Alliance (INQ0053); MSD (INQ0055); and University of Birmingham MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research (INQ0056).
223 Q 46 (Professor Arne Akbar)

121. One area which has received less attention is how the immune system changes with age. It is generally understood that the immune system gradually deteriorates with age, affecting our ability to respond to infections. This is why older people are offered additional protections such as flu vaccinations. The long-term memory of the immune system is also reduced with age, which is why vaccinations are less effective in older people.[224] It has also been hypothesised that the ageing immune system is less able to detect and remove senescent cells, and this may contribute to their accumulation in the body.[225]

122. The British Society for Immunology told us:

> "The scientific understanding of the immune system as the body ages is not as complete as it could, or should, be. Whilst some areas are better understood than others, e.g. the adaptive immune system is better comprehended than the innate immune system, and we know there are stark differences between young and old immune systems, in general terms there is much more work to be done to understand the basic science and biological processes behind the effects of ageing on the immune system."[226]

123. Professor Arne Akbar, President of the British Society for Immunology, told us that understanding the ageing immune system is important, because the immune system "interacts with every other organ, so any change in the immune system also effects changes in other organs. If the immune system goes downhill with ageing, organ function will generally be altered as well."[227]

124. Understanding is also limited for the role of the gut microbiome—the "community of microbes, which include bacteria, fungi and viruses" that inhabits the gut—in ageing.[228] We heard that the diversity of the gut microbiome declines with age,[229] and links have been established to the lifespan and health of some animal species.[230] In humans there are correlations between the diversity of the gut microbiome and some age-related diseases.[231] There is evidence of links to underlying biological processes of ageing, including inflammation and changes in the immune system, but causal links are yet to be established in humans.[232] Dr Dobson highlighted the potential to use the gut microbiome in improve health, including "metabolising drugs that may be used to extend health span" and "produc[ing] nutrients that are absorbed by the gut, which … constitute a reservoir of potentially exploitable therapeutics."[233]

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224 Written evidence from the British Society for Immunology (INQ0057)
225 Larissa Langhi Prata *et al.*, 'Senescent cell clearance by the immune system: Emerging therapeutic opportunities', *Seminars in Immunology*, vol. 40 (December 2018): https://www.sciencedirect.com/science/article/abs/pii/S1044532318300654 [accessed 7 September 2020]. See also Branca Pereira *et al.*, 'Senescent cells evade immune clearance via HLA-E-mediated NK and CD8+ T cell inhibition', *Nature Communications* (June 2019): https://www.nature.com/articles/s41467–019-10335-5 [accessed 7 September 2020]
226 Written evidence from the British Society for Immunology (INQ0057)
227 Q 45 (Professor Arne Akbar)
228 Q 54 (Dr Marina Ezcurra)
229 *Ibid.*
230 See, for example, written evidence from Dr Adam Dobson (INQ0069).
231 Q 54 (Dr Marina Ezcurra)
232 Written evidence from the Society for Applied Microbiology (INQ0029)
233 Written evidence from Dr Adam Dobson (INQ0069)

125. There was agreement that understanding of ageing in animals and model systems is greater than it is in humans. The Lifelong Health Research Theme at the University of Surrey told us that "progress in animal models has not been sufficiently translated into humans".[234] Professor Melzer explained a particular challenge of extrapolating evidence from animal models:

> "Mice share a lot of genetics with us, but of course their lifespan is a tiny fraction of ours. We have already evolved many of the protective mechanisms that some of these laboratory experiments are trying to add to these short-lived organisms. Going from an organism that lives three years to one that lives for 100 or 110 years is a big jump, and I think we need to be more realistic or a bit cautious about simply extrapolating to a long-lived organism."[235]

126. **Understanding of the underlying biological processes of ageing has advanced significantly in animal models, but translation to human ageing is incomplete. The lack of accurate biomarkers for human ageing is an impediment to assessing an individual's biological age.**

Potential treatments targeting ageing processes

127. Understanding the biological processes underlying human ageing opens up the potential for pharmaceutical interventions that target these processes. These could help to slow down, reverse or reduce biological ageing and, as a result, age-related diseases. These drugs are referred to as geroprotectors. Researchers predict that treating these core pathways may affect multiple disease pathways simultaneously, particularly where those conditions cluster in individuals (multimorbidity).[236] Professor Partridge explained that "no single intervention catches everything, but different interventions capture different things that go wrong", and that animal studies so far have suggested that targeting the processes of ageing, such as cell senescence, might prevent several age-related diseases in a single organism and reduce the length of the unhealthy period at the end of life.[237]

128. If effective interventions are identified, treating the underlying processes of ageing instead of individual diseases should have a number of benefits. If used preventatively, the burden of multimorbidity should be lessened, and as a result, the incidence of polypharmacy should reduce. For patients who already have multimorbidity, treatments that target underlying ageing processes could still reduce the number of drugs they need to take (their 'pill burden') by treating several age-related diseases at once.

129. Witnesses suggested it is likely that such drugs would be needed less frequently than conventional medications, and at lower dosages, reducing the likelihood of adverse drug reactions. Treatments that target multiple disease pathways are likely to save costs nationally. For example, Dr Michael Fossel told us that if cell senescence was treated effectively, "the costs of

234 Written evidence from the Lifelong Health Research Team, University of Surrey (INQ0017). See also written evidence from the Academy of Medical Sciences (INQ0078).
235 Q 24 (Professor David Melzer)
236 Written evidence from Professor Lynne Cox (INQ0034). See also written evidence from the Academy of Medical Sciences (INQ0078).
237 Q 36 (Professor Dame Linda Partridge)

treating age-related disease will fall substantially, to perhaps 10% of current annual costs".[238]

Drugs targeting nutrient pathways

130. Targeting nutrient sensing-pathways using drugs may be more effective than dietary interventions (such as caloric restriction), which we were told humans generally find difficult to maintain.[239] One drug that is proving promising is rapamycin, which is currently used as an immunosuppressant in organ transplant patients (among other uses). Rapamycin, along with other rapamycin-like molecules known as rapalogues, inhibits mTOR activity and has already been shown to extend lifespan in mice.[240] Professor Partridge thought drugs targeting nutrient-sensing pathways will be the "fastest route to tackling aspects of the underlying ageing process to prevent disease".[241] She added that a further benefit of rapamycin is that it is "proving effective at much, much lower doses than are normally used clinically", so if used in a preventative capacity, "the problem of polypharmacy will be much less."[242]

131. Another drug which targets nutrient-sensing pathways is metformin, which has been used for treating diabetes for over 50 years.[243] Professor Jesús Gil, Professor of Cell Proliferation at Imperial College London, told us:

> "There has been evidence for a number of years that people on [metformin] were doing better in other age-related diseases. Five years ago, retrospective studies were conducted in the States on almost 75,000 people who had been treated with the drug and it was realised that they had been doing better on some other outcome measures."[244]

A 2016 review noted that metformin also appears to target a number of other ageing mechanisms, but that "it is currently unclear whether metformin has multiple effects on multiple pathways or whether its observed effects reflect downstream consequences of a primary action on a single mechanism of aging."[245]

132. In light of such findings, a number of trials, such as the Metformin in Longevity Study (MILES)[246] and the Targeting Aging with Metformin (TAME) trial, were developed. TAME is funded by the American Federation of Aging Research and aims to test whether metformin can delay "development or progression of age-related chronic diseases—such as heart

238 Written evidence from Michael Fossell MD, PhD (INQ0009). See also Q 27 (Professor Richard Faragher).
239 Q 42 (Professor Sir Michael Ferguson)
240 Q 39 (Professor Sir Michael Ferguson). See also David Harrison *et al.*, 'Rapamycin fed late in life extends lifespan in genetically heterogeneous mice', *Nature Communications*, vol 460, (July 2009): https://www.nature.com/articles/nature08221/ [accessed 7 September 2020]; and Richard Miller *et al.*, 'Rapamycin, but not resveratrol or simvastatin, extends life span of genetically heterogeneous mice', *The Journals of Gerontology: Series A*, vol. 66A (February 2011) https://doi.org/10.1093/gerona/glq178 [accessed 7 September 2020]
241 Q 39 (Professor Dame Linda Partridge)
242 Q 38 (Professor Dame Linda Partridge). See also Q 39 (Professor Sir Michael Ferguson).
243 Nir Barzilai *et al.*, 'Metformin as a Tool to Target Aging', *Cell Metabolism*, vol 23(6), (June 2016): https://doi.org/10.1016/j.cmet.2016.05.011 [accessed 7 September 2020]
244 Q 46 (Professor Jesús Gil)
245 Nir Barzilai *et al.*, 'Metformin as a Tool to Target Aging', *Cell Metabolism*, vol 23(6), (June 2016): https://doi.org/10.1016/j.cmet.2016.05.011 [accessed 7 September 2020]
246 U.S. National Library of Medicine, ClinicalTrials.gov, '*Metformin in Longevity Study (MILES)*' (May 2018): https://clinicaltrials.gov/ct2/show/results/NCT02432287?view=results [accessed 7 September 2020]

disease, cancer, and dementia."[247] The trial seeks to recruit 3,000 subjects.[248] Professor Cox told us that the TAME trial is "remarkable in being approved by the FDA", because instead of targeting an individual disease it measures the "first progression to any of a number of age-related diseases."[249] This was the "first time that the FDA changed from it having to be one specific disease to being any one of a number of different age-related diseases."[250]

Senolytics and senomodifiers

133. One set of potential treatments for targeting the underlying processes of ageing are senolytics and senomodifiers. Senolytics kill senescent cells, while senomodifiers (also known as senostatics) alter their behaviour. Both aim to reduce the negative consequences of senescent cells accumulating. While senolytics appear to have received more attention, Professor Cox told us that it is important to focus on senolytics and senomodifiers in parallel, because it is not known whether it is desirable to kill all senescent cells in older people.[251] She explained that senomodifiers may be required for the "very old and [for] diseases where there is a very high senescent cell burden."[252]

134. Professor Gil told us that senolytics are a "quickly developing area". He explained:

> "The first scientific evidence that eliminating senescent cells can be beneficial for living longer and healthier came just eight years ago, in 2011. In 2016 the first drugs that are able to specifically kill senescent cells were described; they show some benefits on age-associated diseases and living longer and healthier in mice."[253]

135. After the success of animal studies, senolytics are beginning to be trialled in humans to target individual organ systems to slow the progression of age-related diseases by reducing the senescent cell burden. Professor Gil told us that the first clinical trials using senolytics started in 2018 and that "five to ten trials have either started now or are starting".[254] Conditions being targeted include osteoarthritis, idiopathic pulmonary fibrosis and chronic kidney disease.[255]

136. Witnesses told us that senolytics and senomodifiers could be available to treat specific age-related diseases relatively soon. Professor Gil told us: "In the best-case scenario, if things go very well, it could be that in five to 10 years some of these senolytics are being used to treat specific ageing diseases—maybe osteoarthritis, glaucoma or others."[256] Professor Cox told us she is "slightly more optimistic that some of the senomodifiers could be available within a very short period", explaining that a senomodifier drug in development by the company ResTORbio had "very promising outcomes in

247 American Federation for Aging Research (AFAR), '*The Targeting Aging with Metformin (TAME) Trial*': https://www.afar.org/tame-trial [accessed 16 December 2020]
248 Nir Barzilai *et al.*, 'Metformin as a Tool to Target Aging', *Cell Metabolism*, vol 23(6), (June 2016): https://doi.org/10.1016/j.cmet.2016.05.011 [accessed 7 September 2020]
249 Q 46 (Professor Lynne Cox)
250 *Ibid.*
251 Q 44 (Professor Lynne Cox)
252 Written evidence from Professor Lynne Cox (INQ0034)
253 Q 44 (Professor Jesús Gil)
254 *Ibid.*
255 *Ibid.*, see also Q 39 (Professor Dame Linda Partridge), written evidence from Professor Lynne Cox (INQ0034).
256 Q 44 (Professor Jesús Gil)

both asthmatic and frail elderly patients" in phases 2a and 2b clinical trials, and the company is hoping to get Food and Drug Administration approval in the next few years.[257]

137. In the longer term, scientists hope senolytics and senomodifiers could be used preventatively, to slow biological ageing and reduce the risk of multiple age-related diseases.[258] By reducing the risk of onset of multiple diseases, an individual's overall 'pill burden' would reduce. The burden of polypharmacy would also likely be reduced by the way in which the drugs would be administered. Professor Partridge explained that when used to tackle the ageing process in general, the drugs would likely be given "in a pulsatile, intermittent fashion: clear out the senescent cells then take the person off the drug. You would not want it continuously because the [senescent] cells are important in wound healing, tissue growth and regeneration. This would be a quick blast and then a gap."[259]

Anti-inflammatories

138. In addition to senolytics, Professor Akbar told us there may be other ways to reduce the pro-ageing effects of senescent cell accumulation. Senescent cells induce damage by causing inflammation in nearby tissue, but other mechanisms also cause inflammation. Professor Akbar explained that "when you get older, inflammation is bad for you, regardless of where it comes from".[260] Targeting inflammation, rather than its causes, could prove another fruitful avenue for slowing biological ageing. Professor Akbar told us:

> "There are already drugs out there that different pharmaceutical companies have taken through phase 1 to phase 3 trials for their anti-inflammatory effects. In a recent, small, experimental medicine study, we have shown that we can boost immune responses in older humans by targeting inflammation with a GSK drug. It worked; we can actually boost the immune response in vivo, in the skin of older people."[261]

139. We heard that another cause of inflammation are cells of the innate immune system, neutrophils, causing damage to tissue as they migrate towards a site of infection or injury. In young people these cells move efficiently, causing minimal damage, but in older adults they follow a more circuitous route, inflicting damage on nearby cells. Professor Cox explained that research from the Institute of Inflammation and Ageing at the University of Birmingham has shown that statins (drugs usually used to reduce cholesterol levels) can

257 Q 44 (Professor Lynne Cox)
258 James Kirkland *et al.*, 'The Clinical Potential of Senolytic Drugs', *Journal of the American Geriatrics Society*, vol 65, (October 2017), pp 2297–2301: https://doi.org/10.1111/jgs.14969 [accessed 7 September 2020]. See also: Ming Xu *et al.*, 'Senolytics improve physical function and increase lifespan in old age', *Nature Medicine*, vol. 24 (July 2018) pp 1246–1256: https://doi.org/10.1038/s41591–018-0092-9 [accessed 7 September 2020]; and Chanhee Kang, 'Senolytics and Senostatics: A Two-Pronged Approach to Target Cellular Senescence for Delaying Aging and Age-Related Diseases', *Molecules and Cells*, vol. 42 (December 2019): https://doi.org/10.14348/molcells.2019.0298 [accessed 7 September 2020]
259 Q 40 (Professor Dame Linda Partridge)
260 Q 46 (Professor Arne Akbar)
261 *Ibid.*

be effective at correcting this defect in neutrophils, reducing inflammation, and reducing mortality in trials of patients with pneumonia.[262]

Role of repurposed drugs

140. Several of the drugs discussed so far are existing drugs that could be repurposed to target ageing mechanisms. We heard that there are several advantages to using repurposed drugs. Professor Avan Aihie Sayer, Professor of Geriatric Medicine at Newcastle University, told us:

> "The pathway from laboratory to clinic for existing drugs that can be repurposed is shorter however, and it is possible that such agents, if shown to be effective in trials, could contribute to the Government's aim of five more years of healthy and independent life by 2035. Repurposing existing medications provides the quickest route to generating drug interventions with benefit across multiple conditions".[263]

141. A major benefit of repurposed drugs is that they have already been tested for safety, dosage and tolerability, which are often the most costly and time-consuming parts of the their production.[264] Witnesses told us that repurposed drugs can be significantly cheaper than new drugs because they are often no longer under patent.[265]

142. That said, a drive towards repurposed drugs could reduce incentives for the pharmaceutical industry to develop these types of drugs. Professor Ferguson told us:

> "When you repurpose, the therapeutics are usually off-patent, so the incentive for the development side of it disappears for the pharmaceutical industry. On the other hand, if a new chemical entity is being developed ab initio [from the beginning], it has patent protection and is much more attractive for the pharmaceutical industry to develop it and deliver it into clinical practice."[266]

143. Professor Ferguson told us that while repurposed drugs can act as a powerful "proof of concept" for how a condition could be treated, "The problem with repurposing is that the molecules were not designed for that purpose".[267] This means the drug usually needs to be redeveloped or reformulated.[268] Professor Gil said that this might be one way companies could "get around" the issue of off-patent drugs, by developing "a different formulation or creating a new chemical entity that modifies directly the repurposed drug" that could then be patented.[269]

144. **Promising advances have been made in the development of drugs that target the underlying processes of ageing. These could delay the onset of age-related diseases and reduce polypharmacy. Research**

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262 Q 47 (Professor Lynne Cox). See also: Elizabeth Sapey *et al.*, 'Simvastatin Improves Neutrophil Function and Clinical Outcomes in Pneumonia. A Pilot Randomized Controlled Clinical Trial', *American Journal of Respiratory and Critical Care Medicine*, vol. 200 (2019): https://www.atsjournals.org/doi/full/10.1164/rccm.201812-2328OC [accessed 7 September 2020]
263 Written evidence from Professor Avan Aihie Sayer (INQ0019)
264 Q 46 (Professor Arne Akbar)
265 Q 46 (Professor Lynne Cox)
266 Q 39 (Professor Sir Michael Ferguson)
267 *Ibid.*
268 *Ibid.*
269 Q 46 (Professor Jesús Gil)

into repurposing drugs is particularly welcome, as such drugs have already been tested for safety, dosage and tolerability.

Challenges facing treatments targeting ageing processes

Clinical trials

Regulatory issues

145. New drugs must be tested on humans under stringent conditions in clinical trials before they can be authorised for use. All project-based health research in England and Wales requires approval from the Health Research Authority and Health and Care Research Wales. These bodies assess the legal compliance of the research and give ethical approval for it to take place.[270] Clinical trials involving medicinal products also need approval ('Clinical Trial Authorisation') from the Medicines and Healthcare products Regulatory Agency (MHRA).[271] Before drugs can be marketed, they need authorisation from the MHRA in the UK or the European Medicines Agency (EMA) in the EU.[272] The equivalent of the MHRA in the US is the Food and Drug Administration (FDA).

146. We heard that the current system of trial approval and drug authorisation presents a challenge for the trialling of drugs that target the underlying processes of ageing. For a drug to be authorised for use, it must be shown in clinical trials that it is effective against a condition (known as an indication). For example, diabetes is an indication for the drug metformin. Drugs can be prescribed only for the condition or conditions for which they are indicated. Trials must have clearly defined the outcome that is being measured, known as the endpoint. For example, the endpoint of a trial for a cancer drug may be survival rate after five years.

147. Witnesses told us that clinical trials are generally approved only if they target a single indication; Professor Cox explained that this was in part due to "FDA and EMA regulations".[273] This presents a problem for drugs targeting the underlying processes of ageing. The Innovative Therapeutics for Ageing Consortium noted that ageing itself "is not currently a disease indication recognised by regulators".[274] This means that multiple indications would need to be listed, as such drugs are intended to target multiple conditions and symptoms of ageing.

148. One approach to get drugs such as senolytics into trials has been to target single indications initially, such as osteoarthritis or chronic kidney disease.[275] Biogerontology researchers hope that these trials may show wider benefits

270 NHS Health Research Authority, *'HRA Approval'* (2017): https://www.hra.nhs.uk/approvals-amendments/what-approvals-do-i-need/hra-approval/ [accessed 7 September 2020]

271 Medicines and Healthcare products Regulatory Agency, *'Medicines and Healthcare products Regulatory Agency'*: https://www.gov.uk/government/organisations/medicines-and-healthcare-products-regulatory-agency [accessed 7 September 2020]

272 Medicines and Healthcare products Regulatory Agency, *'Guidance: Apply for a licence to market a medicine in the UK'* (18 February 2020): https://www.gov.uk/guidance/apply-for-a-licence-to-market-a-medicine-in-the-uk [accessed 7 September 2020]. Arrangements will be subject to any future arrangement between the UK and the EU.

273 Q 46 (Professor Lynne Cox)

274 Written evidence from Innovative Therapeutics for Ageing Consortium (INQ0042)

275 Q 46 (Professor Jesús Gil)

than for just that disease, paving the way for more flexible clinical trials targeting multiple indications. Professor Gil explained:

> "the senolytic trials going on at the moment have been targeted to specific diseases, for instance osteoarthritis of the knee, glaucoma, idiopathic pulmonary fibrosis and chronic kidney disease. That is, in part, because it is easier to design a clinical trial against a specific disease or a specific endpoint.[276] Because many of these trials have been targeting senescence as the root cause of many of those diseases, the assumption is that, even if it is effective just in the disease involved in the trial, it might also have widespread benefits in some other multimorbidities."[277]

149. Professor Cox told us that trials targeting single indications can be useful for providing proof of safety and efficacy before attempting wider application of the treatments:

> "A lot of the trials have to be against a single indication because of current FDA and EMA regulations, and because of the precautionary principle. Unity Biotech, with which I am not associated, has decided to go for privileged compartments such as the knee and the eye, in case there are adverse consequences of a totally new type of therapeutic. If they can show safety and efficacy in an enclosed compartment, they may be happier to go to a more systemic application."[278]

150. Alongside trials targeting single indications, some groups attempt to gain approval for trials that target multiple indications and as such have novel endpoints—for example the time taken to develop a second age-related disease after the onset of the first.[279] Professor Cox told us that the TAME trial is "remarkable in being approved by the FDA because it has a mixed endpoint",[280] namely the progression of any of a number of age-related diseases, including congestive heart failure, stroke, dementia and most cancers.[281] The stated aim of the TAME trial is to provide proof of concept that ageing can be treated as an indication in and of itself.[282] Professor Witham told us there is a role for regulators in "creat[ing] a regulatory environment that facilitates this work" and "allow[ing] companies to get marketing authorisations for medicines with multiple benefits."[283]

151. Even if trials with novel endpoints are authorised, a further challenge for anti-ageing drugs is to find endpoints that can be measured in reasonable timescales. Jim Mellon, Chair and co-founder of drug-development company Juvenescence, told us: "The problem for us as drug developers is that looking at old age as something to be treated is very difficult, because we cannot hang around long enough commercially".[284] One solution could be to use biomarkers of ageing to measure the progression of biological ageing over

276 An endpoint is the outcome that is being measured by a trial; for example, the endpoint of a trial for a cancer drug may be survival rate after five years.
277 Q 46 (Professor Jesús Gil)
278 Q 46 (Professor Lynne Cox)
279 *Ibid.*, see also Q 184 (Dr Fiona Marshall).
280 Q 46 (Professor Lynne Cox)
281 Steven B Kritchevsky and Mark A Espeland, 'Trials of geroscience-based therapeutics: the Targeting Aging with Metformin (TAME) example', *Innovation in Aging*, vol. 2 (November 2018): https://doi.org/10.1093/geroni/igy023.3065 [accessed 7 September 2020]
282 American Federation for Aging Research (AFAR), '*The Targeting Aging with Metformin (TAME) Trial*': https://www.afar.org/research/TAME/ [accessed 7 September 2020]
283 Q 41 (Professor Miles Witham)
284 Q 184 (Jim Mellon)

shorter time frames. However, Professor Cox said that there are no "readily analysable" biomarkers which show drug efficacy through simple means such as a blood sample.[285] Dr Marioni explained that as yet broad biomarkers of ageing, such as epigenetic clocks, are "not precise enough for specific anti-ageing trial outcomes."[286]

152. Professor Faragher explained how the TAME trial intends to overcome the issue of ageing operating on long timescales, and how this could be circumvented using a novel trial design:

> "The way in which TAME is postulated to work is this: the age at which you develop your first age-related impairment is very variable from one person to another, but the time from first impairment to second impairment is relatively tight, 18 to 24 months. So, a compound that improves healthy lifespan would be predicted to lengthen the time from first impairment to second impairment."[287]

153. Dr Fiona Marshall of the Academy of Medical Sciences and Vice President Head of Neuroscience and Head of UK Discovery at MSD told us that this approach is similar to how "statins were approved for cardiovascular disease just by lowering cholesterol, rather than seeing an endpoint in a cardiovascular mortality trial", and that "we need the regulators to accept" such biomarkers of disease progression and ageing.[288] Professor Cox told us that endpoints based on whether (or when) someone develops an age-related condition will be necessary "until we have really reliable biomarkers" of ageing which can indicate improvement.[289]

154. The Innovative Therapeutics for Ageing Consortium suggested that the "MHRA's Innovation Office could have a powerful global impact" in this area, by "working with international counterparts to define the future of multimorbidity trials and endpoints that the industry can have confidence will be approved." They noted there was a role for the National Institute for Clinical Excellence (NICE) to "create a framework for industry whereby a significant reduction in polypharmacy for [patients with] multimorbidity … would be a positive aspect for the adoption and reimbursement of a novel therapy".[290]

155. **The fact that clinical trials are usually approved only if they target a single indication poses a challenge to research into drugs that target underlying ageing processes. The novel design of the TAME trial in the US hopes to provide proof of concept for trials targeting the ageing process itself.**

156. ***We recommend that the Medicines and Healthcare products Regulatory Agency (MHRA) show greater willingness to approve trials which target multiple conditions. It should also explore the use of novel trial endpoints, such as using biomarkers of ageing as measures of success in treatments targeting the ageing process.***

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285 Q 46 (Professor Lynne Cox)
286 Q 33 (Dr Riccardo Marioni)
287 Q 27 (Professor Richard Faragher)
288 Q 184 (Dr Fiona Marshall)
289 Q 46 (Professor Lynne Cox)
290 Written evidence from Innovative Therapeutics for Ageing Consortium (INQ0042)

Trial exclusion criteria

157. A compounding challenge is that older people and people with multimorbidity have historically been excluded from clinical trials. Professor Witham told us:

> "Until a few years ago, it was very common to find protocols saying, "Nobody above the age of 65". There were reasons for that … They get ill; sometimes they die. They find it difficult to come to clinic appointments. If you are trying to do a trial, particularly if you are a pharmaceutical company for which time is money, that is all terribly inconvenient."[291]

158. Professor Witham said that "explicit exclusion on the criterion of age is less common now", but "unfortunately, people are still excluded because of multimorbidity, which means that the overall effect is the same."[292] He continued:

> "There is no point bringing older people into clinical trials unless they have multimorbidity and polypharmacy, otherwise we end up with evidence that [is] … applicable only to a very selective and healthy group of older people".[293]

The reason people with multiple conditions are often excluded from trials is that the co-morbidities from which they suffer, and any medications they take for those conditions, could confound the results of the study. This variability could reduce the significance of a trials' findings, and more people would need to be enrolled in a trial to address this issue.[294]

159. The exclusion of people with multimorbidity from clinical trials is a particular issue for drugs targeting the ageing process because, as Professor Cox highlighted: "They are exactly the target population that will be taking anti-ageing medication".[295]

160. Exclusion criteria for clinical trials are not a new concern; the 2005 report into ageing by this Committee found it was a problem, concluding:

> "The Department of Health and the research councils should take steps to ensure that older people are not routinely excluded from clinical trials, and that positive steps are taken to include them in the testing of medicines to be used to treat conditions prevalent among older people. The Medicines and Healthcare Products Regulatory Agency should ensure that the pharmaceutical industry does likewise."[296]

161. Co-lead of NIHR, Dr Louise Wood, told us that the current regulatory environment is "permissive" but patients with multimorbidity are "often excluded from trials."[297] She told us that "non-commercial funders, including NIHR, are absolutely supporting studies that involve older patients", including, for example, "changing our application process to require

291 Q 38 (Professor Miles Witham). See also Q 45 (Professor Lynne Cox).
292 Q 38 (Professor Miles Witham)
293 Q 41 (Professor Miles Witham)
294 Written evidence from Innovative Therapeutics for Ageing Consortium (INQ0042)
295 Q 45 (Professor Lynne Cox)
296 Science and Technology Committee, *Ageing: Scientific Aspects* (1st Report, Session 2005–06, HL Paper 20-I)
297 Q 178 (Dr Louise Wood)

investigators to justify more fully the populations that they are seeking to target in recruitment into trials."[298] Professor Witham also noted progress in this area, telling us that the NIHR has "started a series of work streams to accelerate bringing more older people into trials and to reach older people who have been neglected, particularly those who may be housebound or in care homes who do not fit into our current models of delivering clinical trials well."[299]

162. However, some witnesses thought that greater effort is needed and that regulators could incentivise more representative participant pools. Professor Witham told us:

> "There is a role for regulators here in making sure that the regulatory environment supports bringing older people, people with multimorbidity, into trials. It has been highly effective in the US in making sure that we study men and women in trials; the NIH [National Institutes of Health] mandates that … Similar changes to the regulatory environment in the UK are probably part of the answer".[300]

163. Several witnesses mentioned the success of paediatric investigation plans—assessments which ensure there are sufficient data on the effect of medicines in children—which the EMA requires before it will give market authorisation for a new medicine.[301] Dr Walker told us: "We should look at whether we should have elderly investigation plans, or multimorbidity investigation plans, where we ensure that we recruit a cohort of people into trials who are truly representative of the population we are prescribing to."[302]

164. Despite these suggestions, some witnesses (from the public sector and industry) suggested that the exclusion of older people and those with multimorbidity from clinical trials was a global problem, and one the UK could not fix alone. Dr Wood told us that "drug development is a global business, so unilateral action by the UK would not address this problem."[303] Dr Sheuli Porkess from the Association of the British Pharmaceutical Industry said that the problem of strict exclusion criteria is:

> "not just a UK phenomenon; it is a global phenomenon. The ICH [International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use] has produced guidelines to help companies to overcome this and ask how they can get older patients in. The EMA has also identified this as an area of focus and has some guidelines. Given that this is a global issue, we would like to see that global thinking reflected within the UK."[304]

165. **Historically, clinical trials excluded older people and people with multimorbidity, and some continue to do so. This is a particular issue for drugs targeting the ageing process, as older people and those with multimorbidity will be the main recipients of such drugs.**

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298 *Ibid.*
299 Q 41 (Professor Miles Witham). See also National Institute for Health Research, '*Research Ready*': https://enrich.nihr.ac.uk/research-ready/ [accessed 7 September 2020].
300 Q 38 (Professor Miles Witham)
301 Q 185 (Dr Lauren Walker). See also Q 41 (Professor Miles Witham, footnote) and Q 178 (Dr Louise Wood).
302 Q 185 (Dr Lauren Walker)
303 Q 178 (Dr Louise Wood)
304 Q 184 (Dr Sheuli Porkess)

166. ***We recommend that the Medicines and Healthcare products Regulatory Agency (MHRA) ensures that older people are included more frequently in clinical trials, particularly where the drug will be used primarily in that population. When developing novel trial designs for drugs targeting the ageing process, as recommended above, these should also allow for inclusion of people with multimorbidity.***

Targeting and administration of drugs

167. Another challenge will be when to administer approved drugs which aim to prevent the onset of age-related disease, and to whom. Professor Ferguson told us that the "ideal situation" is that people are given a medicine only if they will benefit from it, as "giving a chemical entity to people who may not benefit from it is anathema to medical treatment."[305] Identifying patients who will benefit from drugs will rely on having "good biomarker diagnostics to stratify patients and decide when to put them on those therapies."[306] Professor Pirmohamed told us that, in turn, this will allow for personalised medicine within strata of the population, which will provide a "much better effect in particular populations."[307]

168. Alternatively, we heard suggestions that drugs that target the ageing process, such as metformin, could be applied more broadly, "almost like a supplement".[308] Professor Ferguson highlighted the example of preventative treatments for HIV:

> "[HIV patients] used to be treated only when their CD4 count was at a low level. It became very clear over several years that that was not a good thing to do and that you should test and treat as soon as somebody shows positive. They should be treated right away because you will reduce their subsequent decline very considerably".

He added that it will be necessary to "wait for the data to come in on whether a therapeutic is sufficiently safe and beneficial to all before deciding whether you want to introduce it" in a supplemental way to a large number of people who do not yet suffer from an age-related disease.[309]

169. Professor Witham told us that there could be a "sweet spot" in who, in the first instance to target with such drugs, and when, referring to:

> "people who are not well but are not too frail or multimorbid. They are people at higher risk of accelerated decline or ageing, for whom we can potentially demonstrate a net benefit in a relatively short window—within five years, say."

Another advantage of targeting this group is that they have "more to gain" from such interventions than younger age groups, but "are not so frail that they will not be able to tolerate side-effects from these new agents."[310]

170. **How to target 'anti-ageing' drugs to provide the greatest benefit to the individual, the NHS and society will be an important issue**

305 Q 40 (Professor Sir Michael Ferguson)
306 *Ibid.*
307 Q 40 (Professor Sir Munir Pirmohamed)
308 Q 40 (Professor Sir Michael Ferguson)
309 Q 40 (Professor Sir Michael Ferguson)
310 Q 40 (Professor Miles Witham)

in future but requires further research and evidence from clinical trials. A health economics analysis of such treatments will be needed to determine the optimal time and populations for intervention.

Prioritisation of biomedical research into the ageing process

171. The main public funder of biomedical research in the UK is UK Research and Innovation (UKRI), predominantly via the Biotechnology and Biological Sciences Research Council (BBSRC) and the Medical Research Council (MRC). Many charities fund biomedical research; members of the Association of Medical Research Charities support around half of publicly funded medical research in the UK.[311] Drug companies also play an important role in funding clinical trials.

172. We heard mixed views about the adequacy of funding for ageing research in the UK. Professor Gil told us that there is funding available for research into the underlying biological processes of ageing:

> "There is specific funding for things such as the root causes and the molecular and cellular causes of ageing. The BBSRC and MRC fund medical research on healthy ageing. For example, I am researching cellular senescence. We are researching the process at the cellular and molecular level and are not necessarily focusing on a specific disease. There is funding for that."[312]

173. However, other witnesses told us that funding for research into the biological processes of ageing is not adequately covered by the major funders. Professor Cox said:

> "it is falling between two stools. We have research councils, BBSRC, that fund healthy ageing; we have the Medical Research Council that funds disease. Ageing is a process that ends up with disease, and it is hard to fit the remit of either research council … A lot of the smaller charities are focused on their particular disease, whereas we think that we have a course of multiple diseases, so it is hard to rebadge for specific disease indications."[313]

174. The sense that the majority of biomedical research funding is targeted at specific diseases was prominent in our evidence. The British Society for Immunology told us:

> "The current funding landscape is very much geared towards disease specific research, with a significant portion of funding being awarded through medical research charities that, unsurprisingly, have a specific disease focus. This leaves a gap for a broader focus on research into ageing and how bodily systems change during this process, e.g. the immune system, and for research into understanding the basic molecular interactions that underlie the ageing process."[314]

311 Association of Medical Research Charities (AMRC), '*Our sector's footprint*' (23 June 2020): https://www.amrc.org.uk/our-sectors-footprint-in-2019 [accessed 7 September 2020]
312 Q 50 (Professor Jesús Gil)
313 Q 46 (Professor Lynne Cox)
314 Written evidence from the British Society for Immunology (INQ0057)

175. We heard that this is also the case for drug development. Dr Porkess told us that her association's members are "primarily focusing on the diseases, rather than on ageing itself."[315]

176. The focus of biomedical research and development on individual diseases was a finding in this Committee's 2005 report into ageing:

> "Most of the research on ageing and health within the UK is focused on specific diseases and medical conditions for which age is the single largest risk factor. However, there is little research on underpinning mechanisms of such diseases which may be linked to basic processes of ageing."[316]

The report recommended: "The Department of Health and other medical research funders, including the major charities, should develop and implement strategies to address links between ageing and disease."[317]

177. **There has been a lack of effort since our report in 2005 to ensure research into ageing—as opposed to research into specific age-related disease—is properly funded, co-ordinated and included within the remit of particular research councils. This may have contributed to the poor translation of basic research into clinical trials or new medicines.**

178. ***We recommend that UK Research and Innovation commit to funding further research into the biological processes underlying ageing as a priority, in particular to address gaps in understanding the relevance of ageing hallmarks to humans. Research to identify accurate biomarkers of ageing in humans should also be prioritised, to support studies to improve health span.***

179. ***We recommend that UK Research and Innovation and the National Institute for Health Research support further research into drugs that target the ageing process—including proof of concept trials using repurposed drugs (such as in the TAME trial).***

180. ***We recommend that UK Research and Innovation and the National Institute for Health Research commit to working more closely to ensure rapid translation of ageing research into clinical benefit.***

181. ***We recommend that the Chief Medical Officer is given responsibility for overseeing the coordination of ageing research between UK Research and innovation and the National Institute for Health Research.***

The UK's position

182. A common theme in our evidence was that the UK has the potential to be a major global player in the development of treatments for ageing. Jim Mellon thought the UK could be in the "top three" leading countries in treatments for ageing.[318] Professor Cox said that the UK has historically been "fantastic

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315 Q 184 (Dr Sheuli Porkess)
316 Science and Technology Committee, *Ageing: Scientific Aspects* (1st Report, Session 2005–06, HL Paper 20-I)
317 *Ibid.*, conclusion 9.35
318 Q 185 (Jim Mellon)

at developing drugs", having developed "a quarter of all the drugs in use globally."[319]

183. However, Professor Cox expressed concern that the funding situation for biomedical research into ageing means that the UK is missing out on opportunities.[320] She told us:

> "Despite an early UK lead in cell senescence research, the bulk of exciting studies are now being carried out in the USA, as researchers benefit from the focus on ageing of the NIA [US National Institute for Aging], significant ring-fenced funding, government lobbying by AFAR [American Federation for Aging Research] and the more entrepreneurial attitude of US universities. While many traditional UK universities are excellent at basic discovery science, funding is extremely patchy and UK basic science can also be stifled by poor tech transfer and a lack of administrative speed and flexibility needed when working with commercial partners."[321]

184. Professor Akbar found it "very difficult to get funding in the UK for ageing research", to the extent that he currently had "a grant application in [for US funding] with a colleague in California to work on an ageing process which we identified here in the UK."[322]

185. Professor Cox suggested that the reason funding is easier to access in the US than the UK is because the US spends a larger fraction of its overall research budget on ageing research:

> "The [US National Institute for Aging] takes up 10% of the [National Institutes for Health] budget. That comes in at $3.9 billion a year … It is hard to get a definite figure for [overall] UKRI funding but it is about £6 billion, 10% of which is £600 million. That sounds horrendous, but it is 0.4% of what we spend on treating illness in the NHS, instead of keeping people well."[323]

186. The British Society for Immunology highlighted that in the US there are charities which fund basic ageing research, whereas UK charities largely fund research into specific diseases. This means that ageing researchers compete for research council funding with researchers who are also eligible for medical research charity funding.[324]

187. We heard that engagement and funding from the private sector and venture capitalists is much greater in the US than the UK. Venture capital can be an important source of funding for the development of new drugs; however, we heard it can be difficult for companies to obtain in the UK. Tamsin Berry, Director of the Office for Life Sciences, told us:

> "We struggle here in the UK with access to finance for growth capital. As you said, we are really good at doing some of the early-stage stuff. However, when we need more money to get that early-stage stuff to the point of commercialisation, a lot of the biotechs and pharmaceutical

319 Q 46 (Professor Lynne Cox)
320 *Ibid.*
321 Written evidence from Professor Lynne Cox (INQ0034)
322 Q 50 (Professor Arne Akbar)
323 Q 49 (Professor Lynne Cox)
324 Written evidence from the British Society for Immunology (INQ0057)

> companies have to find capital elsewhere, quite often in the States, so they will move over to the States."[325]

Jim Mellon told us that this is in part because venture capital has been "badly burned" by a number of UK companies, and there is now not "the pool, or the depth of experience" in venture capital in the UK.[326]

188. Tamsin Berry noted that a £200 million "scale-up fund" through the British Business Bank was recently announced, to "enable companies to stay here and continue to commercialise their products here in the UK." She acknowledged that, compared with spending on ageing research in the US:

> "£200 million is a modest figure for us to start with, but it is very much the start of our ambition. We will not stop work in this policy space. We are very keen to do everything we can with the life sciences industrial strategy to continue to make the UK as attractive a place as possible for life sciences so that we can attract the US-based fund managers over to the UK".[327]

189. We asked witnesses whether they thought the UK would benefit from the formation of a national funding body equivalent to the US National Institute on Aging.[328] Responses were mixed: some witnesses, such as Professor Ferguson, thought a national institute would be beneficial for coordinating research:

> "The national institute can co-ordinate all these different arms. They are different pieces that need to be joined up: the social science aspect of ageing, the new therapeutics design and delivery for ageing, the assisted living and digital components of ageing—these are all extremely important and all need to go in parallel. Having a central national institute that co-ordinates and looks after that is really what you want, but it must have funding capability to commission and make sure that the right pieces happen—and they all need to happen at the same time."[329]

190. There was a general consensus that a "bricks and mortar" institute wasn't necessary, but that a virtual institute would be of value.[330] However, some witnesses argued that better coordination of activities could be achieved within existing structures, without the need for creating a separate institute.[331] For example, Professor Partridge told us that "what is required is much better co-ordination of the existing effort and better funding." She explained that progress in ageing research "tends to be rather slow, which does not play well to the career reward system or the funding system that we currently have", and that there "needs to be some recognition of the peculiar requirements of this kind of work and appropriate funding for it, which should be rather more long term than is typical."[332]

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325 Q 179 (Tamsin Berry)
326 Q 185 (Jim Mellon)
327 Q 179 (Tamsin Berry)
328 U.S. Department of Health and Human Services, '*National Institute on Aging*': https://www.nia.nih.gov/ [accessed 7 September 2020]
329 Q 42 (Professor Sir Michael Ferguson). See also Q 49 (Professor Lynne Cox).
330 Q 42 (Professor Dame Linda Partridge). See also Q 49 (Professor Jesús Gil, Professor Lynne Cox), Q 122 (Professor Russell Foster).
331 Q 172 (Professor Fiona Watt) See also Q 42 (Professor Dame Linda Partridge).
332 Q 42 (Professor Dame Linda Partridge)

191. **The UK has historically been a major player in drug research and development, and has the potential to be a key player in the development of treatments targeting the processes of ageing. However, companies in the UK struggle to commercialise such innovations and often have to move abroad to access finance.**

192. ***We recommend that the Government ensure the UK remains a global leader in drug research and development. It should work towards making the UK a more attractive environment for growth capital investment, to stop UK innovations moving abroad after the discovery stage of research.***

Contribution of biomedical research to the Ageing Society Grand Challenge

193. We heard a range of views on whether biomedical research and development could contribute to the Ageing Society Grand Challenge mission to "Ensure that people can enjoy at least five extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest."[333] Professor Faragher was optimistic about the role that treatments such as senolytics could play in reaching this target. We heard that it takes about 15 years to get a new drug from "bench to bedside".[334] Professor Faragher highlighted that this is the "same order of magnitude" as the 15-year timescale for the Grand Challenge mission: "If we push hard … it could be achieved."[335]

194. Other witnesses were more cautious. Professor Melzer told us:

> "There are tremendous grounds for optimism, but not boundless optimism. Even in the mice, knocking out the senescence cells does not change maximum lifespan. These mice are still getting ill and dying eventually, although it helps many of the ones that would otherwise die early to live longer and in much better shape. The other big problem is how you do these trials and get them regulated through the drug system."[336]

195. Professor Ferguson noted that, given the 15-year timescale, progress would need to start now, to ensure new therapeutics could be "rolled out, properly clinically trialled and entering clinical practice" by 2035; even then, they would likely not have an impact on healthy life expectancy until beyond 2035.[337]

196. For some hallmarks of ageing where research is in the early stages, we heard that it is difficult to know whether therapies stemming from these findings could contribute to the Grand Challenge mission. For example, on epigenetics, Dr Bell told us:

> "I think that [therapeutics stemming from epigenetics research] is still quite far in the future. I am not sure, because there are so many changes that we observe, to what extent this will be a viable strategy. Perhaps it

333 Department for Business, Energy and Industrial Strategy, 'Policy paper: The Grand Challenge missions, Ageing Society': https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#ageing-society [accessed 7 September 2020]
334 Q 27 (Professor Avan Aihie Sayer). See also Q 40 (Professor Sir Michael Ferguson).
335 Q 27 (Professor Richard Faragher)
336 Q 27 (Professor David Melzer)
337 Q 40 (Professor Sir Michael Ferguson)

> will be in five or ten years' time, but at the moment the research is really focused on using epigenetics as a marker of ageing. It is really focused on that knowledge to develop predictors, such as predictors of age."[338]

197. Some witnesses thought other approaches would be more important for the timescale of the Grand Challenge mission. Professor Sayer told us:

> "there are some near wins that we can think about, certainly coming from a population level and putting interventions in place that we already know do help … we know that, for older people, exercise is effective, as is changing diet to avoid malnutrition; and … obesity, stopping smoking, social connection and avoiding loneliness."[339]

198. We also asked witnesses whether the Ageing Society Grand Challenge was providing support for biomedical research and development, with the aim of it contributing to the five-year target. At the time of writing there are two sources of funding listed under the Ageing Society Grand Challenge which focus on biomedical and pharmaceutical research and development:[340]

- £210 million through the "From data to early diagnosis and precision medicine" Challenge Fund;[341]
- £130 million of investment to support healthcare innovation, including gene-based therapies and artificial intelligence.[342]

199. Dr Alison Cave, Director of the 'From data to early diagnosis and precision medicine' Challenge Fund, told us that neither that fund nor the 'Accelerated Detection of Disease' Challenge Fund, which she also directs, "is focused specifically on ageing." However, "the data platforms they are creating will be a specific enabler … for drug-repurposing approaches" and the funds will enable "better targeting of existing therapies".[343]

200. Some witnesses from the scientific community were unimpressed by the support given to the biomedical sector under the Ageing Society Grand Challenge. The only Challenge Fund dedicated to ageing is the Healthy Ageing Challenge Fund. Several witnesses told us that the Government was more focused on using technologies and related services to address the aims of the challenge. For example, Professor Cox said:

> "I have been talking to the healthy ageing initiative people about the challenge. It is very much driven by business, rather than science. It is all about making money and the post-Brexit economy. Tech looks like it is going to be a quick fix for the economy, whereas pharmaceutical

338 Q 26 (Dr Jordana Bell)
339 Q 27 (Professor Avan Aihie Sayer)
340 Department for Business, Energy and Industrial Strategy, 'Policy paper: The Grand Challenge missions, Ageing Society': https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#healthy-lives [accessed 7 September 2020]
341 UK Research and Innovation, 'Industrial Strategy Challenge Fund' (2020): https://www.ukri.org/innovation/industrial-strategy-challenge-fund/from-data-to-early-diagnosis-and-precision-medicine/ [accessed 7 September 2020]; and Innovate UK, 'Live longer, better, healthier: new innovation funding', (12 March 2018): https://www.gov.uk/government/news/live-longer-better-healthier-new-innovation-funding [accessed 7 September 2020]
342 Department for Business, Energy and Industrial Strategy, 'Government to invest over £130 million in new tech to tackle cancer and debilitating illnesses', (9 September 2019): https://www.gov.uk/government/news/government-to-invest-over-130-million-in-new-tech-to-tackle-cancer-and-debilitating-illnesses [accessed 7 September 2020]
343 Q 171 (Dr Alison Cave)

> industries take a while to build and to bring funds in. I am controversial in my views, but tech has definitely been the focus rather than the biomedical sciences."[344]

201. Professor Faragher also expressed concern about this strategy. He told us:

> "What I fear … is that this country misses the boat and that we push exclusively on technological interventions. That would be akin to when a polio vaccine was on the horizon and the Government deciding that the solution was to ask the British Motor Corporation to build thousands of iron lungs, because there was clearly an immediate market demand."[345]

202. **There was scepticism from the research community that the target of five extra years of healthy life can be achieved by 2035, and a view that the focus of the Industry Strategy Challenge fund on technological solutions and data analysis is unlikely to help deliver the target.**

344 Q 50 (Professor Lynne Cox)
345 Q 27 (Professor Richard Faragher)

CHAPTER 4: LIFESTYLE AND ENVIRONMENTAL INFLUENCES ON HEALTHY AGEING

203. Lifestyle and environmental factors affect physical, cognitive and mental health as humans age. The main risk factors (and protective factors) for age-related diseases are well-known and form the basis of public health advice about healthy lifestyles—for example the importance of a nutritious diet. Evidence for these links comes partly from longitudinal cohort studies that show correlations between risk factors and health at a population level. For example, there is a correlation between clustering of risk factors and poor health affecting people living in areas of high deprivation, in particular people from ethnic minorities.[346] There is also some evidence from biomedical studies, although these are largely carried out in animal models with few long-term intervention studies in humans. Understanding of the links between lifestyle and environmental factors and health has increased significantly in recent years. However, we heard that research has focused mainly on how these factors affect the risk of age-related diseases, and more work is required to understand links to the underlying biological processes of ageing.

Sources of evidence

204. Cohort studies are the main source of information on which factors influence health during life, including in old age. Cohort studies monitor groups (cohorts) of people over a period of years in order to determine correlations between risk factors and health outcomes. For example, birth cohort studies—such as the 1946 National Birth Cohort—follow groups of people who were born in the same year and monitor their lifestyle and health throughout their lives.

205. The UK has a wide range of cohort studies, that are valued highly by the research community.[347] As well as results from each study, further findings can be obtained by combining information from different studies, and some comparisons can be made with studies from other countries.[348]

206. We heard that cohort studies need long-term funding in order to gather meaningful data. However, we were told that long-term funding is not available and that researchers have to apply for new funding periodically. Professor Nazroo explained: "we have to bid for renewal every four years—so for every two waves of data collection. Obviously, if we fail, the study ends."[349]

207. In addition to cohort studies, we heard there is a need for more intervention studies, which test whether relationships between lifestyle factors and health are causal, rather than just correlative. The Academy of Medical Sciences told us: "There is an urgent need for more studies using objective measures, particularly of sleep and physical activity."[350] The UK Biobank is likely to be a valuable resource for such studies; it gathers health data and biological

346 See for example Q 16 (Professor James Nazroo) and The Centre for Ageing Better, *The State of Ageing in 2019, Adding life to our years* (2019): https://www.ageing-better.org.uk/sites/default/files/2019-04/The-State-of-Ageing-in-2019.pdf [accessed 7 September 2020].

347 See, for example, written evidence from UK Research and Innovation (INQ0032) and Q 20 (Dr Stuart Ritchie).

348 See, for example, Q 12 (Professor James Nazroo) and written evidence from UK Research and Innovation (INQ0032).

349 Q 20 (Professor James Nazroo)

350 Written evidence from the Academy of Medical Sciences (INQ0078)

samples, which are useful for studies of mechanisms that underpin links seen in cohort studies.[351]

208. As discussed in Chapter 3, research into ageing as a process, rather than individual age-related diseases, faces challenges because it does not fit neatly into established frameworks for medical research and clinical trials. Some witnesses suggested that part of the solution could be to use changes to the hallmarks of ageing as biomarkers in studies of lifestyle and environmental influences. They gave examples, noting that these are comparatively new areas of study that require more research: epigenetic changes caused by smoking;[352] telomere shortening and senescence caused by stress;[353] and inflammation caused by physical inactivity, stress, and aspects of diet, nutrition and the microbiome.[354]

Influences on health outcomes

Lifestyle and behavioural factors

209. We heard that the most significant risk factors affecting health outcomes in middle and older age are smoking, poor nutrition, obesity, insufficient physical activity and excessive alcohol consumption.[355] These risk factors (with the exception of smoking) have become more prevalent over recent decades,[356] which is associated with worsening health outcomes in the general population.[357]

210. There is consensus from cohort study data that lifestyle factors are strongly linked to lifespan and mortality. Unhealthy lifestyle factors also reduce healthy life expectancy, by increasing the likelihood of developing age-related diseases or bringing forward the age of onset of diseases (or both). The Self-Care Academic Research Unit (SCARU) at Imperial College London explained: "up to 80% of heart disease, stroke and type-2 diabetes and over a third of cancers could be prevented by eliminating shared risk factors including tobacco use, unhealthy diet, physical inactivity and the harmful use of alcohol."[358] The Newcastle University Institute for Ageing told us that, of three lifestyle factors assessed, "obesity is most strongly associated with spending more years of life with disability, with years lived with disability [after] age 55 differing by 2.8 years according to BMI". The other two factors assessed, smoking and alcohol consumption, increased years lived with disability after age 55 by 0.2 years and 1.6 years respectively.[359]

211. Conversely, healthy lifestyle behaviours, and positive lifestyle changes made at any stage in life, can increase healthy life expectancy. The Healthy Ageing Research Group at the University of Manchester wrote: "healthy lifestyle

351 See, for example, discussion in Q 26 (Professor David Melzer).
352 Q 24 (Dr Jordana Bell)
353 Written evidence from Professor Lynne Cox (INQ0034)
354 See, for example, Q 109 (Professor Jane Raymond) and Q 54 (Dr Marina Ezcurra).
355 See, for example, Q 14 (Professor Marcus Richards) and written evidence from Imperial College Self-Care Academic Research Unit (SCARU) (INQ0037).
356 For example, regarding body weight, see: Q 14 (Professor Marcus Richards). He said: "Since 1946, every generation has been heavier than the previous one, and people are becoming overweight at an earlier stage. In the 1946 generation, people reached overweight around the mid-40s. In the cohort of people born in 1970, that has dropped down to about 35."
357 Q 14 (Professor James Nazroo). He said: "more recent cohorts have the same or worse health than more distant cohorts. That means that the population is not getting healthier across younger cohorts. If anything, the health of more recent cohorts is worse than that of older cohorts."
358 Written evidence from Imperial College Self-Care Academic Research Unit (SCARU) (INQ0037)
359 Written evidence from the Newcastle University Institute for Ageing (INQ0025)

behaviours … mitigate many long-term conditions (diabetes, heart disease, respiratory disease), even when positive changes are adopted in later life."[360]

212. Links have been identified between lifestyle factors and cognitive and mental health. A report on the findings of the Lothian Birth Cohort studies[361] noted: "An individual's cognitive trajectory is the result of a combination of shared influences with the rest of the body."[362] Analysis of data from this study found that there is no "silver bullet" for protecting cognitive function in old age, but a number of protective factors can give "marginal gains".[363] For example, there is clear evidence that cognitive function is harmed by smoking, loneliness and social isolation, and is aided by maintaining physical activity into older age.[364]

Environmental factors and local situations

213. Health throughout the life-course can be affected by people's environment, where 'environment' has several aspects. People can be harmed directly, for example by pollution. Public Health England stated in a 2019 report that "poor air quality is the largest environmental risk to public health in the UK" because it "reduces life expectancy, mainly due to cardiovascular and respiratory causes and from lung cancer." It added that the impacts "extend beyond the cardiopulmonary system to affect many other organs, increasing the risk of disease that begins from conception and persists across the life course".[365]

214. There is growing evidence that air pollution harms health in old age, including cognitive health.[366] Professor Cox wrote that pollution increases "premature onset of [age-related diseases]".[367] Professor Jane Raymond, Professor of Visual Cognition at the University of Birmingham, said: "High levels of air pollution are associated with high levels of Alzheimer's disease in many cities … whether it is causal is another question but it is related to inflammation, which affects the hippocampus, which affects memory, which affects cognitive health."[368]

215. The built environment affects health throughout the life-course. Poor quality housing contributes to ill health, for example dampness and poor air quality are associated with respiratory illnesses, and cold is associated with

360 Written evidence from the Healthy Ageing Research Group, University of Manchester (INQ0072)
361 The University of Edinburgh, '*The Lothian Birth Cohorts of 1921 and 1936*' (2015): https://www.lothianbirthcohort.ed.ac.uk/ [accessed 7 September 2020]
362 Janie Corley *et al.*, 'Healthy cognitive ageing in the Lothian Birth Cohort studies: marginal gains not magic bullet', *Psychological Medicine*, vol. 48 (2) (January 2018): https://doi.org/10.1017/S0033291717001489 [accessed 7 September 2020]
363 *Ibid.*
364 *Ibid.*
365 Public Health England, *Review of interventions to improve outdoor air quality and public health* (March 2019) p 20: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/938623/Review_of_interventions_to_improve_air_quality_March-2019–2018572.pdf [accessed 2 November 2020]
366 See, for example: Paula de Prado Bert *et al.*, 'The Effects of Air Pollution on the Brain: a Review of Studies Interfacing Environmental Epidemiology and Neuroimaging', *Current Environmental Health Reports*, vol. 5 (July 2018) pp 351–364: https://doi.org/10.1007/s40572–018-0209-9 [accessed 7 September 2020].
367 Written evidence from Professor Lynne Cox (INQ0034)
368 Q 110 (Professor Jane Raymond)

hypothermia.[369] As discussed in Chapter 5, housing that is ill-suited to life in old age can affect health, including by restricting independence.

216. Health throughout the life-course can be affected by local amenities and services. The Institute of Health Research and Innovation at the University of the Highlands and Islands said that the presence of "health promoting environments such as shops that stock fresh foods, and leisure services such as swimming pools and sports centres, has a direct influence on a region's health span."[370] Several witnesses spoke of the importance of making exercise enjoyable at school and of providing affordable exercise facilities for adults.[371] In order to encourage uptake of healthy food, we heard of the value of introducing children to cooking at school and at home.[372]

Health inequalities

217. Cohort studies show clustering of health issues associated with deprivation, such that people in the most deprived groups are more likely than those in the least deprived groups to suffer from health problems in older age, to have reduced life expectancy and to have reduced healthy life expectancy. For example, women aged 50 and over in the poorest quintile are three times more likely to have type 2 diabetes and four times more likely to have chronic heart disease as those in the richest quintile.[373] Men aged 50 and over in the poorest quintile are twice as likely to have type 2 diabetes and three times more likely to have chronic heart disease as those in the richest quintile.[374] Professor Whitty told us that males in the least deprived decile can expect to live almost 10 years longer than those in the most deprived decile, and listed the conditions that contribute to that difference:

> "Heart disease is the biggest [contributor] at 1.49 years; then lung cancer at 0.93; then chronic lower respiratory conditions at 0.92. All of those are very strongly driven by smoking, to be clear. Then there is cirrhosis at 0.57—I think everyone knows that that is a combination of alcohol and obesity; then pneumonia and influenza, which is a mixed bag, although smoking also contributes; then stroke—back to smoking again."[375]

218. As well as facing clustering of risk factors, people living in deprivation face greater barriers to adopting changes in behaviour that can protect against

369 See for example: NatCen Social Research, *People living in bad housing—numbers and health impacts* (2013): https://england.shelter.org.uk/__data/assets/pdf_file/0010/726166/People_living_in_bad_housing.pdf [accessed 2 November 2020]; and Mary Shaw, 'Housing and Public Health', *Annual Review of Public Health*, vol. 25 (April 2004) pp 397-418: https://doi.org/10.1146/annurev.publhealth.25.101802.123036 [accessed 2 November 2020].

370 Written evidence from the Institute of Health Research and Innovation, University of the Highlands and Islands (INQ0028)

371 See, for example, written evidence from Professor Lynne Cox (INQ0034) and Professor Katherine Appleton (INQ0035).

372 See, for example, written evidence from Professor Lynne Cox (INQ0034).

373 Centre for Ageing Better, *The State of Ageing in 2019, Adding life to our years* (2019): https://www.ageing-better.org.uk/sites/default/files/2019–04/The-State-of-Ageing-in-2019.pdf [accessed 7 September 2020]

374 *Ibid.*

375 Q 4 (Professor Chris Whitty)

ill health. This includes limited access to information[376] and lack of facilities and funds to act upon advice. Professor Marmot told us:

> "a health education strategy in general increases inequalities. If you simply tell people what constitutes a healthy life, the people who read the *Times* and the *Guardian* or whatever will pick it up, and those who do not, will not. That is not just because they are tuned in to information … If you give good advice on what constitutes healthy food, people down at the bottom cannot follow that advice because they do not have enough money to do it."[377]

219. Levels of deprivation are higher amongst ethnic minorities, which contributes to health inequalities.[378] Professor Nazroo said that "ethnic inequalities in later life in terms of health and other outcomes are dramatic. The health of a 40 year-old Pakistani or Bangladeshi person is equivalent to that of a 70 or 80 year-old white British person." However, he noted that disadvantage is "not consistent across different ethnic groups". He also observed that the fact that differences amongst ethnic groups increase as people get older is likely the effect of an "accumulation" of disadvantage.[379] However, he told us that there is a "huge gap" in data in the UK on health and wellbeing outcomes for older people in ethnic minorities, because "particularly [in] the early birth cohorts, there were very few ethnic minority people to be sampled."[380]

220. **The UK has the opportunity to be a leader in understanding the impacts of lifestyle on health, using its well-established cohort studies in conjunction with its expertise in emerging areas of biomedical research. To achieve this, it is important that longitudinal cohort studies are provided with longer-term funding that gives greater security to these studies. It is also important that cohort studies recruit sufficient numbers of people from different ethnicities and socioeconomic groups to better understand health inequalities in older adults and how these may be resolved in the longer term.**

Evidence base for lifestyle risk factors

Smoking and excessive alcohol consumption

221. It is well-established that smoking is harmful to health, contributing to numerous diseases that reduce healthy life expectancy and life expectancy.[381] Smoking is particularly prevalent in groups with higher levels of deprivation, where it tends to be clustered with other harmful lifestyle and environmental factors. Professor Whitty explained: "There is a huge disparity in smoking rates, which drives at least some of, and probably a large part of, the difference between these [groups]".[382]

222. We heard that smoking can cause harm via genetic and epigenetic changes which accelerate the processes of ageing. Professor Melzer said that smoking "greatly increases the number of DNA mutations and the amount of damage

376 See, for example Janie Corley *et al.*, 'Healthy cognitive ageing in the Lothian Birth Cohort studies: marginal gains not magic bullet', *Psychological Medicine*, vol. 48 (2) (January 2018): https://doi.org/10.1017/S0033291717001489 [accessed 7 September 2020]
377 Q 195 (Professor Sir Michael Marmot)
378 Q 4 (Professor Chris Whitty)
379 Q 16 (Professor James Nazroo)
380 *Ibid.*
381 See, for example, written evidence from the Newcastle University Institute for Ageing (INQ0025).
382 Q 7 (Professor Chris Whitty)

to DNA".[383] Dr Bell said: "Smoking, which we know has a major impact on the epigenome, also impacts on ageing".[384]

223. It is well-established that excessive alcohol consumption is harmful to health, contributing to high blood pressure, stroke, liver disease, various forms of cancer, cognitive impairment and mental health disorders. The Newcastle University Institute for Ageing wrote that alcohol reduces disability-free healthy life expectancy after age 55 on average by 1.6 years and reduces overall life expectancy on average by 3.1 years.[385] There is some evidence that alcohol is becoming a less common risk in younger generations, with Professor Richards noting that "the prevalence of hazardous drinking has been falling, particularly in younger people, but not among older people".[386]

224. **The impacts of smoking and excessive alcohol consumption upon ageing—and the potential for ill health and disability in old age—may be an important issue for some people when considering their behaviours and so could be an effective part of public health messaging.**

Diet, nutrition and obesity

225. There is long-standing evidence that health is affected by dietary factors, both the quantity of food and its nutritional quality. In particular, poor diet can lead to obesity and can contribute to increased risk of specific age-related diseases, such as high blood pressure, type 2 diabetes, cardiovascular disease and certain types of cancer.[387] Diet and nutrition can affect the health of the brain and lead to cognitive harm, for example via strokes, and there is some evidence of a link to the risk of developing dementia.[388]

226. There is evidence that the dietary needs of people change as they age, but there is limited knowledge of the nutritional requirements of older people. Professor John Mathers, Professor of Human Nutrition at the University of Newcastle, explained: "Part of the problem is the complexity of the nutritional needs of older people, because that greater age is usually associated with a greater likelihood of people having multiple conditions—diseases of one kind or another, combined with the use of a whole range of drugs."[389]

227. Ruthe Isden of Age UK told us that malnutrition is more common than obesity for older people, noting that "there are around 1.6 million older people who are malnourished or at risk of malnutrition".[390] This high prevalence of malnutrition is partly because the smaller appetite of older people[391] makes it harder for them to obtain the necessary range of nutritional content, for example protein to retain muscle mass.[392]

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383 Q 24 (Professor David Melzer)
384 Q 24 (Dr Jordana Bell)
385 Written evidence from the Newcastle University Institute for Ageing (INQ0025)
386 Q 15 (Professor Marcus Richards)
387 See, for example, written evidence from Imperial College Self-Care Academic Research Unit (SCARU) (INQ0037).
388 See, for example: British Nutrition Foundation, 'Older adults': https://www.nutrition.org.uk/nutritionscience/life/older-adults.html [accessed 5 August 2020]
389 Q 53 (Professor John Mathers)
390 Q 76 (Ruthe Isden)
391 Written evidence from the British Dietetic Association (INQ0080)
392 Q 57 (Professor John Mathers)

228. Recently there has been increased focus on whether dietary factors also influence the underlying biological processes of ageing, including the impact of obesity. Obesity significantly increases the low-level inflammation experienced with age ('inflammaging')[393] and might contribute to enhanced cellular senescence.[394] As discussed in Chapter 3, calorie consumption appears to be linked to the ageing process, but some witnesses cautioned against overinterpreting the results seen in animal interventional studies.[395]

229. There is evidence that the gut microbiome (discussed in Chapter 3) is modified by what is consumed, with impacts on health. Professor Mathers said: "Many of the substances that we ingest influence the microbiome" and "probably dominant in older people are the drugs we use".[396] Dr Marina Ezcurra, Lecturer in Molecular Biosciences at the University of Kent told us: "the Mediterranean diet is associated with a larger microbial diversity and an increase in beneficial species … meat rich diets result in increases of bacterial species [which] promote cardiovascular disease, inflammation and inflammatory bowel disease." She added that some studies suggest that processed foods have a negative effect on the gut microbiome.[397]

230. **Eating a balanced diet and maintaining a healthy body weight into old age are key to healthy ageing. Dietary advice has to reflect the nutritional needs of older people and the diversity of those needs.**

Physical activity and inactivity

231. Physical activity improves various aspects of health throughout humans' lives. Being physically active improves cardiovascular health and musculoskeletal mass and strength, helps to manage body weight, and affects the likelihood of diseases such as diabetes and hypertension.[398]

232. Physical activity can help slow the process of ageing. In youth, when bodies more readily build bone and muscle, it provides a strong basis or 'reserve';[399] in middle age it helps to retain more of that strong basis and slow the natural decline so that old age is reached in the best condition;[400] and in old age it helps to protect against the illnesses and accidents that are common at that stage of life.[401]

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393 See, for example, Daniela Frasca *et al.*, 'Aging, Obesity, and Inflammatory Age-Related Diseases', *Frontiers in Immunology*, vol. 8 (December 2017): https://dx.doi.org/10.3389%2Ffimmu.2017.01745 [accessed 7 September 2020]

394 See, for example: Marissa Schafer *et al.*, 'Exercise Prevents Diet-Induced Cellular Senescence in Adipose Tissue', *Diabetes*, vol. 65 (June 2016): https://doi.org/10.2337/db15-0291 [accessed 7 September 2020]

395 See, for example, Q 56 (Professor Kay-Tee Khaw).

396 Q 54 (Professor John Mathers)

397 Q 54 (Dr Marina Ezcurra, footnote)

398 See, for example: written evidence from the Healthy Ageing Research Group at the University of Manchester (INQ0072); written evidence from the Faculty of Pharmaceutical Medicine (INQ0040); and written evidence from the Self-Care Academic Research Unit (SCARU) at Imperial College London (INQ0037).

399 Q 55 (Professor Kay-Tee Khaw)

400 See, for example: written evidence from the Healthy Ageing Research Group at the University of Manchester (INQ0072). They said: "Engaging in physical activity, to include muscle strengthening, bone health and balance activities at least twice per week from mid-life can reduce falls risk and improve health outcomes."

401 Written evidence from the Medical Research Council (MRC) Unit and the Institute of Healthy Ageing (IHA), University College London (INQ0007)

233. Physical activity improves health for people in old age. The University of Birmingham's Centre for Musculoskeletal Ageing Research told us that there is "strong evidence to support the benefits of physical activity for physical and mental health in older adults".[402] Physical activity covers a spectrum, from light activity and the tasks of daily life to vigorous exercise.[403] Studies show that changing from being sedentary to moderately active brings significant health benefits, even though the individual might still be in relatively poor health.[404] Physical activity helps people retain physiological function. Professor Stephen Harridge from King's College London wrote in the Physiological Society's report *Growing Older, Better* that "highly active older people show levels of physiological function that are far superior to those of inactive people".[405]

234. We heard that physical activity brings benefits for cognitive function and mental health as well as for physical health. Age UK told us that "risk and protective factors for cognitive and brain health are similar to those for physical health".[406] However, the mechanisms that link physical activity and cognitive and mental health are not well understood.[407]

235. Levels of physical activity tend to decline during adulthood,[408] partly due to behavioural changes and partly due to reduced ability. In the Physiological Society's report, *Growing Older, Better*, Professor Harridge wrote that, as humans age, "Our muscles get smaller and weaker, our hearts pump less blood and our ability to perform simple tasks of everyday living are progressively reduced. We know this to be due to an ageing process, because it is evident even in the most vigorously active master athletes whose performances decline as they get older."[409]

236. There is evidence that physical activities tailored to the abilities of different groups of older people have benefits for health, for example reducing the risk of type 2 diabetes and mitigating some effects of rheumatoid arthritis.[410]

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402 Written evidence from University of Birmingham MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research (INQ0056)

403 See supplementary written evidence from Professor Kay-Tee Khaw (INQ0082). She wrote: "It is important to stress that for total physical activity is the relevant measure for public health as most physical activity is not leisure time exercise but activity in the course of everyday life including occupational activity (e.g. whether an individual has a primarily sedentary occupation, standing occupation such as hairdresser, shop assistant; or active occupation e.g. manual worker) or other activities such as bicycling, stair climbing, housework and gardening."

404 See, for example: Eszter Füzéki and Winfried Banzer, 'Physical Activity Recommendations for Health and Beyond in Currently Inactive Populations', *International Journal of Environmental Research and Public Health*, vol. 15 (5) (May 2018): https://doi.org/10.3390/ijerph15051042 [accessed 7 September 2020]

405 The Physiological Society, *Growing Older, Better* (January 2019) p 18: https://static.physoc.org/app/uploads/2019/10/11135853/Growing-old-better-Full-report-and-summary-document.pdf [accessed 7 September 2020]

406 Written evidence from Age UK (INQ0077)

407 See, for example British Nutritional Foundation, '*Older adults*': https://www.nutrition.org.uk/nutritionscience/life/older-adults.html?start=3 [accessed 21 October 2020].

408 See, for example: NHS Digital, *Health Survey for England 2008* (2009) pp 5-7: https://files.digital.nhs.uk/publicationimport/pub00xxx/pub00430/heal-surv-phys-acti-fitn-eng-2008-rep-v1.pdf [accessed 21 October 2020].

409 The Physiological Society, *Growing Older, Better* (2019) p 18 : https://static.physoc.org/app/uploads/2019/10/11135853/Growing-old-better-Full-report-and-summary-document.pdf [accessed 7 September 2020]

410 Written evidence from the University of Birmingham MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research (INQ0056). They told us that high-intensity interval training "is associated with improved fitness and reduced disease activity" in adults at risk of developing diabetes, and with "improved innate immune function in older adults with rheumatoid arthritis".

However, it is difficult to determine the exact contribution that physical exercise makes to health, and by what mechanisms. Professor Alun Hughes of University College London said that "there is limited evidence from what would be regarded as gold-standard interventional clinical trial data". It is therefore difficult to provide tailored advice to people about exactly what types and amounts of physical activity they should undertake at different ages. Professor Paul Greenhaff, Professor of Muscle Metabolism at the University of Nottingham, explained: "we do not know the dose response to exercise; we do not know the frequency; we do not know how quickly the effects of exercise disappear in terms of muscle metabolic health".[411]

237. There is increasing recognition that being sedentary can in itself have adverse health effects. Professor Greenhaff explained: "When you are inactive, muscle protein synthesis falls and insulin resistance in muscle develops."[412] We heard from the Centre for Musculoskeletal Ageing Research at the University of Birmingham that recent research has shown that "acute periods of sitting time induce significant increases in blood pressure in older adults."[413]

238. However, there is limited evidence on the how sedentary behaviour causes harm or on how to mitigate its effects.[414] The Centre for Musculoskeletal Ageing Research at the University of Birmingham wrote: "There is a relative paucity of (sedentary behaviour) research in older adults, and in particular frail older adults … we do not know the threshold of activity required to ameliorate the adverse effects of sedentary time which limits the advice we can give to older adults and those who care for them."[415]

239. **The benefits of physical activity are a cornerstone of public health advice, but a more detailed understanding of its positive effects—and the negative effects of sedentary time—could allow the development of advice that is more targeted. This is important throughout the life-course, including for older adults who have lower levels of physical activity.**

Cognitive function and psychological stress

240. Cognitive function is affected by an individual's health and behaviours, and can itself affect health.[416] We heard that cognitive activity is protective of cognitive ability, in a similar way that physical activity is protective of physical ability. Dr Ritchie of King's College London explained that 'cognitive reserve' can protect against general cognitive decline with age,[417] saying that, if someone starts with a higher level of cognitive reserve, they can in principle "decline for a longer period of time [before] getting to the

411 Q 59 (Professor Paul Greenhaff)
412 Q 63 (Professor Paul Greenhaff)
413 Written evidence from the University of Birmingham MRC Arthritis Research UK Centre for Musculoskeletal Ageing (INQ0056)
414 Written evidence from the British Academy (INQ0024) They told us that "a recent systematic review found no interventions specifically targeting sedentary behaviour itself".
415 Written evidence from the University of Birmingham MRC Arthritis Research UK Centre for Musculoskeletal Ageing (INQ0056)
416 Written evidence from the Academy of Medical Sciences (INQ0078) They referred to "a growing body of evidence linking cognitive ability … to health in later life", but wrote that this has "yet to be fully exploited to protect and improve the health of the public in old age."
417 For further discussion about 'cognitive reserve' see, for example The Government Office for Science, *Mental Capital and Wellbeing: Making the most of ourselves in the 21st century* (October 2008): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/292450/mental-capital-wellbeing-report.pdf [accessed 21 October 2020]

point where there is functional impairment".[418] Professor Barbara Sahakian, Professor of Clinical Neuropsychology at the University of Cambridge, told us that cognitive reserve can mitigate the progression of neurological damage, such as that caused by Alzheimer's. [419]

241. Several witnesses emphasised the role of education in improving cognitive ability, including school-age education[420] and training and education in adulthood.[421] Professor Richards highlighted the links between education and health inequalities: "Educational gradients are observed in a wide variety of health-related outcomes, so any educational policy is likely to have profound impacts on health and wealth."[422]

242. We were told about factors that can contribute to cognitive decline. Professor Foster explained that "as sleep changes with age, we see a correlation with declining cognitive abilities", but said that it is not clear "the extent to which this is correlation or causation".[423] Action on Hearing Loss told us that "if left untreated, hearing loss is associated with cognitive decline/dementia".[424]

243. Psychological stresses can affect health and how well people age. Professor Cox told us that "chronic low-grade stress" is a significant factor in poor health and appears to contribute to underlying processes of ageing, such as inflammation.[425] Stress-related inflammation has been linked to how the brain operates, and to mental health conditions such as depression and anxiety.[426] Professor Raymond said that inflammation in different parts of the brain could explain impacts on specific cognitive functions such as learning and motivation, and could explain mental fatigue.[427]

244. This apparent effect of stress on the ageing process might be linked to the immune system. Professor Raymond explained that stress can trigger a response from the immune system, and that the immune system tends to malfunction as humans age, such that stress can cause neural inflammation

418 Q 14 (Dr Stuart Ritchie)
419 Q 116 (Professor Barbara Sahakian)
420 Q 14 (Dr Stuart Ritchie). He told us that increases to the school leaving age correlate to increases in metrics of intelligence during the 20th century, saying: "For an extra year of education, we are talking of somewhere between one and four additional IQ points." The Committee recognises that there are debates about the use of IQ tests, and that there are different ways of assessing cognitive function.
421 Q 14 (Professor Marcus Richards). He said that there are benefits from education and training undertaken at any time of life, noting that the 1946 birth cohort shows that for "people who went back into the educational system [for] adult evening classes or job training, their cognitive function, even allowing for school-based education, was slightly improved".
422 Q 17 (Professor Marcus Richards)
423 Q 108 (Professor Russell Foster)
424 Written evidence from Action on Hearing Loss (INQ0013)
425 Written evidence from Professor Lynne Cox (INQ0034). She explained "Stress is associated with shorter telomeres (ends of chromosomes) which drives premature cell senescence and consequent higher levels of inflammation and [age-related diseases]."
426 See, for example: Elaine Setiawan *et al.*, 'Role of translocator protein density, a marker of neuroinflammation, in the brain during major depressive episodes', *JAMA Psychiatry*, vol 72 (3), (2015): https://jamanetwork.com/journals/jamapsychiatry/fullarticle/2091919 [accessed 21 October 2020]; and Eiko Fried *et al.*, 'Using network analysis to examine links between individual depressive symptoms, inflammatory markers, and covariates', *Psychological Medicine* (October 2019): https://doi.org/10.1017/S0033291719002770 [accessed 21 October 2020]
427 Q 120 (Professor Jane Raymond)

in old age.[428] The problem is exacerbated by the fact that stress harms the immune system, as the British Society of Immunology wrote:

> "prolonged or chronic psychological stress can have a deleterious effect on the function of the human immune system … it is especially common in elderly individuals and, furthermore, prolonged stress has been found to cause premature and accelerated ageing of the immune system."[429]

245. **Cognitive ability and psychological stresses are key aspects of health throughout the life-course, but they also influence general health and might affect the underlying processes of ageing. Cognitive activities—including education, training and good-quality employment—and reduced stress are means of improving health in later life.**

246. **The factors that contribute to healthy life expectancy are well known, and form the basis of healthy ageing advice, namely: not smoking, avoiding excessive alcohol consumption, eating a balanced and nutritious diet, maintaining a healthy body weight, and being physically active. There is also evidence of the role of cognitive activity and reduced stress in healthy ageing.**

247. **Despite the evidence linking behaviours throughout the life-course to health in old age, the potential gains from healthy behaviours are not being fully achieved. Different aspects of the evidence could potentially have an impact upon people's behaviours, for example: the fact that healthy lifestyles can reduce the time spent with disability in old age; and the discovery that behaviours can modify underlying processes of ageing.**

248. ***We recommend that organisations with responsibility for healthy ageing advice incorporate findings about the benefits of healthy behaviours that may have a larger impact upon people's behaviour than existing messaging. The benefits of building up good levels of physical fitness and cognitive reserve should be promoted, particularly to people in disadvantaged groups that suffer the worst health.***

249. **There is a need to better understand the scientific basis of the mechanisms by which lifestyle factors affect ageing. There is also a need to understand how requirements change in old age in order to develop advice covering, for example: the nutritional needs of older people; the benefits of physical activity for cognitive health; and the impacts of sedentary time.**

250. ***We recommend that UK Research and Innovation and the National Institute for Health Research ensure that they support interventional studies to establish the mechanisms by which lifestyle and environmental factors affect health in old age, in order to improve advice for healthy ageing.***

Public health interventions

251. The aim of public health advice for healthy ageing should be to encourage changes in behaviour that reduce risks and slow the rate of ageing. As noted

428 Q 109 (Professor Jane Raymond)
429 Written evidence from the British Society for Immunology (INQ0057)

in the evidence set out above, the basic tenets of healthy lifestyles are well-established; the challenge is to design interventions that lead to beneficial behaviour changes. In order to achieve the greatest health benefits, interventions should be designed to assist those living in deprivation and who suffer the worst health.

252. We were told about interventions that have been successful in bringing about healthy behaviour change. For example, Public Health England's 'toolkit' of smoking cessation interventions highlights that the most effective methods are 'face–to-face group support with pharmacotherapy' and 'face-to-face individual support with pharmacotherapy'.[430] A 2019 study suggested that the NHS Health Check is an effective intervention, finding that "people who take up a health check generally have lower risk factor values than controls and are more likely to receive risk factor interventions."[431]

Integrated messages and a life-course approach

253. We heard that it is best to address the range of different lifestyle risk factors together. For example, Professor Hughes said, "guidance on lifestyle needs to be integrated across all the risk factors and not focus on just one".[432] However, public health messages currently can be fragmented. Imperial College London's Self-Care Academic Research Unit wrote that there is not a "common framework of understanding of what is involved in following a healthy lifestyle", and explained that "many public health programmes have a 'vertical' approach to tackling single issues (e.g. tobacco smoking or physical exercise)" which "contrasts the holistic approach of considering the self-carer as a whole person."[433]

254. A life-course approach to healthy ageing was a regular theme in the evidence, emphasising that healthy behaviours at all ages contribute to slower rates of ageing. The MRC Unit and Institute of Healthy Ageing at University College London noted that observational data indicate the importance of "optimising early-life reserve (e.g. cognitive, exercise capacity, respiratory function), maintenance of reserve in mid-life, and promoting resilience in later life to enhance healthy ageing."[434]

255. A life-course approach is being encouraged in England. In 2019, Public Health England published a resource for public health professionals and the NHS on a life-course approach to preventing poor health. It states:

> "unlike a disease-oriented approach, which focuses on interventions for a single condition often at a single life stage, a life course approach considers the critical stages, transitions, and settings where large differences can be made in promoting or restoring health and wellbeing."[435]

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430 Public Health England, *Models of delivery for stop smoking services Options and evidence,* (September 2017) pp 6–7: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/647069/models_of_delivery_for_stop_smoking_services.pdf [accessed 28 October 2020]

431 Samah Alageel and Martin Gulliford, 'Health checks and cardiovascular risk factor values over six years' follow-up: Matched cohort study using electronic health records in England', *PLOS Medicine* (July 2019): https://doi.org/10.1371/journal.pmed.1002863 [accessed 28 October 2020]

432 Q 61 (Professor Alun Hughes)

433 Written evidence from Imperial College Self-Care Academic Research Unit (SCARU) (INQ0037)

434 Written evidence from the Medical Research Council (MRC) Unit and the Institute of Healthy Ageing (IHA), University College London (INQ0007)

435 Public Health England, 'Health matters: Prevention—a life course approach' (23 May 2019): https://www.gov.uk/government/publications/health-matters-life-course-approach-to-prevention/health-matters-prevention-a-life-course-approach [accessed 13 October 2020]

256. There are advantages to adopting healthy lifestyles earlier in life. Professor Mathers said, "From a public health perspective, starting early would clearly have bigger advantages", noting that "there is a law of diminishing returns. The later you start, the less you can gain from it."[436] We heard that habits, such as physical activity, are easier to establish earlier in life, as they become engrained and are easier to maintain if circumstances become more challenging later in life.[437] We heard differing views on whether young people tend to engage with the issue of healthy ageing.[438]

257. We heard from several witnesses that one way of implementing a life-course approach to healthy ageing is to focus on key transition points in life, such as childhood development, puberty, starting a family, menopause, approaching retirement or becoming a carer.[439] For the transition points from middle age onwards it was suggested that health services or employers might intervene to have conversations about healthy lifestyles, including through initiatives such as the NHS Health Check.[440] However, we were told that take-up of the NHS Health Check is variable, and that people in lower socio-economic groups who have most to gain are least likely to engage with these types of initiatives.[441]

258. Encouraging healthy behaviour changes at certain transition points (for example retirement) requires input from policy domains other than public health. To help people remain healthy into old age, Professor Nazroo said that consideration should be given to "retirement policies, and later-life work where it is rewarding and engaging … volunteering and other types of activities that give them return and reward."[442] He discussed the merits of "investments in education and educational opportunities for people in their 50s and older".[443] Dr Alison Giles of the Centre for Ageing Better told us that there is insufficient focus on this age group:

> "There is a bit of a gap in policy on the age group 50 to 70 … We need to be thinking of people who are still in work but have probably become carers, who may have the onset of long-term conditions. What can we put in place for those people to keep them in work and fulfilled and engaged, rather than waiting until they get to that older age and into real difficulty?"[444]

259. It was emphasised that a life-course approach to healthy ageing must not forget those who are already in old age. Age UK told us that "the majority of public health guidelines aim to promote healthy behaviours in children and working adults, with older people often being overlooked."[445]

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436 Q 55 (Professor John Mathers)
437 Q 61 and Q 63 (Dr Samuel Nyman)
438 See, for example Q 55 (Professor Kay-Tee Khaw) and written evidence from Professor Peter Gore (INQ0063). Professor Khaw was sceptical about whether messages relating to healthy ageing would motivate younger people to adopt healthier lifestyles. Professor Gore cited a project that showed "the passion with which 16-17-year olds could be engaged around the subject".
439 Q 69 (Dr Alison Giles)
440 Q 75 (Professor Maggie Rae), Q 76 (David Sinclair) and Q 76 (Ruthe Isden). See also: written evidence from HM Government (INQ0023) The Government told us that the NHS Health Check is "available to 15 million adults in England" and that "Between April 2014 and June 2019 over 14 million people were offered and 6.7 million people had an NHS Health Check."
441 Q 75 (Professor Maggie Rae)
442 Q 18 (Professor James Nazroo)
443 Q 19 (Professor James Nazroo)
444 Q 70 (Dr Alison Giles)
445 Written evidence from Age UK (INQ0077). See also Q 76 (Ruthe Isden).

260. **Public Health England's advocacy for a life-course approach to healthy ageing is to be commended. Early uptake and adherence to a healthy lifestyle may continue into mid- and later life, but it is never too late to benefit from an improved lifestyle. Interventions tend to be more successful if they are designed with an understanding of what motivates people at different ages and the transition points at which they are more likely to act on public health advice.**

Motivations for, and barriers to, behaviour change

Positive messaging

261. Advice about healthy ageing it is more likely to be accepted and acted on if people have positive expectations of the level of health that can be maintained in old age. Age UK said: "[people] tend to believe that age-related conditions are inevitable or that your health in later life is dependent on your genes. Such beliefs can be a barrier to taking action. People may be aware that there are things they can do to maintain aspects of health, but find it difficult to 'convert' this to action."[446] The Physiological Society explained that people may feel that certain conditions or behaviours are a normal part of ageing (such as aching joints or a reduction in social interaction) and so might not seek help or support, or that certain activities, such as cycling, are no longer appropriate as they age.[447]

262. The Government told us that it recognised the importance of positive societal attitudes towards ageing:

> "Social attitudes in relation to ageing need to change. By thinking that ageing will be a negative process, people may have a more pessimistic view of their own future and expect to face difficulties in their daily lives and relationships as they age. This then manifests itself as stress, depression and anxiety."[448]

263. Similarly, we heard that public health advice is more likely to be acted on if the message is positive and resonates with people's interests and ambitions, rather than focusing on fear of poor health.[449] Professor Peter Gore, Professor of Practice in Ageing and Vitality at Newcastle University, told us that researchers have found "articulating ageing in terms of maintaining personal independence to be much more effective."[450] Dr Nyman explained that "there is a theory about the psychology of ageing which suggests that, as we get older, we tend to prioritise activities that we enjoy".[451] Conversely, focusing on negative issues can be counterproductive by deterring people from helpful interventions. For example, Dr Nyman said: "there is a stigma around falls. People do not want to accept the label of being at risk of falls, so they distance themselves from falls prevention interventions".[452]

Tailoring advice

264. Public health advice and interventions—including those for healthy ageing—can be provided to the population as a whole, or they can be tailored to groups

446 Written evidence from Age UK (INQ0077)
447 Written evidence from the Physiological Society (INQ0066)
448 Written evidence from HM Government (INQ0023)
449 Q 74 (David Sinclair)
450 Written evidence from Professor Peter Gore (INQ0063)
451 Q 63 (Dr Samuel Nyman)
452 *Ibid.*

and individuals. The Physiological Society said that non-tailored advice could be a deterrent for some people who are in old age or have physical limitations: "arbitrary targets (such as the amount of exercise achieved per week or the number of steps per day) may act as a barrier to participation for some members of society if they are considered unattainable (owing to age or baseline functional capacity)".[453]

265. The Institute of Health Research and Innovation at the University of the Highlands and Islands thought that a 'personalised healthcare' approach—"in contrast to the current 'one-size-fits-all' model of healthy ageing"—will be important "when considering the diverse geographical, cultural, and socio-economic contexts of an ageing society".[454] Professor Gore gave the example of the LIFE study, a tailored approach which "intervened with people at the point of losing the ability to walk 400 yards". The study found that "group and individual exercises were dramatically more effective—delaying further decline for at least 2.6 years longer than general public health advice".[455]

266. One aspect of personalised healthcare is 'social prescribing'. The Government describes this thus: "Social prescribing—sometimes referred to as community referral—is a means of enabling GPs, nurses and other health and care professionals to refer people to a range of local, non-clinical services."[456] It is an attempt to improve health outcomes and reduce costs to public services. It was welcomed in evidence, but with questions about resources. Age UK wrote: "While social prescribing is a very welcome move forward, primary care providers need relevant activities and services to which they can prescribe patients."[457]

267. Not all witnesses agreed that tailored advice is necessarily effective. The British Academy wrote:

> "There is a risk of a continued waste of resources on downstream behavioural interventions (targeting individuals) which are consistently shown to be less effective and more likely to generate inequalities than upstream interventions (e.g. targeting whole workplaces, communities, or the whole population)."[458]

268. We heard that focusing on individuals risks failing to help those most in need and hence increasing health inequalities. Professor Sayer told us: "Health behaviours are socially patterned, such that 'healthier' lifestyles are far more common among more affluent, educated sectors of the population and less common among disadvantaged groups". Because much health advice is currently targeted at individuals, with an emphasis on individual responsibility, "these initiatives may even act to widen health inequalities."[459]

269. Witness discussed barriers to uptake of public health advice in general, which can apply to advice for healthy ageing. Elaine Rashbrook said that

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453 Written evidence from the Physiological Society (INQ0066)
454 Written evidence from the Institute of Health Research and Innovation at the University of the Highlands and Islands (INQ0028)
455 Written evidence from Professor Peter Gore (INQ0063)
456 Public Health England, 'Social prescribing: applying All Our Health' (17 June 2019): https://www.gov.uk/government/publications/social-prescribing-applying-all-our-health/social-prescribing-applying-all-our-health [accessed 17 October 2020]
457 Written evidence from Age UK (INQ0077)
458 Written evidence from the British Academy (INQ0024)
459 Written evidence from Professor Avan Aihie Sayer (INQ0019)

"about 40% of people in England find it quite difficult to understand health messaging and language".[460] There was concern that some healthcare professionals do not understand how to communicate the concept of healthy ageing to deprived communities[461] and that messaging can be inaccessible to disadvantaged groups.[462] We were given several examples of where messaging was more effective because it was developed with involvement from communities and people for whom it was intended.[463]

270. **A balanced approach to public health advice can help to achieve healthy ageing, with general messages provided to the whole population and tailored advice for groups with specific needs—in particular, disadvantaged groups who suffer from the worst health.**

Responsibility for public health in England

271. It was clear from our evidence that public health advice for healthy ageing requires involvement from national government, local government and their agencies.[464] The current allocation of responsibilities for public health in England was set out in the Health and Social Care Act 2012.[465] The Secretary of State retained overall responsibility for improving health. National public health functions were delegated to Public Health England (PHE), which was created following the Act. Local authorities were given responsibility for improving the health of their local populations and for public health services.

272. Some witnesses were concerned about this division of public health responsibilities and its effect on efforts to develop public health advice, including for healthy ageing. For example, the Physiological Society wrote:

> "The fragmentation of commissioning between local and national government in England for various aspects of lifelong health, encourages a siloed approach to policy making. This has the potential to create barriers that will make it difficult to achieve healthy ageing targets. Structural barriers between commissioning organisations, separate budgets and differing organisational priorities make it much more difficult to implement broad, ambitious projects that may have the most potential to improve health outcomes."[466]

273. We heard about barriers to communicating expertise in the sector, and how these barriers can impair policy development. Birmingham Health Partners were concerned about "a lack of clinicians who work in ageing" in Public Health England.[467] The Imperial College London Self-Care Academic Research Unit was concerned about the number of organisations trying to inform policy:

> "With over 40–50 different stakeholders, each with their own agenda and interpretation of how to encourage healthy lifestyles, there is a real tendency to overlook other constituencies. This creates a silo effect

460 Q 69 (Elaine Rashbrook)
461 Written evidence from Professor Peter Gore (INQ0063)
462 Written evidence from the National Institute for Health Research (NIHR) Devices for Dignity MIC (INQ0065). MIC stands for 'MedTech and In vitro diagnostic Co-operatives'.
463 See, for example, Q 69 (Elaine Rashbrook) and Q 57 (Professor John Mathers).
464 See, for example, Q 75 (Ruthe Isden).
465 Health and Social Care Act 2012, section 11, section 12 and section 30
466 Written evidence from the Physiological Society (INQ0066)
467 Written evidence from Birmingham Health Partners (BHP) (INQ0051)

> which is inevitably duplicative, certainly confusing to the self-carer, and ultimately impedes the efforts of policymakers."[468]

274. In August 2020, after we had taken evidence for this inquiry, the Government announced the creation of the National Institute for Health Protection. This new public body will bring together functions undertaken by several organisations including Public Health England. We have not examined the merits of these changes, which were made without consultation. It is not yet clear where responsibility for public health objectives—such as managing obesity—will sit in the new structure and whether the changes will assist with the task of encouraging and facilitating healthy ageing.

275. ***We recommend that the Government clearly defines the roles and responsibilities for healthy ageing among national and local government and their agencies. The creation of the National Institute for Health Protection should be used as an opportunity to revitalise work to promote healthy ageing across the life-course, including by improving coordination across the sector and drawing on the best information for developing public health advice.***

Government policies

276. Central government policies can have a significant impact on health throughout the life-course. Dr Giles stated: "The biggest impact that we can have on public health is through central government regulations."[469]

277. We heard from several witnesses that regulation and fiscal measures can be effective at disincentivising unhealthy behaviours and establishing an atmosphere conducive to healthy lifestyles. They cited examples of effective regulatory interventions to tackle behaviours associated with unhealthy ageing, including: the smoking ban;[470] reductions in dietary salt intake;[471] the levy on sugar in soft drinks;[472] and minimum alcohol pricing in Scotland.[473]

278. Alternatives to regulatory changes include 'nudge' interventions. This approach has been defined as an intervention which "alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives."[474] However, Dr Giles said that nudge approaches were insufficient.[475] This Committee analysed the effectiveness of nudge theory in its 2011 report *Behaviour Change*, concluding that:

> "non-regulatory or regulatory measures used in isolation are often not likely to be effective and that usually the most effective means of changing behaviour at a population level is to use a range of policy tools, both regulatory and non-regulatory."[476]

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468 Written evidence from Imperial College London Self-Care Academic Research Unit (SCARU) (INQ0037)
469 Q 67 (Dr Alison Giles)
470 See, for example: Q 55 (Professor Kay-Tee Khaw) and Q 68 (Elaine Rashbrook).
471 Q 57 (Professor Kay-Tee Khaw)
472 Q 57 (Professor John Mathers)
473 Q 73 (Professor Maggie Rae). See also: written evidence from the British Academy (INQ0024) They told us that minimum alcohol pricing is expected to reduce consumption particularly by those on lower incomes (who tend to have the worst health outcomes).
474 Richard Thaler and Cass Sunstein, *Nudge* (Yale University Press, 2008)
475 Q 67 (Dr Alison Giles)
476 Science and Technology Committee, *Behaviour Change* (2nd Report, Session 2010–12, HL Paper 179)

279. If the Government is to introduce strong regulatory policies to contribute to healthy ageing, this will necessitate change in certain industries—including the food, drinks and tobacco industries—which have incentives that do not align with healthy ageing. The MRC Unit and Institute of Healthy Ageing at University College London said there is a "Lack of effective mechanisms to ensure costs of harms are factored into the price of consumer products, with the consequence that unhealthy choices are often cheaper."[477]

Local public health service funding

280. Spending has fallen on local public health services aimed at preventable ill health, including lifestyle factors that affect how well people age. The King's Fund reported in 2020 that local government public health reforms in 2012 coincided with cuts to local government funding and spending on public health services.[478] The British Geriatrics Society and Royal College of Physicians referred to "the considerable budget reductions that [public health] services have had to work within over the last few years."[479]

281. These funding cuts have affected services that promote healthy living across the life-course. Councillor Ian Hudspeth of the Local Government Association supported the life-course approach to preventing illness, but told us that local authorities' funding was more likely to be cut on discretionary services—such as those which promote good health in younger people—than on services that local authorities are statutorily obliged to provide.[480]

282. We heard that funding cuts have affected services that support health in old age. Age UK said that "care packages can only focus on the essentials such as meals and toileting, without any time for help with mobility", which prevents some older people from accessing services.[481] Age UK also told us that:

> "There is significant variation across the country in the availability of services to stay well … These services are frequently provided by the voluntary sector, but deprived areas tend to have fewer such organisations operating in their communities."[482]

283. Reduced spending on public health to promote healthy ageing is counterproductive, because prevention is better (and cheaper) than treatment. Age UK argued that supporting healthy lifestyles "can produce financial savings: preventative activities through the public health grant are up to four times more cost-effective than NHS spending."[483] However, efforts to achieve this overall gain are undermined by conflicting financial incentives of individual organisations, as the Physiological Society wrote:

> "There is a tension between local government's responsibility for public health and leisure activities and the 'savings' accrued to the nationally-

477 Written evidence from the Medical Research Council (MRC) Unit and the Institute of Healthy Ageing (IHA), University College London (INQ0007)
478 The King's Fund, *The English local government public health reforms—An Independent Assessment* (January 2020): https://www.kingsfund.org.uk/sites/default/files/2020–01/LGA%20PH%20reforms%20-%20final.pdf [accessed 7 September 2020]
479 Written evidence from the British Geriatrics Society and the Royal College of Physicians (INQ0049)
480 Q 66 (Councillor Ian Hudspeth)
481 Written evidence from Age UK (INQ0077)
482 *Ibid.*
483 *Ibid.*

commissioned health service from healthier ageing and this is leading to reluctance among policymakers to invest in preventative services."[484]

284. ***We recommend that the Government implement a concerted and coordinated set of national policies to support healthy ageing, including: regulatory and fiscal measures, actively to encourage people to adopt lifestyles that support healthy ageing; increasing the reach of the NHS Health Check to those in disadvantaged groups who will benefit the most; and working with local authorities on the funding of local services, housing and infrastructure to encourage and facilitate healthier living across the life-course, including the necessary services to maintain health and independence in old age.***

484 Written evidence from the Physiological Society (INQ0066)

CHAPTER 5: TECHNOLOGY AND SERVICES

285. Technologies and related services have a role in helping people to live healthily and independently in old age. These include assistive technologies, which can compensate for declining ability and help individuals to cope better with their environment,[485] and medical technologies, which can improve health and capability. These two objectives can overlap: improved health can allow greater independence; and independent living can contribute to better health.

Independent living

286. Remaining in one's own home and community (referred to as 'ageing in place') is important to many older people, and can contribute to an improved sense of health and wellbeing. The Centre for Ageing Better explained that independent living can be facilitated by "supportive products, services and environments that maintain people's functional ability so that they can continue to take part as active and productive members of society, even when their health limits their intrinsic capacity".[486] However, we heard it will be important to ensure that increased "independence does not result in loneliness and an absence of support."[487]

Housing and the built environment

287. A basic requirement of independent living is the ability to move around the home and undertake the tasks of daily life. However, we heard that many homes are poorly suited to life in old age. According to the Centre for Ageing Better, the UK's housing stock is "among the oldest in Europe, with some of the highest associated health and care costs and is not suitable for us as we get older."[488] They told us that "just 7% of housing in England meets basic accessibility standards."[489]

288. The Government aims to increase the availability of accessible housing. The requirements for housing accessibility are set out in Part M of the Building Regulations[490] and the Ministry of Housing, Communities and Local Government provides guidance for councils preparing planning policies on housing for older and disabled people.[491] The 'Home of 2030' project, a cross-departmental initiative funded by the Government, is seeking house designs that meet a range of criteria, including being "able to respond to different and changing needs as people move through their lives … being well set up for people to be able to care for children and ageing relatives,

485 See, for example Centre for Ageing Better, *Industrial Strategy Challenge Fund—Healthy Ageing Challenge Framework* (2019), p 8, Figure 2 and related discussion: https://www.ageing-better.org.uk/sites/default/files/2019–02/Healthy-Ageing-Challenge-Framework.pdf [accessed 12 October 2020].
486 Written evidence from the Centre for Ageing Better (INQ0016)
487 Written evidence from the Northern Health Science Alliance (NHSA) (INQ0053)
488 Centre for Ageing Better, 'Transforming later lives–our strategy' (31 July 2018): https://www.ageing-better.org.uk/news/transform-later-life [accessed 12 October 2020]
489 Written evidence from the Centre for Ageing Better (INQ0016)
490 Ministry of Housing, Communities and Local Government, 'Approved Document M: Access to and use of buildings' (1 March 2015): https://www.gov.uk/government/publications/access-to-and-use-of-buildings-approved-document-m [accessed 12 October 2020]
491 Ministry of Housing, Communities and Local Government, 'Housing for older and disabled people' (26 June 2019): https://www.gov.uk/guidance/housing-for-older-and-disabled-people [accessed 12 October 2020]

such as through multi-generational homes that can accommodate changing caring responsibilities."[492]

289. Nevertheless, existing homes without suitable features for old-age living will continue to dominate the housing sector—almost all existing homes are expected to remain in use, and new homes are built at a rate of up to 1% of existing stock per year.[493] Many existing homes do not have adequate space to move around with walking aids or wheelchairs, and often lack load-bearing beams for the installation of hoists. Rosamond Roughton, Director for Care and Transformation at the Department of Health and Social Care, told us about the £500 million Disabled Facilities Grant that is available to "help people make adaptations to their homes." She said that adapting a home "leads to people potentially staying about four years longer, on average, independently at home."[494]

290. We heard about ensuring that the local built environment is conducive to independent living in old age. Ruthe Isden said that issues with the local built environment include a lack of accessible transport and whether older people feel safe in their local environments.[495] Councillor Ian Hudspeth said that local authorities consider how to make communities more conducive to healthy lifestyles that can be adopted for the entire life-course "so that by the time they are thinking about retirement they are active". He said local authorities seek to provide services that are accessible to residents, for example using libraries "where communities can come together and more services can be co-located."[496]

291. The quality of housing and the local environment are associated with socio-economic factors and age. Sarah Weir, Chief Executive of the Design Council, told us: "Less good housing is disproportionately lived in by older people and by people from lower socioeconomic backgrounds". She added that these groups experience the combination of "poor health, poor diet, lack of fresh air, lack of places to walk safely near your home, and lack of transport." She was concerned that initiatives aimed at improving housing could disproportionately benefit wealthier people and hence increase health inequalities in old age, saying, "There is a widening gap."[497]

292. ***We recommend that the Government use planning rules to ensure that homes and communities are accessible for people with limited mobility and adaptable as their needs change with age. The Government should ensure that sufficient funds are available—for example through the Disabled Facilities Grant—to facilitate improvements to existing homes. The priority should be areas***

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492 Design Council, *Home of 2030—A Public Vision for the Home of 2030* (July 2020), p 72: https://www.homeof2030.com/wp-content/uploads/2020/07/A-Public-Vision-for-the-Home-of-2030-July-2020.pdf [accessed 12 October 2020]

493 Ministry of Housing, Communities and Local Government, *Housing supply; net additional dwellings, England: 2018–19* (13 December 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/850825/Housing_Supply_England_2018-19.pdf [accessed 28 October 2020]. In the year 2018–19, over 241,000 new dwellings were built in England, which was about 1% of the housing stock at the start of the that year; that building rate was higher than in previous years. Around 8,000 existing dwellings were demolished; that is roughly typical of previous years.

494 Q 156 (Rosamond Roughton)

495 Q 73 (Ruthe Isden)

496 Q 66 (Councillor Ian Hudspeth)

497 Q 87 (Sarah Weir)

with poor housing and infrastructure, in order to reduce health inequalities.

Alerts and digital services

293. There is a wide range of available technologies that can be used in the home to aid independent living and to give confidence to older people—and their families—about living alone. This is referred to as technology-enabled care, or telecare. Stuart Butterfield, Chief Executive of Canary Care, told us the predominant technologies used for telecare include pendant alarms, pull cords and fall detectors, which send alerts to family members or service providers in emergencies. He said that there are 1.7 million telecare users in the UK but that "that figure has not moved for 10 years", even though there are over 4 million potential users.[498]

294. The technology for many telecare systems is quite basic, but significant change is expected over the next few years. Stuart Butterfield explained that most of the alarm systems use analogue technology (phone lines) to send the alerts.[499] The digital telephone switchover in 2025 is therefore causing "panic within the industry" because so many existing telecare systems rely on analogue technology. However, he thought that the switchover presents an opportunity for the industry, which should now "start looking beyond the pendant alarm" to "all the other technologies that are available".[500]

295. Witnesses told us about digital telecare technologies that can do more than respond to incidents. Newer systems can monitor some of a person's activities, in order to detect changes of routine that might give early warning of a potential decline in function and trigger action to avert accidents. Stuart Butterfield referred to Canary Care's service in which wireless monitoring devices are placed around the home to monitor daily activities of an individual.[501] The data can be accessed by formal and informal carers, who can make real-time care decisions. The Agile Ageing Alliance said that a wider range of sensors is being developed and could be available by 2035 or sooner. The monitoring could be done directly (for example, by devices which monitor gait, breathing or speech) or indirectly (for example, by devices which monitor the use of the fridge, or utilities such as water and electricity). They suggested that chatbots could be used to assess mood, language and sense of detachment.[502]

296. Digital service provision is increasingly important for older people's housing. The Institute of Health Research and Innovation at the University of the Highlands and Islands told us about the fully digital homes in the FIT House project which "demonstrated that adaptable, technology-enabled housing may play a part in allowing people to live independently within their communities for as long as possible".[503]

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498 Q 80 (Stuart Butterfield)
499 *Ibid.*
500 Q 86 (Stuart Butterfield)
501 Q 80 (Stuart Butterfield). See also Canary Care: https://www.canarycare.co.uk/ [accessed 12 October 2020]
502 Written evidence from the Agile Ageing Alliance (INQ0052)
503 Written evidence from the Institute of Health Research and Innovation at the University of the Highlands and Islands (INQ0028). See also Technology Enabled Care in Housing (TECH), 'Albyn Housing Society—Fit Homes': https://techousing.co.uk/fit-homes/ [accessed 12 October 2020]

297. However, this is currently not the reality in many older people's homes. Stuart Butterfield said that statistics from 2018 suggested that "only 59% of one-person households where the householder is over 65 have broadband." He observed that this widespread lack of broadband connection will be less of an issue as 5G is introduced, because 5G has "the potential to provide those kinds of service connections to those properties."[504]

298. **More widespread use of telecare services—particularly modern digital systems with monitoring capabilities—may enable more people to live independently in their homes for longer in old age. The upcoming digital telephone switchover provides impetus for this change and is an opportunity for local authorities to introduce more comprehensive services to facilitate safe and independent living.**

Data-driven services, robotics and artificial intelligence

299. Data-driven services and emerging robotic and artificial intelligence (AI) technologies could provide services to help maintain independence for older people.[505] The National Physical Laboratory described the potential for data-driven technologies to "transform the way the health and care system works." They told us that these approaches will "support faster and cheaper research" and will "enable the health and care system to perform comprehensive data analysis with greater confidence in the outcomes". They argued that "full exploitation of the potential of artificial intelligence and machine learning tools" is "vital for future improvements in healthcare especially in diagnosis, treatment and drug discovery."[506]

300. Professor Praminda Caleb-Solly, Professor of Assistive Robotics and Intelligent Health Technologies at the University of the West of England, said there are several types of robotics that could assist with independent living. She described a prototype 'physical assistance robot' that "can help you to get out of bed and walk", saying that it is "much like a walking frame, but it allow[s] the user to avoid obstacles and help[s] with navigation". She explained that the technology is modular, so different 'tools' can be added to it to provide multiple functions.[507]

301. Other examples given by Professor Caleb-Solly included robotic arms on wheelchairs for people who "cannot use their limbs", "clinical rehabilitation devices for upper-limb rehab"[508] and "robotic feeding devices".[509] She discussed 'socially assistive robots' that can gather information to "generate a lot more richness in relation to individual issues". Giving the example of sleep quality, she explained that a robot might ask how the person was feeling and help them identify possible causes of poor sleep.[510]

302. The Manchester Institute for Collaborative Research on Ageing told us: "Assistive robots have the potential to support people to live independently for longer, with better health and wellbeing. For example, they can provide

504 Q 86 (Stuart Butterfield)
505 See, for example: written evidence from the Manchester Institute for Collaborative Research on Ageing (INQ0033); and written evidence from the Centre for Assistive Technology and Connected Healthcare at the University of Sheffield (INQ0026).
506 Written evidence from the National Physical Laboratory (NPL) (INQ0050)
507 Q 85 (Professor Praminda Caleb-Solly)
508 Q 80 (Professor Praminda Caleb-Solly)
509 *Ibid.*
510 Q 83 (Professor Praminda Caleb-Solly)

support for reminders and monitoring of medication compliance, and to encourage people to engage in physical exercises." They also noted the potential to "offer a 'personalised' approach, as the robot can have a specific model of the user's needs and medical status and adapt its reminders and exercises to the specific and changing needs of the users". The Institute added that "Pilot studies on assistive robotics for older people, including people with dementia, have shown that robots can play a role in providing assistive companionship for people in their own homes or care home." They noted a further use for assistive robots in "telemedicine and for remote access and communication with family members, as well as with health professionals."[511]

303. The Centre for Assistive Technology and Connected Healthcare at the University of Sheffield cautioned that "it will take some time before robots will play major roles in healthcare."[512] In particular, the UK has had limited involvement in the field, beyond developing prototypes, whereas assistive robots have been trialled more extensively in the EU and Japan.[513] Whilst recognising the UK has had less direct investment in such projects, the Manchester Institute for Collaborative Research on Ageing told us: "Targeted and strategic investment in the design, evaluation and uptake of assistive robot technologies can help develop national expertise and critical mass in this area of expertise". It said that:

> "The effective uptake and sustained acceptability of AI and robotics systems for older people care requires the addressing of two grand challenges in AI and Robotics: (1) Machine Explainability, i.e. to enable AI-empowered robotic systems to interpret and explain their actions to support understanding and collaborative decision-making in assistive robots; (2) Machine Trust, to enable users to understand the robot's decision making and accept its behaviour and recommendations."[514]

304. **Data-driven services and emerging robotics and AI systems could provide significant support to older people, to enable them to live independently for longer. The results of ongoing projects in the UK and abroad will help to determine what role robotics can play.**

305. ***We recommend that the Government makes targeted and strategic investments in research for the design, evaluation and uptake of data-driven services, assistive robot technologies and AI for older people, in order to develop national expertise and critical mass in this important area.***

Health monitoring and telemedicine

306. Technology can be used to monitor the health of older people from a distance, and to provide or recommend treatments; this is sometimes referred to as 'telemedicine'. The Centre for Assistive Technology and Connected Healthcare at the University of Sheffield told us that the potential to monitor health conditions is "rapidly increasing as a result of miniaturisation of sensors, smart and energy-efficient data collection technologies, speech and

511 Written evidence from Manchester Institute for Collaborative Research on Ageing (MICRA) (INQ0033)
512 Written evidence from the Centre for Assistive Technology and Connected Healthcare at the University of Sheffield (INQ0026)
513 Written evidence from Manchester Institute for Collaborative Research on Ageing (MICRA) (INQ0033)
514 *Ibid.*

activity recognition, big data analysis and artificial intelligence."[515] Some telemedicine devices can be worn, while others are implanted in the body, in order to gather data and relay them to the individual and a medical professional or other provider.

Wearable and implantable medical devices

307. Miniaturised devices applied to the skin or implanted into the body can allow precise and timely interventions to improve healthcare, whilst reducing the number of medical appointments. For example, people with diabetes can use implanted technology to monitor blood glucose levels and deliver insulin.[516] The Centre for Assistive Technology and Connected Healthcare told us that there are "fascinating developments in the field of micro-robotics that may in the future enable very local drug delivery or other treatments (e.g. microsurgery) within the body", as well as "non-invasive surgical techniques, 'robotic' implants, ingestible robots, in-body sensors for monitoring purposes, implanted drug delivery systems (like insulin pumps), and many others."[517]

308. The Manchester Institute for Collaborative Research on Ageing referred to barriers to implementing and developing implantable devices—particularly those using nanotechnology and stem cells—saying: "knowledge of the regulatory requirements is essential and therefore appropriate support is required, even at the very start of research ideas."[518] Professor Graham Hart, Dean of the Faculty of Population Health Sciences at University College London, told us that more research and development is needed for devices to deliver drugs that "fit well with people's lifestyles/circumstances and are safe and easy to troubleshoot." He explained that when devices don't work with patients' or carers' lifestyles, they have been known to adapt the devices, "sometimes inappropriately".[519]

309. **The use of wearable and implantable technologies for monitoring health conditions and administering treatments is likely to become increasingly common. Such technologies have potential to provide more precise and timely treatment, and could contribute to better health and greater independence in old age.**

Non-medical products

310. 'Non-medical products' that provide information about some aspect of health—such as fitness trackers and apps—may be able to contribute to healthy ageing. Dr Nyman said that there is "good evidence" that devices such as trackers are motivational and that they can assist with "self-monitoring".[520] Dr Paola Zaninotto, Associate Professor in Medical Statistics at UCL, said that this type of device "has proved to be very valuable" for research purposes, for example when collecting data on physical activity in older people.[521]

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515 Written evidence from the Centre for Assistive Technology and Connected Healthcare at the University of Sheffield (INQ0026)

516 Diabetes UK, *Type 1 Technology—A guide for adults with type 1 diabetes* (2017): https://www.diabetes.org.uk/resources-s3/2017–08/JDRF-Type1Tech-Adults-8.pdf [accessed 12 October 2020]

517 Written evidence from Centre for Assistive Technology and Connected Healthcare, University of Sheffield (INQ0026)

518 Written evidence from Manchester Institute for Collaborative Research on Ageing (MICRA) (INQ0033)

519 Written evidence from University College London (INQ0027), submitted by Professor Graham Hart

520 Q 61 (Dr Samuel Nyman)

521 Q 146 (Dr Paola Zaninotto)

311. However, some witnesses were concerned about the interactions between the domains of medical devices and non-medical devices. Professor Ferdinando Rodriguez y Baena, Professor of Medical Robotics at Imperial College London, said that wearable technology "blurs the line between the mass market for gadgets and the truly useful wearable for diagnostics and therapy."[522] Professor Esther Rodriguez-Villegas, Professor in Low Power Electronics at Imperial College London, explained that the difference in applicability is due to different levels of accuracy: "Wearable technologies for wellness are not regulated [so] manufacturers do not have to commit to providing a level of accuracy—the output is uncertain … Unfortunately, [some people] are trying to use those wearable technologies for quasi-medical applications".[523] In the example of non-medical devices that monitor sleep, Professor Foster was concerned that inaccurate or incomplete data could alarm people, saying: "Their analysis … can actually be very misleading. … It is causing huge anxiety."[524]

312. On the other hand, Charles Lowe, Chief Executive of the Digital Health and Care Alliance, was concerned about the strict delineation between medical and non-medical applications, saying that the Medical Devices Regulation "creates a cliff edge". He thought that this was "a significant constraint on the development of artificial intelligence by SMEs" and contrasted it to the situation in the USA where "the [Food and Drug Administration] has a much more gradual process and it is possible to approach the concept of a medical device gradually."[525]

313. **Non-medical devices can be a source of useful information for individuals seeking to live more healthily. It will be necessary for the Government to continue to monitor developments in the sector to ensure an appropriate approach to standards.**

Reducing social isolation and loneliness

314. Two million people in the UK people aged over 75 live alone[526] and could be at risk of loneliness. We heard about the use of technology to reduce social isolation and loneliness by enabling older people to connect with friends and family on social media or communication platforms. Age UK told us that technology can be an effective way to deliver 'befriending' services, such as their 'A Call in Time' service.[527] No Isolation, a Norwegian technology company, described their product 'KOMP', a one-button screen and communication system for older people with limited digital skills with which they can stay in touch with their families.[528] The Challenge, a UK charity, explained that, as well as directly improving social connections, technology can help indirectly "by providing older people with the tools to stay living independently in their homes for longer, and therefore stay connected to the community in which they live."[529]

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522 Q 99 (Professor Ferdinando Rodriguez y Baena)
523 Q 96 (Professor Esther Rodriguez Villegas)
524 Q 117 (Professor Russell Foster)
525 Q 144 (Charles Lowe)
526 Age UK, 'Loneliness': https://www.ageuk.org.uk/information-advice/health-wellbeing/loneliness/ [accessed 12 October 2020]
527 Written evidence from Age UK (INQ0077)
528 Written evidence from No Isolation (INQ0039). See also KOMP, 'This is KOMP—Easy communication technology for elderly relatives': https://www.noisolation.com/uk/komp/ [accessed 12 October 2020]
529 Written evidence from The Challenge (INQ0073)

315. We heard about the effectiveness of communications technology as a means of reducing loneliness and mental health issues. No Isolation told us that "research … shows that when ICT is used to maintain contact with family and friends it can lead to a decline in loneliness, depression and an increase in overall wellbeing. Video-calls have shown to have long-term effects in alleviating both depressive symptoms and loneliness for elderly residents in nursing homes".[530] Age UK told us: "Evidence around the impact of technology on older people's mental health and loneliness is patchy, but there are promising signs that technological solutions could benefit some older people if appropriately developed, introduced and supported."[531]

316. Witnesses cautioned that technologies should not replace face-to-face interactions. The Institute for Public Health in Ireland told us that this is the case for "interactions with healthcare professionals which for some older people can be a very important source of human interaction."[532] The Centre for Research in Public Health and Community Care at the University of Hertfordshire wrote: "If human support has been reduced as a result of receiving technology but the older person stops using the device over time because it is not sufficiently tailored to their need, there may be unintended consequences such as an increase in the person's isolation."[533]

317. The Government published its Loneliness Strategy in 2018. This recognised that "digital technology can provide a powerful way to tackle loneliness", but it can "exacerbate some people's experience of loneliness."[534]

318. **The Government is to be commended for developing its loneliness strategy. Older people need strong social contacts, with the priority being face-to-face interactions. There is also the need for people to develop digital skills to use technologies that can reduce social isolation and loneliness.**

Use of data for healthy ageing

319. There is potential to improve healthcare by using data more effectively, including to provide more personalised services. This approach could assist people to age more healthily. Sources of data that could be used include: NHS primary and secondary care settings; consumer mobile health apps; wearables and sensors; implantable biosensors; and point-of-care testing devices.[535]

320. Combining data from a diverse range of sources poses challenges. Matthew Gould, Chief Executive of NHSX—a unit which sets national policy for NHS technology, digital and data—identified four main barriers to sharing and integrating health and care data: 'siloisation' means that "data does not for the most part flow easily between the two sectors"; lack of technical

530 Written evidence from No Isolation (INQ0039)
531 Written evidence from Age UK (INQ0077)
532 Written evidence from the Institute of Public Health in Ireland (IPH) (INQ0048)
533 Written evidence from Centre for Research in Public Health and Community Care, University of Hertfordshire (INQ0059)
534 HM Government, *A connected society: A strategy for tackling loneliness – laying the foundations for change* (October 2018), p 45: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936725/6.4882_DCMS_Loneliness_Strategy_web_Update_V2.pdf [accessed 12 October 2020]
535 PHG Foundation, *The personalised medicine technology landscape* (August 2018): https://www.phgfoundation.org/documents/phgf-personalised-medicine-technology-landscape-report-50918.pdf [accessed 12 October 2020]

interoperability results in "systems not being able to speak to each other"; 'semantic interoperability', which is "people describing things in different ways"; and "concerns around information governance inhibiting the flow of data".[536]

321. The NHS can share data with external organisations for use in research, under strict rules to protect patient privacy. Charles Lowe told us about challenges for SMEs in obtaining permission to use NHS data, including costs, procedures for obtaining ethical approval and data interoperability. He noted that costs were supposed to fall, but that this depended on a new data application, which was not currently available for systems used by most GP practices.[537]

322. Witnesses from academia were concerned that rules on access to NHS data can delay or prevent research. Professor Julian Peto, Professor of Epidemiology at the London School of Hygiene and Tropical Medicine, spoke about what researchers must do to obtain permission to use medical records in clinical trials. He said that, for primary healthcare records, consent must be sought from individual GP practices—which are legally the 'data controllers'—rather than a central body.[538] Dr Zaninotto gave examples of the challenges in using NHS data in epidemiological studies, saying that it took several years to obtain permission to use data as part of the English Longitudinal Study of Ageing cohort study, and that the data could not be shared with other researchers.[539]

323. Some witnesses referred to difficulties in accessing data from commercial data sources—for example for wearable fitness trackers. Stuart Butterfield told us that, while individual companies store and use these data, there is "no central repository for all that data."[540] Dr Ewa Truchanowicz, Managing Director of Dignio Ltd, said that siloisation and technical interoperability are issues with data gathered by companies, and that "interoperability and common standards would be really useful."[541]

324. We heard views about the accuracy and reliability of data collected in non-medical settings or by non-medical devices. Professor Rodriguez-Villegas explained that there are high standards required for medical devices: "With a medical device, we have a regulatory framework. The technology is linked to an intended use and, as manufacturers, we need to guarantee that what we say is correct so that patient safety is not damaged." In contrast: "Wearable technologies for wellness are not regulated [so] manufacturers do not have to commit to providing a level of accuracy—the output is uncertain."[542] However, Charles Lowe maintained that data from non-medical devices are useful but are not valued by clinicians: "The current view of many clinicians is that much of that information is not reliable and doctors do not have time to analyse it … We have to overcome the issue that just because information is collected in somebody's home it is not reliable."[543]

536 Q 132 (Matthew Gould)
537 Q 141 (Charles Lowe)
538 Q 140 (Professor Julian Peto). In that same question, Professor Peto made a similar point about samples for analysis, saying that the Human Tissue Act required that samples be destroyed and hence are not available for research.
539 Q 141 (Dr Paola Zaninotto)
540 Q 83 (Stuart Butterfield)
541 Q 100 (Dr Ewa Truchanowicz)
542 Q 96 (Professor Esther Rodriguez Villegas)
543 Q 141 (Charles Lowe)

325. **With much healthcare data now held electronically, alongside data generated by non-medical devices, there is a valuable opportunity to develop more sophisticated methods of monitoring and predicting how well people age. There is a need to further reduce technical barriers to data integration across different platforms and administrative barriers to providing anonymised patient data for clinical trials.**

Barriers to uptake of technology and services

Design and targeting

326. A significant barrier to uptake of technologies and services which assist healthy and independent living in old age is that they are often designed without input from older people and so might not address the right issues. In the case of technologies such as wearables, Age UK told us: "older people are rarely seen as targets for fitness and health applications, which means that devices are not suitable for them."[544] As well as suitability, devices should be appealing to older people; Sarah Weir said that older people "do not want something grey and boring and that looks as if it is for an old person".[545]

327. The Challenge explained that lack of input by older people in the design process may be due to the age profile of those in the technology sector:

> "The technology sector is dominated by younger professionals … It would therefore be unsurprising if ageist attitudes existed within the technology workforce, and skewed the kinds of technologies being developed in favour of younger people. Indeed, anecdotal evidence suggests that the technology sector has a culture which tends towards overt disinterest in older age groups."[546]

328. Lack of awareness of products and services is a barrier to uptake. Stuart Butterfield said: "people simply do not understand that those [telecare] technologies are available. Typically, people come across them only when their loved one has had an unplanned health event."[547] Similarly, he said that there is a "lack of staff awareness and staff training to be able to use the tools", such that there are "local authorities that buy systems that sit unused".[548] He commented that "GPs are not really aware of technologies", and that they "typically do not want to get involved in [responding to alerts]", but that they could be made aware of the benefits in terms of helping patients who have the most problems and frequent GPs' appointments.[549]

329. **In order to improve uptake and usefulness of technologies and services that can contribute to healthier and independent living in old age, it is important to base the process of development and deployment around older people's needs, preferences and abilities. It is beneficial for older people to be involved in the design of these products and services.**

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544 Written evidence from Age UK (INQ0077)
545 Q 82 (Sarah Weir)
546 Written evidence from The Challenge (INQ0073)
547 Q 82 (Stuart Butterfield)
548 Q 80 (Stuart Butterfield)
549 Q 86 (Stuart Butterfield)

Trust and privacy

330. Levels of acceptance and trust can limit uptake. The Agile Ageing Alliance told us that installing technology can be an issue because of nervousness about tradespeople coming into homes.[550] For novel technologies such as robotics and AI, the Manchester Institute for Collaborative Research on Ageing wrote that acceptance increased when older people could engage and interact with robots, and that trust improved when AI systems interact and provide explanations for their recommendations.[551]

331. Privacy was raised as a concern. The British Geriatrics Society and Royal College of Physicians told us that in-home monitoring and assistive devices are a form of surveillance so issues of consent and capacity need to be considered, and applications may need to be made under the Deprivation of Liberty Safeguards.[552] The Positive Ageing Research Institute at Anglia Ruskin University explained that older people are often not aware of the ability of companies to collect their data from devices, and that there is little national guidance or policy on the rights and privacy of consumers.[553] The Agile Ageing Alliance cautioned that the "interfaces are often poor from a security perspective making them easy to hack, take data from, and own for nefarious purposes."[554]

332. Issues of public trust have been at the centre of controversies over recent healthcare data projects—for example care.data[555] and DeepMind's work in the health sector.[556] In both cases criticisms centred on not giving enough information to patients, including details on what personal information would be shared and how to opt out of the scheme. Dame Fiona Caldicott, the National Data Guardian, said that the care.data project had caused upset to GPs and patients because it appeared that they would have no control of access to patient data.[557] In 2016 the National Data Guardian reviewed patient data security and consent/opt-out options,[558] and produced ten data security standards.[559] In 2018 the Government launched the Centre for Data Ethics and Innovation, tasked with "connect[ing] policymakers, industry,

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550 Written evidence from Agile Ageing Alliance (INQ0052)
551 Written evidence from Manchester Institute for Collaborative Research on Ageing (MICRA) (INQ0033)
552 Written evidence from the British Geriatrics Society and Royal College of Physicians (INQ0049)
553 Written evidence from the Positive Ageing Institute, Anglia Ruskin University (INQ0020)
554 Written evidence from Agile Ageing Alliance (INQ0052)
555 The care.data programme was an NHS England initiative that ran from 2013 to 2016. The NHS England webpage from 2013 says: "the care.data programme will link information from different NHS providers to give healthcare commissioners a more complete picture of how safe local services are, and how well they treat and care for patients across community, GP and hospital settings." NHS England, 'NHS England sets out the next steps of public awareness about care.data' (16 October 2013): https://www.england.nhs.uk/2013/10/care-data/ [accessed 22 October 2020]
556 DeepMind is a UK-based AI company. There was controversy about its collaborations with healthcare providers. The issue is discussed in the following report: Select Committee on Artificial Intelligence, *AI in the UK: ready, willing and able?* (Report of Session 2017–19, HL Paper 100)
557 Q 136 (Dame Fiona Caldicott)
558 National Data Guardian for Health and Care, Review of Data Security, *Consent and Opt-Outs* (June 2016): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/535024/data-security-review.PDF [accessed 22 October 2020]
559 NHS Digital, *Data Security Standards: Overall Guide* (2018): https://www.dsptoolkit.nhs.uk/Help/Attachment/24 [accessed 22 October 2020]

civil society, and the public to develop the right governance regime for data-driven technologies".[560]

333. **Public trust in data security is key if data-driven services and new technologies are to be deployed widely and used to their potential. Ongoing public engagement will be necessary to reassure the public on matters of trust and privacy regarding healthcare data, so that people are more willing to share data that can contribute to their own healthcare and to the development of wider advice for healthy ageing.**

Affordability

334. The cost of technologies and related adjustments to homes was raised as a key barrier to uptake for individuals and public bodies. Stuart Butterfield said that evidence of cost-effectiveness of 'passive activity-monitoring systems' was "siloed and very patchy", because of the difficulties of "having people with full access to the data who can say what the outcomes are and what the financial models are". However, he cited two reports by Northamptonshire County Council showing "savings of £8,000 over a year every time they deployed the system" through "cost avoidance and cost saving".[561] Professor Caleb-Solly said the £8,000 cost of a physical assistance robot should be considered alongside the avoided costs of providing this care in person, particularly in the context of staff shortages in the care sector.[562]

335. Where technologies are provided by a local authority, it uses its Integrated Community Equipment Services (ICES) fund. An ICES fund is often used in conjunction with the Government's Disabled Facilities Grant (DFG), which is for adaptations to homes.[563] Coordination between funding streams was identified as an issue affecting uptake. At present, the DFG—but not the ICES—is part of the 'Better Care Fund', which brings together budgets from health, social care and housing to enable "the NHS and local authorities [to] work together, as equal partners, with shared objectives."[564] A 2018 review recommended: "The DFG and ICES budgets [should] be in the same funding pot … to join up DFG services with equipment provision and minor adaptations."[565]

Digital literacy

336. Several witnesses highlighted digital literacy and lack of training as barriers to the uptake of new technologies by older people. Office for National Statistics data in 2019 show that, while the proportion of older people using

560 Department for Digital, Culture, Media and Sport, '*Centre for Data Ethics and Innovation*': https://www.gov.uk/government/organisations/centre-for-data-ethics-and-innovation [accessed 22 October 2020]

561 Q 90 (Stuart Butterfield)

562 Q 85 (Professor Praminda Caleb-Solly)

563 Centre for Public Health and Wellbeing at the University of the West of England, *Disabled Facilities Grant (DFG) and Other Adaptations—External Review: Main Report* (December 2018): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/762920/Independent_Review_of_the_Disabled_Facilities_Grant.pdf [accessed 22 October 2020]

564 Department of Health and Social Care and the Ministry of Housing, Communities and Local Government, *2019–20 Better Care Fund: Policy Framework* (10 April 2019), p 2: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/821676/Better_Care_Fund_2019-20_Policy_Framework.pdf [accessed 22 October 2020]

565 Centre for Public Health and Wellbeing at the University of the West of England, *Disabled Facilities Grant (DFG) and Other Adaptations—External Review: Main Report* (December 2018): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/762920/Independent_Review_of_the_Disabled_Facilities_Grant.pdf [accessed 22 October 2020]

the internet has risen rapidly, of the 4 million people who have never used it, more than half are over 75; and just over half of adults over the age of 75 had not used the internet in the previous three months.[566] The Centre for Ageing Better wrote that non-internet users are more likely to be poor, less well educated and in worse health than their peers, and there is a risk of further entrenching inequalities in older age if they cannot access digital technologies and services.[567]

337. Age UK told us that, as health information and services are increasingly accessed online, "digital technology [is now] a form of health literacy", which in turn is linked to health outcomes.[568] In a similar vein, the Agile Ageing Alliance told us that people can find systems confusing because of the "technological fragmentation of the smart home ecosystem" such that "many devices are 'stand-alone' [which] leads to problems around interoperability and confusion."[569]

338. ***We recommend that Government ensures internet access for all homes so that older people can access services to help them live independently and in better health. The Government should promote and support lifelong digital skills training so that people enter old age with the ability to use beneficial technologies. Greater support should be provided to the large proportion of the current older generation which lacks these skills, so that they do not miss out on the benefits of available technologies.***

Support for innovation and deployment

Funding for technologies and services

339. Through the Industrial Strategy Challenge Fund, and as part of the Ageing Society Grand Challenge, the Government has allocated £98 million "to invest in developing projects that will help older people remain independent and in research into further understanding of healthy ageing."[570] The funding is available for technologies and services at different stages of development, and for interdisciplinary academic-led research into social, behavioural and design aspects of healthy ageing.

340. Several witnesses told us these funds are focused on larger companies and are not suited to SMEs, which generate much of the innovation in a market. Catherine McClen, Founder and CEO of BuddyHub, said: "There were barriers for smaller innovative start-ups to get involved, because it looked like the focus was on consortiums of bigger organisations."[571] Luella Trickett, Director of Value and Access at the Association of British HealthTech Industries, said that SMEs find it hard to obtain smaller investments

566 Office for National Statistics, *Internet users, UK: 2019* (24 May 2019): https://www.ons.gov.uk/businessindustryandtrade/itandinternetindustry/bulletins/internetusers/2019 [accessed 22 October 2020]

567 Centre for Ageing Better, *The digital age: new approaches to supporting people in later life get online* (May 2018): https://www.ageing-better.org.uk/sites/default/files/2018–06/The-digital-age.pdf [accessed 22 October 2020]

568 Written evidence from Age UK (INQ0077)

569 Written evidence from Agile Ageing Alliance (INQ0052

570 UK Research and Innovation, 'Industrial Strategy Challenge Fund': https://www.ukri.org/innovation/industrial-strategy-challenge-fund/healthy-ageing/ [accessed 22 December 2020]

571 Q 130 (Catherine McClen)

that match the scale of their projects—for example to repurpose existing technologies.[572]

341. We were told there is a shortfall in funding to commercialise innovations in the UK.[573] The same issue applies to existing technologies, where there is limited funding to support deployment. Stuart Butterfield said that the focus should be on "technology that is available", as there is often "money available to develop new stuff but no money available to use the stuff that is there."[574]

342. Ami Shpiro, Founder of Innovation Warehouse, said that small companies struggle to attract equity if their product offers only linear returns on investment: "if there is no hockey stick, as they call it—a potential exponential return—they will not get funded … At the moment, there definitely is a gap, and not just in this sector. There are businesses that can make contributions to society, but there is no way for them to get funding".[575]

343. **The funding for new innovation in products and services seems to be aimed more at larger companies, presumably in the hope of achieving commercialisation more quickly and with less risk. However, small and medium-sized enterprises contribute significantly to innovation, and there would be merit in these organisations having easier access to funding to support innovation.**

344. **There is significant potential for development of new technologies and services to support healthier and independent living in old age, including medical devices and robotics. There is scope for further deployment of existing technologies such as telecare and 'activities of daily living' systems.**

Feasibility of the Ageing Society Grand Challenge mission

345. We asked witnesses whether technology and services could achieve the target of five more years of healthy, independent living by 2035, whilst reducing health inequalities. As per the various examples given in this chapter, there was enthusiasm that technology and services have an important role to play, but there was not strong confidence in the feasibility of the target. The Northern Health Science Alliance judged that independence in old age is likely to be more achievable than improving health.[576] Age UK cautioned that "technology should not be seen as a silver bullet", and said that "investment is needed in public health, housing, communities, transport, and welfare, alongside investment in the NHS and social care … Technology can support strategies but should not be seen as a solution in itself."[577]

346. In particular, there was concern about the contribution of technology to achieving the second part of the mission—to reduce health inequalities. Some witnesses thought that technology is not the right approach. Sinead Mac Manus, Senior Programme Manager in Digital Health at Nesta, said: "I am very sceptical about reducing health inequalities. It is a very complicated

572 Q 164 (Luella Trickett)
573 See, for example, Q 164 (Luella Trickett).
574 Q 93 (Stuart Butterfield)
575 Q 165 (Ami Shpiro)
576 Written evidence from the Northern Health Science Alliance (NHSA) (INQ0053)
577 Written evidence from Age UK (INQ0077)

area which technology is not going to contribute to."[578] Others were worried that technology would increase health inequalities. Several of the barriers to uptake of technologies have a socio-economic gradient, as Professor Marmot said: "In general, innovations have a big equity implication, because they tend to get taken up first by people with more education, more money and the like."[579] The Government Office for Science raised this concern in its 2016 report on the future of an ageing population: "people with higher incomes are likely to be healthier and to own and use new technologies", which means there is a risk that "the potential of technologies to support health will not translate to those with highest need, exacerbating existing health inequalities."[580]

347. To avoid widening health inequalities, witnesses advised promoting uptake of technologies by groups that are disadvantaged or face barriers to uptake. The Institute for Public Health in Ireland told us "it is particularly important that assistive technologies are tailored very specifically at those who may not be computer-literate and that special efforts are made to find effective interventions for these cohorts to enable them [to] access the benefits of technological advances."[581] Catherine McClen was concerned about the risk of increasing inequalities, but said: "As long as [technologies] can be adopted and the public purse eventually pays to allow people on a lower income or who are suffering health inequalities to be able to access them, hopefully the challenge can meet its aims." [582]

348. **Technology and services can contribute to independence and social connectedness in old age, and to health to a lesser extent, but it seems unlikely that they can add five years of healthy and independent living by 2035. Moreover, there is a risk of technology and services widening health inequalities in old age, due to barriers to uptake that are more prevalent in disadvantaged groups. The Government will have to intervene decisively and for the long-term in order to make these tools ubiquitous and beneficial for the whole population in old age.**

349. ***When allocating funding through the Ageing Society Grand Challenge, we recommend that the Government supports the deployment of technologies that contribute to healthier and independent living—both those available now and those that may become available in future. This should prioritise disadvantaged groups in order to bring the greatest health benefits, whilst also realising economic benefits of innovations that are developed in the UK.***

578 Q 130 (Sinead Mac Manus)
579 Q 195 (Professor Sir Michael Marmot)
580 Government Office for Science, *Future of an Ageing Population* (2016), p 86: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/816458/future-of-an-ageing-population.pdf [accessed 22 October 2020]
581 Written evidence from the Institute of Public Health in Ireland (INQ0048)
582 Q 130 (Catherine McClen)

CHAPTER 6: THE AGEING SOCIETY GRAND CHALLENGE

350. In this report we have referred to the Ageing Society Grand Challenge, a prominent Government policy on healthy ageing, and the extent to which various sectors might contribute to its mission to increase healthy life expectancy by five years by 2035. In this chapter we assess the challenge, including the feasibility and means of achieving its associated mission.

Feasibility of achieving the Ageing Society Grand Challenge mission

The five-year target

351. The first part of the Ageing Society Grand Challenge mission is to increase healthy life expectancy by five years by 2035; specifically "an increase of five years in disability-free life expectancy at birth for both males and females by 2035 … compared to the UK baseline of 62.5 years for males and 62.1 years for females in the years 2014–16".[583]

352. Most witnesses thought that the five-year target was a worthy ambition, but were pessimistic that it could be achieved by 2035. David Sinclair, Director at the International Longevity Centre, thought the target was "laudable and exciting but unbelievably unachievable without major policy change."[584]

353. Professor Marmot explained that, even if trends in life expectancy improvement were restored to pre-2010 levels, it would produce an increase in life expectancy of only 3.75 years by 2035. The improvement in healthy life expectancy would be even less, because "the inequalities are bigger and the social gradient is steeper" and so "we certainly would not make [the target] for healthy life expectancy".[585] Indeed, the Marmot 2020 report noted that, for females, healthy life expectancy has decreased since the period 2009–11.[586] The Centre for Ageing Better told us that analysis by the Health Foundation suggested that healthy life expectancy would rise by just over a year by 2035 and "it will take 75 years to boost the average number of years that men spend in good health by five years assuming the recent rates of improvements continue."[587]

354. A representative from the Department of Health and Social Care agreed that the UK is not on track to meet the target. Rosamond Roughton told us: "We are not on track to achieve [the five-year target] at the moment, and, in fact, we have gone backwards. The ONS publishes annual data and in the data before Christmas [2019] things have got worse."[588] However, Elaine Rashbrook from Public Health England was more optimistic, telling us that "we are moving in the right direction" and that it is "hard to say exactly whether we will [achieve the target], but the ambition is there."[589]

355. There was consensus amongst Government officials, and those from organisations that contributed to defining the mission (such as the Centre for Ageing Better), that the target was still worthwhile. George MacGinnis,

583 Written evidence from HM Government (INQ0023)
584 Q 72 (David Sinclair). See also a similar point in Q 73 (Ruthe Isden).
585 Q 189 (Professor Sir Michael Marmot)
586 Institute of Health Equity, *Health Equity in England: The Marmot Review 10 Years On* (February 2020): http://www.instituteofhealthequity.org/resources-reports/marmot-review-10-years-on/the-marmot-review-10-years-on-full-report.pdf [accessed 7 September 2020]
587 Written evidence from the Centre for Ageing Better (INQ0016)
588 Q 150 (Rosamond Roughton)
589 Q 71 (Elaine Rashbrook)

Challenge Director of the Healthy Ageing Challenge Fund, told us that "regardless of the global trends and the wider influences on the Grand Challenge mission", the five-year target "remains a worthwhile goal, even if the actual five years looks less deliverable than it did when first devised."[590] Dr Giles said "it is a long shot—it is shooting for the moon—but we might get somewhere towards it."[591]

Inequalities in healthy ageing

356. There was even less optimism from witnesses about the feasibility of achieving the second part of the mission: to reduce the gap in healthy life expectancy between the richest and poorest. Professor Marmot told us that reducing health inequalities has not been a priority for Government over the past decade:

> "I do not think the Government did enough over the last 10 years. They said that they welcomed my [2010] report and included in the Health and Social Care Act [2012] the fact that health authorities should have regard to the reduction of health inequalities, and I was pleased with that. But they did not do much subsequently. They had other priorities."[592]

Professor Marmot did not think the Government was adequately monitoring progress in health inequalities; he said that, in the preparation of the Marmot 2020 report, a representative of a health charity expressed surprised that the Government was not undertaking this kind of analysis themselves.[593]

357. Dr Anna Dixon, Chief Executive of the Centre for Ageing Better, told us that in order to address inequalities the Government needs to address the wider determinants of health.[594] This would mean focusing more on prevention earlier in life, using "bold regulatory action" in areas such as obesity, alcohol and smoking, and "a greater focus on physical activity." This would necessitate a "redesign of our environment, investment in public transport, and active travel."[595]

358. We heard from several witnesses that the focus so far on technology and services in Ageing Society Grand Challenge initiatives may heighten inequalities, if products are not affordable and accessible to deprived groups. Professor Marmot explained that "in general, innovations … tend to get taken up first by people with more education [and] more money".[596] This is also the case for non-technical interventions, such as healthy eating advice:

> "If people followed Public Health England's healthy eating advice, those in the bottom 10% of household income would spend 74% of their income on eating. If you give good advice on what constitutes healthy food, people down at the bottom cannot follow that advice because they do not have enough money to do it."[597]

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590 Q 150 (George MacGinnis)
591 Q 71 (Dr Alison Giles)
592 Q 194 (Professor Sir Michael Marmot)
593 Q 193 (Professor Sir Michael Marmot)
594 Q 166 (Dr Anna Dixon)
595 *Ibid.*
596 Q 195 (Professor Sir Michael Marmot)
597 Q 195 (Professor Sir Michael Marmot). Professor Marmot was citing figures from the following report: The Food Foundation, *Affordability of the UK's Eatwell Guide* (2018), pp 7–8: https://foodfoundation.org.uk/wp-content/uploads/2018/09/Affordability-of-the-Eatwell-Guide_Final_Web-Version.pdf [accessed 30 December 2020]

Dr Dixon told us that products and services aimed at increasing healthy lifespan should be "designed frugally to be affordable" and that we should not assume that expensive technologies will eventually "trickle down" and become affordable to everyone.[598]

359. Despite the focus on inequalities in the mission statement, the Government told us that the mission to reduce inequalities is not solely the responsibility of the Ageing Society Grand Challenge, but is a requirement for public authorities, as set out in statutory duties including the NHS Act 2006 and section 149 of the Equality Act 2010.[599]

Monitoring progress towards the mission

360. We asked witnesses what data is being used to test whether the mission is being achieved. Elaine Rashbrook said that "a range of metrics is available", but that there is a need to "[identify] which are the most appropriate to measure progress".[600] Dr Dixon told us that "at the high level the mission is trackable", as data are available on disability-free life expectancy by socioeconomic group. However, she added that the end of the mission is a "long way into the future", and:

> "the question is how we are going to capture and evaluate the other impacts that we think are so important to the mission that we should be generating along the way. That is where there is a need for us to look at the policy actions that are needed. It would be great if those policy actions were all set out … in a cross-government strategy so it was really clear what each department was going to contribute to those policies, and then we could evaluate the extent to which those policies were having the impacts they specifically wanted."[601]

She added that, for the mission, it was important to "ensure the social impacts are sitting alongside these broader economic impacts and capture both those together", but the current evaluation is "not sophisticated enough" to assess social impacts.[602]

361. Despite data being available for monitoring progress towards the mission at a high level, it does not appear that this is happening within the Department of Health and Social Care or across Government. When we asked Rosamond Roughton whether there are regular reports to Parliament on progress towards the mission, she said there are currently "no plans" for such monitoring and progress updates.[603]

362. **The Government is not on track to achieve the Ageing Society Grand Challenge mission to ensure five years of extra healthy life by 2035 while reducing inequalities, and does not appear to be monitoring progress towards the mission. It is hard to see how the target could be met without significant changes to the way it is managed.**

363. ***We recommend that the Government review the feasibility of the target to increase healthy life expectancy by five years by 2035, and***

598 Q 166 (Dr Anna Dixon)
599 Written evidence from HM Government (INQ0023)
600 Q 71 (Elaine Rashbrook)
601 Q 160 (Dr Anna Dixon)
602 *Ibid.*
603 Q 152 (Rosamond Roughton)

revise or re-commit to it. The Secretary of State for Health and Social Care should commit to reporting annually to Parliament on progress towards the target. The Government should also revise or re-commit to the target to reduce inequalities and outline measurable targets for the reduction in inequalities it hopes to achieve by 2035.

Responsibility and strategy for Ageing Society Grand Challenge mission

364. Given the lack of progress towards achieving the mission, we were interested in speaking to those in charge of its delivery. We were surprised to learn that there does not appear to be a person or team responsible for progress on the mission specifically, as opposed to the overall challenge. Rosamond Roughton, the Senior Responsible Officer for the challenge, told us that the mission "is the responsibility of the Department of Health and Social Care and the responsibility of the Secretary of State for Health and Social Care",[604] but added:

> "The Secretary of State has asked all of us in the department to take some responsibility for the mission. There is not a single person who is just doing the mission. The mission is so big I do not know how you could give it to one person. It requires action across such a wide number of things that it is not a single responsibility … I have other colleagues, other directors in the department, who could equally be sitting here today and telling you stuff about what they are doing and what they are responsible for."[605]

365. Rosamond Roughton drew a distinction between the aims of the challenge (to stimulate economic activity) and the aims of the mission:

> "The underpinning mission guides all the work across the Department of Health and Social Care, because it goes beyond just looking at ageing … It covers a much wider portfolio than just the economic and innovation stimulation of the Grand Challenge."[606]

366. She later told us that there will be initiatives beyond the remit of health and social care which will affect the mission, not all of which will necessarily have an economic benefit to the country. She said:

> "That is why the Grand Challenge side of looking at the business end of it is also an important element. However, just doing the business end will not deliver the mission and just doing the mission will not necessarily deliver the economic objectives of the Grand Challenge. I think of them as two very closely overlapping, but not identical, goals."[607]

367. The lack of clarity over who in Government is responsible for the mission specifically—aside from ministerial oversight by the Secretary of State—and its apparent separation from the team managing the challenge, was concerning to other witnesses. Professor Mariana Mazzucato, Professor in the Economics of Innovation and Public Value at University College London

604 Q 148 (Rosamond Roughton)
605 Q 152 (Rosamond Roughton)
606 Q 148 (Rosamond Roughton)
607 Q 150 (Rosamond Roughton)

and Founding Director of the UCL Institute for Innovation and Public Purpose, wrote to us after that evidence session:

> "I was concerned to hear from the Senior Responsible Officer for the Ageing Grand Challenge in the [Department of Health and Social Care] that, in fact, there is not an individual or a team within government either tasked with this important mission specifically or coordinating action across government (Question 152). In addition, having reflected on the evidence given on the 3rd March, I am left unclear how the grand challenge for ageing, or the mission itself, is being delivered across government, or where authority and responsibility lie."[608]

368. We also heard concern that there is not a coordinated, cross-government strategy for achieving the mission, which may be related to the lack of clarity over responsibility for the mission. The Government's website lists a range of initiatives associated with the Grand Challenge (Box 1), but it is not clear how they are intended to fit together to achieve the mission.[609] Several of the initiatives associated with the Ageing Society Grand Challenge are not specific to healthy ageing or to the aims of the mission. For example, the £210 million investment in the 'from data to early diagnosis' Challenge Fund was included as part of a £300 million investment in the Ageing Society Grand Challenge in 2018, but it has a broader focus than conditions of ageing or improving healthy life expectancy.[610]

Box 1: Initiatives associated with the Ageing Society Grand Challenge, as of 10 October 2020

Initiative
• £98 million of investment through the Healthy Ageing Industrial Strategy Challenge Fund to stimulate well-designed innovations that support people to enjoy active and independent lives for longer
• announced Andy Briggs as the Business Champion and plans to establish a UK Longevity Council to help the UK seize the economic opportunities of ageing societies
• launched a joint UK-Japan competition to support British and Japanese businesses to harness AI and robotics to develop and showcase a new generation of assisted living products
• announced plans to launch a 'Home of 2030' design and innovation competition later this year—with the Clean Growth Grand Challenge—which will seek to prototype the homes of the future, that are built to a standard suitable for the changing needs across a lifetime, whilst also being environmentally sustainable

608 Supplementary written evidence from Professor Mariana Mazzucato (INQ0097)

609 *Department for Business, Energy and Industrial Strategy*, 'Government announces £300 million for landmark ageing society grand challenge', (12 March 2018): https://www.gov.uk/government/news/government-announces-300-million-for-landmark-ageing-society-grand-challenge [accessed 14 September 2020]

610 *Ibid.*

- published Greater Manchester's Local Industrial Strategy with a focus on seizing the opportunities of an ageing population building on its status as the UK's first World Health Organisation Age Friendly city-region
- part-funded the new National Innovation Centre for Ageing in Newcastle, which is due to open later [in 2019]
- announced over £130 million of investment to support healthcare innovation, including £69.5 million through UKRI's Strategic Priorities Fund to unlock new treatments that allow people to lead healthier and longer lives

Source: Department for Business, Energy and Industrial Strategy, Policy paper: The Grand Challenge missions, Ageing Society: https://www.gov.uk/government/publications/industrial-strategy-the-grand-challenges/missions#healthy-lives [accessed 10 October 2020]

369. Several witnesses called for a cross-government strategy for achieving the mission. The Centre for Ageing Better told us:

> "Although it is feasible for the Ageing Grand Challenge to make progress towards this goal, it will require actions across departments, not just [the Department of Health and Social Care]. Despite the Ageing [Society] Grand Challenge, there has yet to be a cross-departmental understanding of what ageing really means for the whole of government and how departments beyond just [the Department of Health and Social Care] play a part in keeping people healthier for longer."[611]

370. Dr Dixon expanded on how that coordination should occur:

> "The first thing [the Government] needs to do is commit and publish a cross-government strategy on ageing. Many other countries have had and do have ageing strategies. Given the huge demographic challenges we face in this country, along with many others, it seems surprising that we have no cross-government strategy on this issue, despite the fact that some of your colleagues some time ago had called for this in previous Lords Committees."[612]

Dr Dixon suggested that responsibility for the cross-governmental strategy could sit in the Cabinet Office.[613]

371. Professor Mazzucato told us that a 2019 report by the UCL Commission for Mission-Oriented Innovation and Industrial Strategy, co-chaired by herself and Lord Willetts, recommended a cross-government approach to all the Grand Challenges:

> "To implement and deliver a mission-oriented industrial strategy, the Government should form multi-disciplinary, cross-departmentally-staffed, boundary-crossing Grand Challenge teams. These must be fully resourced, both in terms of funding but also in terms of leadership, staff, support and analytical capability, with operational autonomy to set their own goals and programmes, as well as senior reporting responsibility within government and the freedom to take initiative in a given challenge area."[614]

611 Written evidence from the Centre for Ageing Better (INQ0016)
612 Q 163 (Dr Anna Dixon)
613 Q 167 (Dr Anna Dixon)
614 Supplementary written evidence from Professor Mariana Mazzucato (INQ0097)

372. She added that a recent report by the Government Office for Science echoed this, recommending that the Government ensures there is "An empowered and accountable mission leader … appointed by the Permanent Secretary of the lead department" and that "The [mission leader] is directly supported by a … flexible and empowered core team of sufficient critical mass … of no more than 8–10 people … [which] consists of members from the key departments".[615] The Government Office for Science report recommended that a "team is formed solely to deliver the mission and therefore has a lifetime that spans the duration of the mission."[616]

373. A cross-government strategy should help achieve the part of the mission on reducing health inequalities. Professor Marmot thought the Prime Minister should be responsible for achieving this part of the mission "because it is cross-government":

> "We said in 2010 that 4% of the NHS budget goes on prevention. That is quite apart from investing in early child development and education. The spend on education went down by 8% per child. If you had health equity at the heart of government, you would never allow the per-child spending on education to go down by 8%. That is why I think it should be the Prime Minister. This should be a corporate issue for the whole of government."[617]

374. **It is not clear who in Government is responsible for overseeing the Ageing Society Grand Challenge mission, aside from broad ministerial oversight from the Secretary of State for Health and Social Care. We are concerned that this policy has no clear ownership.**

375. **The position taken by the Government that the challenge and the mission are overlapping but distinct is confusing, and we are concerned that achieving the mission does not appear to be at the core of the Grand Challenge.**

376. ***We recommend that the Secretary of State for Health and Social Care appoints a senior responsible officer for achieving the mission of the Ageing Society Grand Challenge, as this does not appear to be covered by the senior responsible officer for the challenge.***

377. **We are concerned that there is not a cross-government strategy for achieving the mission. Without one, the Ageing Society Grand Challenge is unlikely to achieve the mission of increasing healthy life expectancy by five years while reducing inequalities.**

378. **The Government's statement that the part of the mission pertaining to inequalities is not the sole responsibility of the Ageing Society Grand Challenge is confusing. Other aspects of policy will contribute to this goal, but that does not mean that reducing inequalities should not be at the core of the cross-government strategy for healthy ageing.**

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615 Supplementary written evidence from Professor Mariana Mazzucato (INQ0097). See also Government Office for Science, *Realising our ambition through science* (November 2019): https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/844502/a_review_of_government_science_capability_2019.pdf [accessed 14 September 2020].

616 Government Office for Science, *Realising our ambition through science* (November 2019), p 83: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/844502/a_review_of_government_science_capability_2019.pdf [accessed 14 September 2020]

617 Q 194 (Professor Sir Michael Marmot)

379. ***We recommend that the Secretary of State for Health and Social Care—along with the senior responsible officer—produces a cross-government strategy which clearly states how the Government plans to achieve the Ageing Society Grand Challenge mission by 2035. The strategy should include a roadmap for how the Government intends to achieve the mission, and should specify the departments responsible for working towards the target.***

380. ***We recommend that the cross-government strategy explicitly addresses the issue of reducing inequalities in healthy ageing, without 'passing the buck' to wider Government goals or statutory obligations. In producing the strategy, the Government should seek wide input from stakeholders; most importantly, from older people.***

POST-SCRIPT: COVID-19 PANDEMIC

Vulnerability of older people

381. The COVID-19 pandemic has had disproportionate impacts upon older people, in terms of severity of disease and death rates. The population of England aged 65 and over is currently around 18%,[618] but patients in that age group accounted for 60% of hospital admissions for COVID-19 (up to 30 September 2020). Patients aged 60 and over represented 92% of patients who died in hospitals having tested positive for COVID-19 (in England, up to 5 November 2020).[619]

382. Risk factors associated with vulnerability to COVID-19 are more prevalent in the older population, including pre-existing health conditions such as respiratory illnesses, cardiovascular disease, diabetes and obesity.[620] As discussed in this report, these risk factors are frequently associated with lifestyle and environmental factors, and are more common amongst people living in deprivation. COVID-19 has been more severe amongst deprived communities, and in particular ethnic minorities. The Office for National Statistics reported that, in England in the period April to July 2020, "the mortality rate in the least deprived areas (decile 10) in England was less than half of the mortality rate in the most deprived areas".[621] In August 2020, Public Health England reported that, compared to White British people, "people of Bangladeshi ethnicity had around twice the risk of death" and "People of Chinese, Indian, Pakistani, Other Asian, Black Caribbean and Other Black ethnicity had between 10 and 50% higher risk of death" due to COVID-19.[622]

383. There is evidence that the ageing of the immune system is related to the increased vulnerability of older people to COVID-19. The reduced ability of the aged immune system to detect and kill virus-infected cells, together with the increased propensity for an over-exuberant and damaging inflammatory response, were identified in a report by the Academy of Medical Sciences and the British Society for Immunology as reason why older people are more susceptible to severe COVID-19 disease.[623]

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618 Office of National Statistics, '*Population estimates for the UK, England and Wales, Scotland and Northern Ireland: mid-2019*' (24 June 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/bulletins/annualmidyearpopulationestimates/mid2019estimates [accessed 12 November 2020]. According to this data, 18.2% of the population is aged 65+, and approximately a further 5.5% is aged 60–64.

619 NHS England, 'COVID-19 Daily Deaths' (2020): https://www.england.nhs.uk/statistics/statistical-work-areas/covid-19-daily-deaths/ [accessed 12 November 2020] From 1 March to 5 November, the total number of deaths listed was 34,424 across all age groups. For the age group 60-79 the number was 13,146; and for the age group 80+ the number was 18,452.

620 See, for example, oral evidence given to the Science and Technology Committee for its inquiry into The Science of COVID-19, on 15 September 2020 (Session 2019–21), Q 181 (Dr Sonya Babu-Narayan) and Q 191 (Professor Donal O'Donoghue).

621 Office of National Statistics, '*Deaths involving COVID-19 by local area and socioeconomic deprivation: deaths occurring between 1 March and 31 July 2020*' (28 August 2020): https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/deaths/bulletins/deathsinvolvingcovid19bylocalareasanddeprivation/deathsoccurringbetween1marchand31july2020 [accessed 12 November 2020]

622 Public Health England, *Disparities in the risk and outcomes of COVID-19* (August 2020) p 39: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/908434/Disparities_in_the_risk_and_outcomes_of_COVID_August_2020_update.pdf [accessed 12 November 2020]

623 Academy of Medical Science and British Society for Immunology, *COVID-19 immunology research* (1 May 2020): https://acmedsci.ac.uk/file-download/24858714 [accessed 12 November 2020]

Wider health impacts of the pandemic

384. Even after recovery from the acute infection, the effects of the illness may have wider impacts upon health. The British Geriatrics Society was concerned about older people who have been seriously ill with the virus and developed delirium, which "contributes to poor outcomes including falls, increased length of hospital stay, new institutionalisation, and mortality".[624]

385. The public health measures to address the pandemic have had impacts upon people's health, including the physical and psychological health of older people. The British Geriatrics Society was "extremely concerned about the increased numbers of older people who will have new onset or worsening frailty as a result of the lockdown and shielding guidelines."[625] NHS England and NHS Improvements told us that they are "currently investigating potential impact[s] of the pandemic on older people's mental health".[626]

Changes to health and care services

386. The pandemic has highlighted to need for—and has required the development of—close coordination between different parts of the health and care system. NHS England and NHS Improvement said that "The pandemic has reinforced the urgency to join up health and care at a local level".[627] The British Geriatrics Society told us that there has been "rapid innovation across the health and social care pathway, with integration occurring where it wasn't considered possible before", and that "work is underway to ensure that the gains made during the pandemic are not lost as we adjust to a 'new normal'."[628]

387. The increased use of remote working in the health system during the pandemic has illustrated the value of digital services, including in the care of older people. The British Geriatrics Society said that "The quality and sustainability of future health and care services will be improved by digitally enabled care". They saw benefits in "remote and mobile health monitoring in the community", in "clinicians working in different settings [being able] to access and interact with patient records and care plans" and virtual or telephone consultations with patients.[629]

388. **The COVID-19 pandemic has shown tragically how poor health makes people more vulnerable to further health risks, and has highlighted the health inequalities associated with deprivation—including for ethnic minorities. The pandemic has harmed the health of the wider population, and the longer-term health impacts—including on mental health—are unknown, increasing the need for action to encourage and facilitate healthy ageing.**

624 Written evidence from the British Geriatrics Society (INQ0101)
625 *Ibid.*
626 Written evidence from NHS England and NHS Improvement (INQ0102)
627 *Ibid.*
628 Written evidence from the British Geriatrics Society (INQ0101)
629 *Ibid.*

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Below is a list of all of the Committee's conclusions and recommendations (recommendations appear in italics).

Trends and challenges

1. Life expectancy in the UK continues to rise, but since 2011 it has risen at a slower rate. Healthy life expectancy is not keeping pace with increases in life expectancy, resulting in a growing period of poor health towards the end of life. Inequalities in healthy life expectancy are stark, with people in the least deprived groups living more than 18 years longer in good health than those in the most deprived groups. (Paragraph 30)

2. *We recommend that the Government, along with NHS England, Public Health England, and other agencies, prioritise reducing health inequalities. In its response to this report we request that the Government sets out a plan for reducing health inequalities over the next Parliament.* (Paragraph 31)

3. Multimorbidity—the state of having two or more long-term conditions—is more common in old age. There is evidence that the rate of multimorbidity is increasing, so it will become an increasing issue for the NHS. The environmental and biological factors driving the development of multimorbidity are not fully understood. (Paragraph 47)

4. Care pathways are not well coordinated or integrated for older people, particularly those with multimorbidity. Patients often have to see multiple doctors, with multiple specialisms, with little coordination between specialists to reduce the burden on patients. (Paragraph 66)

5. *We recommend that, as was proposed in 2013, the NHS ensures that all older patients have a designated clinician. This clinician would have oversight of the patient's care as a whole, and should coordinate activity across multidisciplinary teams, which should include members from across the health and social care sectors. The clinician could be from either primary or secondary care, depending on the patient's needs.* (Paragraph 67)

6. *We recommend that designated clinicians for older people ensure that Comprehensive Geriatric Assessments are used regularly for older patients, particularly for those with multimorbidity. The Government should ensure that training in how to conduct Comprehensive Geriatric Assessments is a core part of medical training, and that training is provided on an ongoing basis, in particular to GPs.* (Paragraph 68)

7. Medicine reviews are a core component of Comprehensive Geriatric Assessments, and if these are used more widely, with the involvement of multidisciplinary teams, the incidence of polypharmacy and the risk of adverse drug reactions should reduce. (Paragraph 80)

8. *We recommend that the review into overprescribing—which is due to report to the Secretary of State for Health and Social Care in late 2020—should be published as soon as possible.* (Paragraph 81)

The Science of Ageing

9. Understanding of the underlying biological processes of ageing has advanced significantly in animal models, but translation to human ageing is incomplete.

The lack of accurate biomarkers for human ageing is an impediment to assessing an individual's biological age. (Paragraph 126)

10. Promising advances have been made in the development of drugs that target the underlying processes of ageing. These could delay the onset of age-related diseases and reduce polypharmacy. Research into repurposing drugs is particularly welcome, as such drugs have already been tested for safety, dosage and tolerability. (Paragraph 144)

11. The fact that clinical trials are usually approved only if they target a single indication poses a challenge to research into drugs that target underlying ageing processes. The novel design of the TAME trial in the US hopes to provide proof of concept for trials targeting the ageing process itself. (Paragraph 155)

12. *We recommend that the Medicines and Healthcare products Regulatory Agency (MHRA) show greater willingness to approve trials which target multiple conditions. It should also explore the use of novel trial endpoints, such as using biomarkers of ageing as measures of success in treatments targeting the ageing process.* (Paragraph 156)

13. Historically, clinical trials excluded older people and people with multimorbidity, and some continue to do so. This is a particular issue for drugs targeting the ageing process, as older people and those with multimorbidity will be the main recipients of such drugs. (Paragraph 165)

14. *We recommend that the Medicines and Healthcare products Regulatory Agency (MHRA) ensures that older people are included more frequently in clinical trials, particularly where the drug will be used primarily in that population. When developing novel trial designs for drugs targeting the ageing process, as recommended above, these should also allow for inclusion of people with multimorbidity.* (Paragraph 166)

15. How to target 'anti-ageing' drugs to provide the greatest benefit to the individual, the NHS and society will be an important issue in future but requires further research and evidence from clinical trials. A health economics analysis of such treatments will be needed to determine the optimal time and populations for intervention. (Paragraph 170)

16. There has been a lack of effort since our report in 2005 to ensure research into ageing—as opposed to research into specific age-related disease—is properly funded, co-ordinated and included within the remit of particular research councils. This may have contributed to the poor translation of basic research into clinical trials or new medicines. (Paragraph 177)

17. *We recommend that UK Research and Innovation commit to funding further research into the biological processes underlying ageing as a priority, in particular to address gaps in understanding the relevance of ageing hallmarks to humans. Research to identify accurate biomarkers of ageing in humans should also be prioritised, to support studies to improve health span.* (Paragraph 178)

18. *We recommend that UK Research and Innovation and the National Institute for Health Research support further research into drugs that target the ageing process—including proof of concept trials using repurposed drugs (such as in the TAME trial).* (Paragraph 179)

19. *We recommend that UK Research and Innovation and the National Institute for Health Research commit to working more closely to ensure rapid translation of ageing research into clinical benefit.* (Paragraph 180)

20. *We recommend that the Chief Medical Officer is given responsibility for overseeing the coordination of ageing research between UK Research and innovation and the National Institute for Health Research.* (Paragraph 181)

21. The UK has historically been a major player in drug research and development, and has the potential to be a key player in the development of treatments targeting the processes of ageing. However, companies in the UK struggle to commercialise such innovations and often have to move abroad to access finance. (Paragraph 191)

22. *We recommend that the Government ensure the UK remains a global leader in drug research and development. It should work towards making the UK a more attractive environment for growth capital investment, to stop UK innovations moving abroad after the discovery stage of research.* (Paragraph 192)

23. There was scepticism from the research community that the target of five extra years of healthy life can be achieved by 2035, and a view that the focus of the Industry Strategy Challenge fund on technological solutions and data analysis is unlikely to help deliver the target. (Paragraph 202)

Lifestyle and environmental influences on healthy ageing

24. The UK has the opportunity to be a leader in understanding the impacts of lifestyle on health, using its well-established cohort studies in conjunction with its expertise in emerging areas of biomedical research. To achieve this, it is important that longitudinal cohort studies are provided with longer-term funding that gives greater security to these studies. It is also important that cohort studies recruit sufficient numbers of people from different ethnicities and socioeconomic groups to better understand health inequalities in older adults and how these may be resolved in the longer term. (Paragraph 220)

25. The impacts of smoking and excessive alcohol consumption upon ageing—and the potential for ill health and disability in old age—may be an important issue for some people when considering their behaviours and so could be an effective part of public health messaging. (Paragraph 224)

26. Eating a balanced diet and maintaining a healthy body weight into old age are key to healthy ageing. Dietary advice has to reflect the nutritional needs of older people and the diversity of those needs. (Paragraph 230)

27. The benefits of physical activity are a cornerstone of public health advice, but a more detailed understanding of its positive effects—and the negative effects of sedentary time—could allow the development of advice that is more targeted. This is important throughout the life-course, including for older adults who have lower levels of physical activity. (Paragraph 239)

28. Cognitive ability and psychological stresses are key aspects of health throughout the life-course, but they also influence general health and might affect the underlying processes of ageing. Cognitive activities—including education, training and good-quality employment—and reduced stress are means of improving health in later life. (Paragraph 245)

29. The factors that contribute to healthy life expectancy are well known, and form the basis of healthy ageing advice, namely: not smoking, avoiding excessive alcohol consumption, eating a balanced and nutritious diet, maintaining a healthy body weight, and being physically active. There is also evidence of the role of cognitive activity and reduced stress in healthy ageing. (Paragraph 246)

30. Despite the evidence linking behaviours throughout the life-course to health in old age, the potential gains from healthy behaviours are not being fully achieved. Different aspects of the evidence could potentially have an impact upon people's behaviours, for example: the fact that healthy lifestyles can reduce the time spent with disability in old age; and the discovery that behaviours can modify underlying processes of ageing. (Paragraph 247)

31. *We recommend that organisations with responsibility for healthy ageing advice incorporate findings about the benefits of healthy behaviours that may have a larger impact upon people's behaviour than existing messaging. The benefits of building up good levels of physical fitness and cognitive reserve should be promoted, particularly to people in disadvantaged groups that suffer the worst health.* (Paragraph 248)

32. There is a need to better understand the scientific basis of the mechanisms by which lifestyle factors affect ageing. There is also a need to understand how requirements change in old age in order to develop advice covering, for example: the nutritional needs of older people; the benefits of physical activity for cognitive health; and the impacts of sedentary time. (Paragraph 249)

33. *We recommend that UK Research and Innovation and the National Institute for Health Research ensure that they support interventional studies to establish the mechanisms by which lifestyle and environmental factors affect health in old age, in order to improve advice for healthy ageing.* (Paragraph 250)

34. Public Health England's advocacy for a life-course approach to healthy ageing is to be commended. Early uptake and adherence to a healthy lifestyle may continue into mid- and later life, but it is never too late to benefit from an improved lifestyle. Interventions tend to be more successful if they are designed with an understanding of what motivates people at different ages and the transition points at which they are more likely to act on public health advice. (Paragraph 260)

35. A balanced approach to public health advice can help to achieve healthy ageing, with general messages provided to the whole population and tailored advice for groups with specific needs—in particular, disadvantaged groups who suffer from the worst health. (Paragraph 270)

36. *We recommend that the Government clearly defines the roles and responsibilities for healthy ageing among national and local government and their agencies. The creation of the National Institute for Health Protection should be used as an opportunity to revitalise work to promote healthy ageing across the life-course, including by improving coordination across the sector and drawing on the best information for developing public health advice.* (Paragraph 275)

37. *We recommend that the Government implement a concerted and coordinated set of national policies to support healthy ageing, including: regulatory and fiscal measures, actively to encourage people to adopt lifestyles that support healthy ageing; increasing the reach of the NHS Health Check to those in disadvantaged groups who will benefit the most; and working with local authorities on the funding*

of local services, housing and infrastructure to encourage and facilitate healthier living across the life-course, including the necessary services to maintain health and independence in old age. (Paragraph 284)

Technology and services

38. *We recommend that the Government use planning rules to ensure that homes and communities are accessible for people with limited mobility and adaptable as their needs change with age. The Government should ensure that sufficient funds are available—for example through the Disabled Facilities Grant—to facilitate improvements to existing homes. The priority should be areas with poor housing and infrastructure, in order to reduce health inequalities.* (Paragraph 292)

39. More widespread use of telecare services—particularly modern digital systems with monitoring capabilities—may enable more people to live independently in their homes for longer in old age. The upcoming digital telephone switchover provides impetus for this change and is an opportunity for local authorities to introduce more comprehensive services to facilitate safe and independent living. (Paragraph 298)

40. Data-driven services and emerging robotics and AI systems could provide significant support to older people, to enable them to live independently for longer. The results of ongoing projects in the UK and abroad will help to determine what role robotics can play. (Paragraph 304)

41. *We recommend that the Government makes targeted and strategic investments in research for the design, evaluation and uptake of data-driven services, assistive robot technologies and AI for older people, in order to develop national expertise and critical mass in this important area.* (Paragraph 305)

42. The use of wearable and implantable technologies for monitoring health conditions and administering treatments is likely to become increasingly common. Such technologies have potential to provide more precise and timely treatment, and could contribute to better health and greater independence in old age. (Paragraph 309)

43. Non-medical devices can be a source of useful information for individuals seeking to live more healthily. It will be necessary for the Government to continue to monitor developments in the sector to ensure an appropriate approach to standards. (Paragraph 313)

44. The Government is to be commended for developing its loneliness strategy. Older people need strong social contacts, with the priority being face-to-face interactions. There is also the need for people to develop digital skills to use technologies that can reduce social isolation and loneliness. (Paragraph 318)

45. With much healthcare data now held electronically, alongside data generated by non-medical devices, there is a valuable opportunity to develop more sophisticated methods of monitoring and predicting how well people age. There is a need to further reduce technical barriers to data integration across different platforms and administrative barriers to providing anonymised patient data for clinical trials. (Paragraph 325)

46. In order to improve uptake and usefulness of technologies and services that can contribute to healthier and independent living in old age, it is important to base the process of development and deployment around older people's

needs, preferences and abilities. It is beneficial for older people to be involved in the design of these products and services. (Paragraph 329)

47. Public trust in data security is key if data-driven services and new technologies are to be deployed widely and used to their potential. Ongoing public engagement will be necessary to reassure the public on matters of trust and privacy regarding healthcare data, so that people are more willing to share data that can contribute to their own healthcare and to the development of wider advice for healthy ageing. (Paragraph 333)

48. *We recommend that Government ensures internet access for all homes so that older people can access services to help them live independently and in better health. The Government should promote and support lifelong digital skills training so that people enter old age with the ability to use beneficial technologies. Greater support should be provided to the large proportion of the current older generation which lacks these skills, so that they do not miss out on the benefits of available technologies.* (Paragraph 338)

49. The funding for new innovation in products and services seems to be aimed more at larger companies, presumably in the hope of achieving commercialisation more quickly and with less risk. However, small and medium-sized enterprises contribute significantly to innovation, and there would be merit in these organisations having easier access to funding to support innovation. (Paragraph 343)

50. There is significant potential for development of new technologies and services to support healthier and independent living in old age, including medical devices and robotics. There is scope for further deployment of existing technologies such as telecare and 'activities of daily living' systems. (Paragraph 344)

51. Technology and services can contribute to independence and social connectedness in old age, and to health to a lesser extent, but it seems unlikely that they can add five years of healthy and independent living by 2035. Moreover, there is a risk of technology and services widening health inequalities in old age, due to barriers to uptake that are more prevalent in disadvantaged groups. The Government will have to intervene decisively and for the long-term in order to make these tools ubiquitous and beneficial for the whole population in old age. (Paragraph 348)

52. *When allocating funding through the Ageing Society Grand Challenge, we recommend that the Government supports the deployment of technologies that contribute to healthier and independent living—both those available now and those that may become available in future. This should prioritise disadvantaged groups in order to bring the greatest health benefits, whilst also realising economic benefits of innovations that are developed in the UK.* (Paragraph 349)

The Ageing Society Grand Challenge

53. The Government is not on track to achieve the Ageing Society Grand Challenge mission to ensure five years of extra healthy life by 2035 while reducing inequalities, and does not appear to be monitoring progress towards the mission. It is hard to see how the target could be met without significant changes to the way it is managed. (Paragraph 362)

54. *We recommend that the Government review the feasibility of the target to increase healthy life expectancy by five years by 2035, and revise or re-commit to it. The*

Secretary of State for Health and Social Care should commit to reporting annually to Parliament on progress towards the target. The Government should also revise or re-commit to the target to reduce inequalities and outline measurable targets for the reduction in inequalities it hopes to achieve by 2035. (Paragraph 363)

55. It is not clear who in Government is responsible for overseeing the Ageing Society Grand Challenge mission, aside from broad ministerial oversight from the Secretary of State for Health and Social Care. We are concerned that this policy has no clear ownership. (Paragraph 374)

56. The position taken by the Government that the challenge and the mission are overlapping but distinct is confusing, and we are concerned that achieving the mission does not appear to be at the core of the Grand Challenge. (Paragraph 375)

57. *We recommend that the Secretary of State for Health and Social Care appoints a senior responsible officer for achieving the mission of the Ageing Society Grand Challenge, as this does not appear to be covered by the senior responsible officer for the challenge.* (Paragraph 376)

58. We are concerned that there is not a cross-government strategy for achieving the mission. Without one, the Ageing Society Grand Challenge is unlikely to achieve the mission of increasing healthy life expectancy by five years while reducing inequalities. (Paragraph 377)

59. The Government's statement that the part of the mission pertaining to inequalities is not the sole responsibility of the Ageing Society Grand Challenge is confusing. Other aspects of policy will contribute to this goal, but that does not mean that reducing inequalities should not be at the core of the cross-government strategy for healthy ageing. (Paragraph 378)

60. *We recommend that the Secretary of State for Health and Social Care—along with the senior responsible officer—produces a cross-government strategy which clearly states how the Government plans to achieve the Ageing Society Grand Challenge mission by 2035. The strategy should include a roadmap for how the Government intends to achieve the mission, and should specify the departments responsible for working towards the target.* (Paragraph 379)

61. *We recommend that the cross-government strategy explicitly addresses the issue of reducing inequalities in healthy ageing, without 'passing the buck' to wider Government goals or statutory obligations. In producing the strategy, the Government should seek wide input from stakeholders; most importantly, from older people.* (Paragraph 380)

COVID-19 pandemic

62. The COVID-19 pandemic has shown tragically how poor health makes people more vulnerable to further health risks, and has highlighted the health inequalities associated with deprivation—including for ethnic minorities. The pandemic has harmed the health of the wider population, and the longer-term health impacts—including on mental health—are unknown, increasing the need for action to encourage and facilitate healthy ageing. (Paragraph 388)

APPENDIX 1: LIST OF MEMBERS AND DECLARATIONS OF INTEREST

Members

Baroness Blackwood of North Oxford (from 21 April 2020)
Baroness Bloomfield of Hinton Waldrist (from 1 July 2019 to 29 July 2019)
Lord Borwick
Lord Browne of Ladyton
Lord Griffiths of Fforestfach (to 29 October 2019)
Baroness Hilton of Eggardon
Lord Hollick
Lord Kakkar
Lord Mair
Baroness Manningham-Buller
Lord Patel (Chairman)
Baroness Penn (from 29 October 2019 to 19 March 2020)
Viscount Ridley
Baroness Rock (from 3 October 2019)
Baroness Sheehan
Baroness Walmsley
Lord Winston (co-opted)
Baroness Young of Old Scone

Declaration of Interest

Baroness Blackwood of North Oxford (from 21 April 2020)
Chair, Genomics England
Baroness Bloomfield of Hinton Waldrist (from 1 July 2019 to 29 July 2019)
No relevant interests declared
Lord Borwick
No relevant interests declared
Lord Browne of Ladyton
No relevant interests declared
Lord Griffiths of Fforestfach (to 29 October 2019)
No relevant interests declared
Baroness Hilton of Eggardon
No relevant interests declared
Lord Hollick
Member, Advisory Board, Royal Society
Lord Kakkar
Professor of Surgery, University College London
Chairman, University College London Partners
Member, Advisory Board, Royal Society
Chairman, Board of Trustees, King's Fund
Lord Mair
Fellow, Royal Society
Fellow, Royal Academy of Engineering
Emeritus Professor of Civil Engineering and Director of Research, University of Cambridge
Baroness Manningham-Buller
Chair, Wellcome Trust

Fellow, Academy of Medical Sciences
Member, Advisory Board, Royal Society

Lord Patel
Previous Chancellor, University of Dundee 2006–18
Fellow, Academy of Medical Sciences
Fellow, Royal Society of Edinburgh

Baroness Penn (from 29 October 2019 to 19 March 2020)
Vice Chair, Specialised Healthcare Alliance

Viscount Ridley
Hon President, International Centre for Life, Newcastle
Fellow, Academy of Medical Sciences
Shareholder, Quantum DX (Medical diagnostic company)

Baroness Rock (from 3 October 2019)
Board Member, Centre for Data Ethics and Innovation
Senior Adviser, Newton Europe

Baroness Sheehan
No relevant interests declared

Baroness Walmsley
No relevant interests declared

Lord Winston (co-opted)
Board Member, Centre for Data, Ethics and Innovation
Imperial College London employee
Research funded (Wellcome Trust; MRC) on apoptosis and ageing
Fellow, Academy of Medical Sciences
Fellow, Royal Academy of Engineering
Fellow, Royal College of Physicians

Baroness Young of Old Scone
Chancellor of Cranfield University

A full list of Members' interests can be found in the Register of Lords Interests: http://www.parliament.uk/mps-lords-and-offices/standards-and-interests/register-of-lords-interests/

Specialist adviser

Professor Janet M Lord, Director of the Institute of Inflammation and Ageing, University of Birmingham
Director of the MRC-Versus Arthritis Centre for Musculoskeletal Ageing Research, University of Birmingham
Fellow of The Academy of Medical Sciences
Member of the British Society for Research on Ageing
Member of the British Society for Immunology
Consultancy work through 'Birmingham Enterprise'
Section Editor for the journal 'Aging Cell'

APPENDIX 2: LIST OF WITNESSES

Evidence is published online at https://committees.parliament.uk/work/1/ageing-science-technology-and-healthy-living/ and available for inspection at the Parliamentary Archives (020 7219 3074).

Evidence received by the Committee is listed below in chronological order of oral evidence session and in alphabetical order. Those witnesses marked with ** gave both oral evidence and written evidence. Those marked with * gave oral evidence and did not submit any written evidence. All other witnesses submitted written evidence only.

Oral evidence in chronological order

**	Professor Chris Whitty, Chief Scientific Adviser, Department of Health and Social Care (DHSC)	QQ 1–10
*	Professor James Nazroo, Professor of Sociology, University of Manchester	QQ 11–21
**	Professor Marcus Richards, Programme Leader at the MRC Unit for Lifelong Health and Ageing, University College London (UCL)	
*	Dr Stuart Ritchie, Lecturer in the Social, Genetic and Developmental Psychiatry Centre, King's College London	
*	Dr Jordana Bell, Head of Epigenomics Research Group, King's College London	QQ 22–27
**	Professor Avan Aihie Sayer, Professor of Geriatric Medicine, Newcastle University	
*	Professor Richard Faragher, Professor of Biogerontology, Brighton University	
*	Professor David Melzer, Professor of Epidemiology and Public Health, Exeter University	
*	Professor Graham Kemp, Professor of Metabolic and Physiological Imaging, Liverpool University	QQ 28–34
*	Dr Riccardo Marioni, Centre for Genomic and Experimental Medicine, Edinburgh University	
**	Professor Sir Michael Ferguson CBE, Regius Professor of Life Sciences, University of Dundee; Wellcome Trust Board of Governors	QQ 35–42
*	Professor Sir Munir Pirmohamed, David Weatherall Chair of Medicine, University of Liverpool	
**	Professor Dame Linda Partridge CBE, Managing Director, Max Planck Institute for Biology of Ageing, and Institute of Healthy Ageing, UCL	
*	Professor Miles Witham, Institute of Neuroscience, Newcastle University	

**	Professor Lynne Cox, Department of Biochemistry, University of Oxford	QQ 43–50
*	Professor Jesus Gil, Professor of Cell Proliferation, Imperial College London and group leader at the MRC London Institute of Medical Sciences	
**	Professor Arne Akbar, President, British Society for Immunology	
*	Dr Marina Ezcurra, Lecturer in Molecular Biosciences, University of Kent	QQ 51–57
**	Professor Kay-Tee Khaw, Professor of Clinical Gerontology, University of Cambridge	
*	Professor John Mathers, Professor of Human Nutrition, University of Newcastle	
*	Professor Paul Greenhaff, Professor of Muscle Metabolism, University of Nottingham	QQ 58–64
*	Professor Alun Hughes, Professor of Cardiovascular Physiology and Pharmacology, UCL	
**	Dr Samuel Nyman, Interim Deputy Head for Research, Department of Medical Science and Public Health, Bournemouth University	
**	Elaine Rashbrook, Consultant Specialist, Life Course, Public Health England (PHE)	QQ 65–71
**	Dr Alison Giles, Associate Director for Healthy Ageing, Centre for Ageing Better	
**	Councillor Ian Hudspeth, Chair, Local Government Association's Community Wellbeing Board and Leader of Oxfordshire County Council	
*	Professor Maggie Rae, President, Faculty of Public Health	QQ 72–78
**	Ruthe Isden, Head of Health Influencing, Age UK	
**	David Sinclair, Director, International Longevity Centre	
*	Stuart Butterfield, Managing Director, Canary Care	QQ 79–94
*	Professor Praminda Caleb-Solly, Professor of Assistive Robotics and Intelligent Health Technologies, University of the West of England (UWE)	
**	Sarah Weir OBE, Chief Executive, Design Council	
**	Professor Ann Blandford, Professor of Human-Computer Interaction, UCL	QQ 95–106
*	Professor Esther Rodriguez Villegas, Professor in Low Power Electronics, Imperial College London	
*	Professor Ferdinando Rodriguez y Baena, Professor of Medical Robotics, Imperial College London	

**	Dr Ewa Truchanowicz, Managing Director, Dignio Ltd	
*	Professor Barbara Sahakian, Professor of Clinical Neuropsychology, University of Cambridge	QQ 107–123
*	Professor Russell Foster, Professor of Circadian Neuroscience, University of Oxford	
*	Dr Sana Suri, Alzheimer's Society Research Fellow, University of Oxford	
*	Professor Jane Raymond, Professor of Visual Cognition, University of Birmingham	
*	Catherine McClen, Founder and CEO, BuddyHub	QQ 124–130
**	Sinead Mac Manus, Senior Programme Manager, Digital Health, Nesta	
**	Simon Ommundsen, Head of User Experience, No Isolation	
*	Dr Chris Blackmore, Lecturer in Mental Health, University of Sheffield	
*	Dame Fiona Caldicott, National Data Guardian for Health and Social Care in England	QQ 131–138
**	Chris Roebuck, Chief Statistician, NHS Digital	
**	Dr Jem Rashbass, Executive Director of Master Registries and Data, NHS Digital	
*	Matthew Gould CMG MBE, CEO, NHSX	
*	Charles Lowe, CEO, Digital Health and Care Alliance (DHACA)	QQ 139–146
**	Professor Julian Peto, Professor of Epidemiology, London School of Hygiene and Tropical Medicine	
*	Dr Paola Zaninotto, Associate Professor in Medical Statistics, UCL	
**	Dr Jeni Tennison, CEO, Open Data Institute	
**	George MacGinnis, Challenge Director, Healthy Ageing, UK Research and Innovation (UKRI)	QQ 147–158
**	Professor Judith Phillips OBE, Industrial Strategy Challenge Fund (ISCF) Research Director, Healthy Ageing Challenge, UKRI; and Professor of Gerontology and Deputy Principal (Research), University of Stirling	
**	Rosamond Roughton, Director for Care and Transformation, Department of Health and Social Care (DHSC)	
**	Professor Mariana Mazzucato, Professor in the Economics of Innovation and Public Value, Founding Director, UCL Institute for Innovation and Public Purpose, UCL	QQ 159–169

**	Dr Anna Dixon, Chief Executive, Centre for Ageing Better	
*	Ami Shpiro, Founder, Innovation Warehouse	
*	Luella Trickett, Director of Value and Access, Association of British HealthTech Industries (ABHI)	
*	Professor Fiona Watt, Executive Chair, Medical Research Council	QQ 170–180
**	Dr Alison Cave, Challenge Director, Data to Early Diagnosis and Precision Medicine Challenge, UKRI	
**	Tamsin Berry, Director, Office for Life Sciences	
**	Dr Louise Wood CBE, Director of Science, Research and Evidence, Department of Health and Social Care, and Co-lead of NIHR	
**	Dr Fiona Marshall, Fellow, Academy of Medical Sciences, and VP Head of Neuroscience and Head of UK Discovery Research, MSD	QQ 181–187
*	Jim Mellon, Co-Founder and Chairman, Juvenescence	
*	Dr Sheuli Porkess, Executive Director, Research, Medical and Innovation, Association of the British Pharmaceutical Industry (ABPI)	
**	Dr Lauren Walker, Chair of StR Committee, British Pharmacological Society, and Academic Clinical Lecturer in Clinical Pharmacology and Therapeutics, University of Liverpool	
*	Professor Sir Michael Marmot, Director, UCL Institute of Health Equity	QQ 188–198

Alphabetical list of witnesses

**	Academy of Medical Sciences (QQ 181–187)	INQ0078
	Action on Hearing Loss	INQ0013
**	Age UK (QQ 72–78)	INQ0077
	Agile Ageing Agency	INQ0052
	Aging Analytics Agency	INQ0043
	Alzheimers Research UK	INQ0092
	Professor Katherine Appleton	INQ0035
	ARCO (Associated Retirement Community Operators)	INQ0085
*	Association of British HealthTech Industries (ABHI) (QQ 159–169)	
*	Association of the British Pharmaceutical Industry (ABPI) (QQ 181–187)	
	Babraham Institute	INQ0070

*	Dr Jordana Bell, Head of Epigenomics Research Group, King's College London (QQ 22–27)	
	Birmingham Health Partners (BHP) (University of Birmingham College of Medical and Dental Sciences)	INQ0051
*	Dr Chris Blackmore, Lecturer in Mental Health, University of Sheffield (QQ 124–130)	
**	Professor Ann Blandford, Professor of Human-Computer Interaction, UCL (QQ 95–106)	INQ0086
	British Academy	INQ0024
	British Dietetic Association (BDA)	INQ0080
	British Geriatrics Society	INQ0101
	British Geriatrics Society and Royal College of Physicians	INQ0049
**	British Pharmacological Society (BPS) (QQ 181–187)	INQ0031
**	British Society for Immunology (BSI) (QQ 43–50)	INQ0057
	Buddi	INQ0084
*	Dame Fiona Caldicott, National Data Guardian for Health and Social Care in England (QQ 131–138)	
*	Professor Praminda Caleb-Solly, Professor of Assistive Robotics and Intelligent Health Technologies, University of the West of England (UWE) (QQ 79–94)	
*	Canary Care (QQ 79–94)	
	Professor Roxana Carare, Lead for Interdisciplinary Ageing and Dementia Centre (IDEAC), University of Southampton	INQ0083
	Sarah Cartmell, University of Manchester	INQ0054
**	Centre for Ageing Better (QQ 65–71) (QQ 159–169)	INQ0016
		INQ0088
		INQ0099
	Centre for Applied Dementia Research, University of Bradford	INQ0038
	Centre for Assistive Technology and Connected Healthcare, University of Sheffield	INQ0026
	Centre for Research in Public Health and Community Care, University of Hertfordshire	INQ0059
	The Challenge	INQ0073
	Christians on Ageing	INQ0015
	Professor Simon Conroy	INQ0003
**	Professor Lynne Cox, Department of Biochemistry, University of Oxford (QQ 43–50)	INQ0034
	Mrs Sheila Darzi	INQ0018

	Dementia Services Development Centre (DSDC), University of Stirling	INQ0047
	Department of Health and Social Care (DHSC)	INQ0103
**	Design Council (QQ 79–94)	INQ0062
*	Digital Health and Care Alliance (DHACA) (QQ 139–146)	
**	Dignio Ltd (QQ 95–106)	INQ0060
	Dr Adam Dobson	INQ0069
	Evergreen Life	INQ0006
*	Dr Marina Ezcurra, Lecturer in Molecular Biosciences, University of Kent (QQ 51–57)	
	Faculty of Pharmaceutical Medicine	INQ0040
*	Faculty of Public Health (QQ 72–78)	
*	Professor Richard Faragher, Professor of Biogerontology, Brighton University (QQ 22–27)	
	Dr Michael Fossel MD, PhD	INQ0009
*	Professor Russell Foster, Professor of Circadian Neuroscience, University of Oxford (QQ 107–123)	
*	Professor Jesus Gil, Professor of Cell Proliferation, Imperial College London and group leader at the MRC London Institute of Medical Sciences (QQ 43–50)	
	Professor Peter Gore	INQ0063
*	Professor Paul Greenhaff, Professor of Muscle Metabolism, University of Nottingham (QQ 58–64)	
	Healthy Ageing Research Group, University of Manchester	INQ0072
	Dr Vanessa Heaslip and Professor Debbie Holley, Bournemouth University	INQ0045
	Hft and Tunstall Healthcare	INQ0036
**	HM Government (QQ 1–10) (QQ 65–71) (QQ 131–138) (QQ 147–158) (QQ 170–180)	INQ0023
	Professor Debbie Holley and Dr Vanessa Heaslip, Bournemouth University	INQ0045
*	Professor Alun Hughes, Professor of Cardiovascular Physiology and Pharmacology, UCL (QQ 58–64)	
**	innovative Therapeutics for Ageing consortium (iTAC) (QQ 35–42)	INQ0042
*	Innovation Warehouse (QQ 159–169)	
	Institute of Health and Research Innovation, University of the Highlands and Islands	INQ0028
	Institute of Public Health in Ireland	INQ0048

**	International Longevity Centre UK (ILC) (QQ 72–78)	INQ0079
	Dr Zhenbao Jin	INQ0044
*	Juvenescence (QQ 181–187)	
	Dr Maggie Keeble, Co-Founder of GeriGPs Group, British Geriatric Society	INQ0100
*	Professor Graham Kemp, Professor of Metabolic and Physiological Imaging, Liverpool University (QQ 28–34)	
**	Prof Kay-Tee Khaw (QQ 51–57)	INQ0082
	Mrs Elizabeth Legge	INQ0075
	Lifelong Health Research Theme, University of Surrey	INQ0017
**	Local Government Association (QQ 65–71)	INQ0087
	Mr Richard Lock	INQ0014
	Manchester Institute for Collaborative Research on Ageing (MICRA)	INQ0033
*	Dr Riccardo Marioni, Centre for Genomic and Experimental Medicine, Edinburgh University (QQ 28–34)	
*	Professor Sir Michael Marmot, Director, UCL Institute of Health Equity (QQ 188–198)	
	Dr Hannah Marston and Dr Charles Musselwhite	INQ0010
**	Professor Mariana Mazzucato (QQ 159–169)	INQ0097
*	Professor John Mathers, Professor of Human Nutrition, University of Newcastle (QQ 51–57)	
*	Catherine McClen, Founder and CEO, BuddyHub (QQ 124–130)	
	Helen McDowall	INQ0004
	medconfidential	INQ0098
**	Medical Research Council (MRC) Unit and Institute of Healthy Ageing (IHA), University College London (QQ 11–21) (QQ 35–42)	INQ0007
*	Medical Research Council (QQ 170–180)	
*	Professor David Melzer, Professor of Epidemiology and Public Health, Exeter University (QQ 22–27)	
	Professor Louise Moody	INQ0068
**	MSD (QQ 181–187)	INQ0055
	Muscle Health Public Involvement in Research	INQ0071
	Dr Charles Musselwhite and Dr Hannah Marston	INQ0010
*	National Institute for Health Research (NIHR) (QQ 170–180)	

	National Institute for Health Research (NIHR) Devices for Dignity (D4D) MIC	INQ0065
	National Physical Laboratory (NPL)	INQ0050
*	Professor James Nazroo, Professor of Sociology, University of Manchester (QQ 11–21)	
**	Nesta (QQ 124–130)	INQ0076
	Newcastle University Institute for Ageing	INQ0025
**	NHS Digital (QQ 131–138)	INQ0095
	NHS England and NHS Improvement	INQ0102
**	NHSX (QQ 131–138)	
**	No Isolation (QQ 124–130)	INQ0039
	Northern Health Science Alliance (NHSA)	INQ0053
**	Dr Samuel Nyman, Interim Deputy Head for Research, Department of Medical Science and Public Health, Bournemouth University (QQ 58–64)	INQ0030
**	Office for Life Sciences (QQ 170–180)	
**	Open Data Institute (QQ 139–146)	INQ0093
	Open University	INQ0061
	Oxford Brookes University	INQ0041
**	Professor Julian Peto, Professor of Epidemiology, London School of Hygiene and Tropical Medicine (QQ 139–146)	INQ0090 INQ0096
	The Physiological Society	INQ0066
*	Professor Sir Munir Pirmohamed, David Weatherall Chair of Medicine, University of Liverpool (QQ 35–42)	
	Positive Ageing Institute, Anglia Ruskin University	INQ0020
**	Public Health England (QQ 65–71)	INQ0091
*	Professor Jane Raymond, Professor of Visual Cognition, University of Birmingham (QQ 107–123)	
*	Dr Stuart Ritchie, Lecturer in the Social, Genetic and Developmental Psychiatry Centre, King's College London (QQ 11–21)	
	Professor Helen Roche, University College Dublin and Queen's University Belfast	INQ0008
*	Professor Esther Rodriguez Villegas, Professor in Low Power Electronics, Imperial College London (QQ 95–106)	
*	Professor Ferdinando Rodriguez y Baena, Professor of Medical Robotics, Imperial College London (QQ 95–106)	

	Royal College of Physicians and British Geriatrics Society	INQ0049
*	Professor Barbara Sahakian, Professor of Clinical Neuropsychology, University of Cambridge (QQ 107–123)	
**	Professor Avan Aihie Sayer, Professor of Geriatric Medicine, Newcastle University (QQ 22–27)	INQ0019
	Self-Care Academic Research Unit (SCARU), Imperial College London	INQ0037
	Society for Applied Microbiology	INQ0029
	Dr Andrew Steele	INQ0067
	Professor Claire Stewart	INQ0046
	Studio Meineck Ltd	INQ0021
*	Dr Sana Suri, Alzheimer's Society Research Fellow, University of Oxford (QQ 107–123)	
	Third Age Trust	INQ0064
	Professor Anthea Tinker, King's College London	INQ0012
**	UK Research and Innovation (UKRI) (QQ 147–158) (QQ 170–180)	INQ0032 INQ0094
	University College London (UCL)	INQ0027
	University of Birmingham MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research	INQ0056
	University of Glasgow College of Medical Veterinary and Life Sciences	INQ0058
	WaveLength	INQ0089
**	Professor Chris Whitty, Chief Scientific Adviser, Department of Health and Social Care (DHSC) (QQ 1–10)	INQ0081
*	Professor Miles Witham, Institute of Neuroscience, Newcastle University (QQ 35–42)	
*	Dr Paola Zaninotto, Associate Professor in Medical Statistics, UCL (QQ 139–146)	

List of seminars

The Committee held a series of seminars in preparation for the inquiry, in private at the House of Lords.

On 2 July 2019, the Committee held a seminar with:

- Professor Chris Todd, Director of the National Institute for Health Research (NIHR) Older People and Frailty Policy Research Unit, University of Manchester;
- David Wood, Chair, London Futurists, and Principal, Delta Wisdom; and
- Stuart Butterfield, CEO, Canary Care.

On 2 July 2019, the Committee also held a seminar with:

- Baroness Bakewell; and
- Sue Armstrong, author of *Borrowed Time*.

On 4 July 2019, the Committee held a seminar with:

- Sir Michael Ferguson CBE, FRS, FRSE, Regius Professor of Life Sciences at the University of Dundee, and Wellcome Trust Board of Governors;
- Professor Peter Clegg, Dean, Institute of Ageing and Chronic Disease, University of Liverpool; and
- Professor Janet Lord, Director of the Institute of Inflammation and Ageing Director of the MRC-Arthritis Research UK Centre for Musculoskeletal Ageing Research, University of Birmingham.

On 9 July 2019, the Committee held a seminar with:

- Sinead Mac Manus, Senior Programme Manager, Digital Health, Nesta; and
- Baroness Greengross OBE.

On 9 July, the Committee also held a discussion with six members of the public who gave their perspectives on the topic of healthy and independent living in old age.

APPENDIX 3: CALL FOR EVIDENCE

The House of Lords Science and Technology Select Committee, under the Chairmanship of Lord Patel, is conducting an inquiry into *Ageing*. The Committee invites interested individuals and organisations to submit evidence to this inquiry. The deadline for receiving written submissions is Friday 20 September 2019.

When preparing your response, please bear in mind that short, concise submissions are preferred and *responses must not be any longer than six sides of A4*–bullet points are acceptable. We do not expect you to address every question below. Equally, if there are any crucial issues not captured by the questions we pose, please highlight what they are and explain their salience.

How to submit evidence is set out in Annex 1 but if you have any questions or require any adjustments to enable you to respond, please contact the staff of the Committee on the details provided. The deadline for receiving written submissions is Friday 20 September 2019.

Public hearings will be held Autumn 2019. The Committee aims to report to the House, with recommendations in spring 2020. The report will receive a response from the Government, and may be debated in the House.

Context and scope

Life span has increased over recent decades, but health span, the period of time people live in good health, has generally not kept pace, and so older people are living longer with ill health. This increased duration of ill health, both physical and psychological, and often compounded by loneliness, can be challenging and unpleasant for individuals. The increasing number of people affected is also placing pressure on health services and social care, threatening to overwhelm the funding mechanisms, and failing those in need. Increasing health span would mean that people could live independently for longer, with better health and wellbeing, and would reduce pressure on services and finances.

Increasing health span has been adopted as a policy objective by the UK Government. "Ageing Society" is one of the Government's Industrial Strategy's four Grand Challenges, and the stated mission is to "Ensure that people can enjoy at least five extra healthy, independent years of life by 2035, while narrowing the gap between the experience of the richest and poorest".

This inquiry will seek to determine whether the Government's ambition to increase health span is achievable in principle, and which approaches may be most successful in practice. It will also look at the ways in which science and technology can be used to mitigate some of the effects of ill health in old age, and to support older people living with poor health.

We are seeking written evidence from a broad range of people and organisations with experience and expertise relating to ageing. These may include:

- older people and those who provide care and services;
- organisations and charities who provide support and services for older people;
- developers of technologies and infrastructure to assist with maintaining health and/or independence in old age, and those who deploy them in homes and communities;
- scientists researching the causes of ageing and potential treatments; and

- policy makers, campaigners and funders.

Several policy areas related to ageing are devolved to Northern Ireland, Wales and Scotland. We would be interested to hear about any differences in approach across the devolved nations, and we would hope that our inquiry's conclusions and recommendations would be of interest to the devolved governments.

The issue of funding the cost of social care is significant, but we will not be considering it in this inquiry because it has been recently considered by the House of Lords Economic Affairs Committee and others.

We seek evidence about the following topics (specific questions are listed further below):

- the scientific understanding of the ageing process, and how these areas of research could lead to treatments for delaying or managing the negative effects of ageing;
- technologies that can improve health and wellbeing in old age, and technologies that can enable independent living in old age;
- opportunities for the UK to commercialise discoveries and innovations relating to healthier ageing; and
- the policy implications of a healthier older population.

Questions

Scientific basis

1. How complete is the scientific understanding of the biological processes of ageing and their epidemiologies (including the relative roles of genetics, epigenetics, lifestyle, environment, etc.)?
2. How firm is the scientific basis for public health advice about healthy lifestyles as a way to increase health span, including physical health and mental health?
   (a) What are the practical impediments for this advice being acted on?
   (b) Are there examples of good practice in the UK/devolved nations, or elsewhere?
3. Which developments in biomedical science are anticipated in the coming years, in time to contribute to the Government's aim of five more years of healthy and independent life by 2035? Research areas may include:
   - Treatments based on new approaches e.g. senolytics, epigenetic therapy
   - Drug repositioning
   - Treatment of co-morbidities and polypharmacy
   - Diagnostics, particularly early diagnostics for ageing-related diseases
   - Biomarkers for diagnostics and for monitoring effectiveness of treatments
   - Personalised medicine for ageing-related diseases and multi-morbidities

4. How complete is the understanding of behavioural determinants and social determinants of health in old age, and of demographic differences?

Technologies

5. What technologies will be needed to facilitate treatments for ageing and ageing-related diseases, and what is their current state of readiness? For example:

    - Drug delivery devices, for existing or future treatments
    - Technologies for monitoring conditions and providing personalised medical advice
    - Technologies for monitoring healthy living e.g. fitness, diet, etc.

6. What technologies will be needed to help people to live independently for longer, with better health and wellbeing? What is the current state of readiness of these technologies, and what should be done to help older people to engage with them? For example:

    - Digital communications for services, social interactions, etc.
    - Devices, machines, etc. for daily living in the home
    - Transport, infrastructure, services, etc. for involvement in community
    - Accessible public spaces
    - Smart homes

7. How can technology be used to improve mental health and reduce loneliness for older people?

8. What are the barriers to the development and implementation of these various technologies (considered in questions 5-7)?

    (a) What is needed to help overcome these barriers?

    (b) To what extent do socio-economic factors affect access to, and acceptance of, scientific advice and use of technology by older people and those who care for them?

Industrial strategy

9. What opportunities are there for industry in the development of new technologies to help increase health span? In which areas of medical research and technology development does the UK excel?

10. What more is required for the UK to benefit from commercialisation of its discoveries and inventions relating to healthy ageing, as envisioned by the Government's Industrial Strategy?

Healthier ageing

11. How feasible is the Government's aim to provide five more years of health and independence in old age by 2035?

    (a) What strategies will be needed to achieve the Government's aim?

(b) What policies would be required, and what are their potential costs and benefits?

(c) Which organisations need to be involved?

(d) Who should lead the work?

12. To what extent are inequalities in healthy ageing, as well as differences in acceptance of technologies, a barrier to achieving the aims of the Government's Ageing Society Grand Challenge?

(a) To what extent could achieving the Government's aim of five more years of healthy and independent life exacerbate, or reduce, these inequalities?

13. What would be the implications of a paradigm shift to people leading healthier lives for longer, and spending less time suffering ill health? For example:

- Economic impacts
- Time spent in work as opposed to in retirement
- Provision of activities and services for active older people

25 July 2019