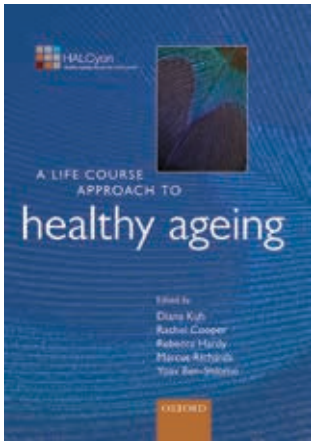
HALCyon
Healthy Ageing across the Life Course

A LIFE COURSE APPROACH TO HEALTHY AGEING

How to keep moving, keep thinking, and keep your spirits up



This brochure has been written to accompany the book
A Life Course Approach to Healthy Ageing.
Life course studies follow groups of people over time in an attempt to understand how we age. This brochure provides a snapshot of what they have found. If you're interested in how to keep moving, keep thinking, and keep your spirits up – all your life – please read on.

Further reading

Kuh D, Cooper R, Hardy R, Richards M, Ben-Shlomo Y (editors).
A Life Course Approach to Healthy Ageing. Oxford University Press, 2014.
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nda PROGRAMME new dynamics of ageing a cross-council research programme

MRC Medical Research Council

ageUK

UCL

Contents

Healthy ageing

Across much of the world, people are living longer. Life expectancy is rising at the rate of around 2 years per decade, an amazing five hours each day. By 2050, two billion people across the world will be aged 60 plus. It's a story that reflects massive improvements in education, medical science and public health. But it presents us with a conundrum. Who wants a longer life if our later years are beset with ill health?

Healthy ageing is a challenge. If we can identify the factors that influence ageing, we can begin to change them. We can start to identify those at risk of poor health, and design interventions to help them, boosting our chances of longer, healthier lives. It's happening already.

Life course studies, where groups of people are studied across their lives, are offering us valuable information about the way we age, and in the process, are redefining the way we think about ageing: The way we age is not set in stone. We're not all destined to frailty and ill health. Some of the factors that influence the way we age are things that we can control ourselves, such as diet and exercise. By changing our lifestyle, we can positively influence the way that we age.

Life course studies also show us that ageing is not something that happens when we hit retirement. It happens through life, from our very first moment in our mother's womb, to our very last breath. Many of the factors that influence it act across life. Some, like what you eat as a child, can influence your health many decades later. So whatever your age, it's never too late to do something to promote good health in later life.

This brochure, based on the book "A Life Course Approach to Healthy Ageing" seeks to capture the essence of life course studies – what they are and what they've taught us. If you'd like to find out what you can do to improve your chances of ageing healthily, please read on.

Healthy ageing is about more than dodging disease and avoiding frailty. It's about how we feel and how we function, physically and mentally, throughout our lives. It's about being able to carry out tasks of everyday living, and enjoying a purposeful and fulfilling life. In short, it's about **keeping moving, keeping thinking** and **keeping your spirits up.**

Life course studies

What are life course studies?

Life course studies follow groups of people through their lives to see how they change over time. Measurements and information about anything from health to wealth, habits to happiness, are recorded at regular intervals. Researchers can then use this information to help them understand ageing and guide the development of new therapies and interventions.

There are different types of life course study. Some, like the Medical Research Council (MRC) National Survey of Health and Development (NSHD) study groups of people all born at the same time from birth right through their lives, whilst others, such as the English Longitudinal Study of Ageing (ELSA), follow participants of different ages, from mid-adulthood into old age. Some use historical records to retrospectively fill in early life information, whilst others gather all their information prospectively. Some studies have finished collecting data. Many are ongoing.

Getting the measure of ageing

Ageing involves changes in how we feel and function, physically and mentally, through life. The book, and a growing number of life course studies, seeks to capture the essence of healthy ageing by focussing on measures of physical and cognitive capability, and also wellbeing.

Physical capabilities can be measured in many different ways, for example, by assessing grip strength, the time it takes to stand from sitting, walking speed and balance. Cognitive capabilities are measured using tests of reasoning, memory and other mental processes, whilst life satisfaction and wellbeing are usually measured by questionnaire.

As we age the telomeres, the protective tips (red) at the end of our chromosomes (blue) erode.

Ageing is underpinned by biological change, within the cells, organs and systems that make up our bodies. So life course studies also record physiological information, such as blood pressure and lung function. New technologies are increasingly being used. Innovative scanning techniques, for example, enable researchers to look simultaneously at the internal structure of bone and muscle, whilst molecular methods let us peer inside the cell.

Crucially life course studies also record detailed information about people's life stories – where they grew up, what their parents were like, their relationships, diet, alcohol intake, exercise, employment history, stressful life events – as much information as possible of relevance to ageing. These measures are recorded through questionnaires, diaries, and interviews, with the latter offering thoughtful, qualitative insights that highlight the value of studying health in detail across life.

What causes ageing?

No one knows for sure, but an increasing body of evidence suggests that ageing is caused by a gradual build-up of damage to molecules, cells, organs and body systems. Telomeres, the protective caps at the ends of our packaged DNA, progressively erode over time. DNA becomes damaged, and cells become less able to repair this damage. Signalling systems, that use chemical molecules to communicate between different parts of the body, go off kilter. Organs function less well. The process can however be slowed by making lifestyle choices that positively influence ageing.

Life course studies

Why are life course studies so important?

Life course studies are helping us to understand what ageing is, how it works and how to influence it. By following people as their lives unfold, they reveal things no other studies can. They've shown, for example how babies of higher birth weight have stronger muscles throughout life. They can show how things change from one era to the next. Life course studies can help identify positive factors, such as a nutritious diet and exercise that contribute to healthy ageing. Life course studies can help identify early markers of healthy ageing; measurements that help predict those most likely to age well later on. The flip side is they also highlight risk factors that negatively influence ageing and early makers of unhealthy ageing, which could be used to predict those likely to age less well.

Life course studies can also help us decide when, as well as how to intervene, to influence ageing. They've shown that sometimes the cumulative effects of an unhealthy lifestyle or environment can build up over the years until they reach a tipping point when people present to the doctor with disease or disabilities. But they show also that there are times in our lives when we are particularly susceptible to the effects of these age-influencing factors – when their effects may be greater or longer lasting. The idea builds on the influential work of British researcher, Professor David Barker, who noted that low birth weight babies were more likely to develop heart disease as adults, and proposed that certain adult diseases might have their origins in the womb. The hypothesis, which acted as a catalyst for life course studies, has since been extended to incorporate other time windows and health outcomes. Adolescence, for example, is a sensitive period for bone development. Life course studies, based on the premise that early life interventions can have long lasting effects, can help to identify, monitor and influence these sensitive periods and subsequent health.

The power of life course studies comes in their sheer scale and depth of data. Hundreds of thousands of participants have contributed to life course studies across the globe. Many of the studies are described in the book. Altogether, the information provides a valuable resource that can be used to guide personal choice, and help health professionals and policy makers devise interventions to improve quality of life.

Life course studies tell us that early life matters – a lot.

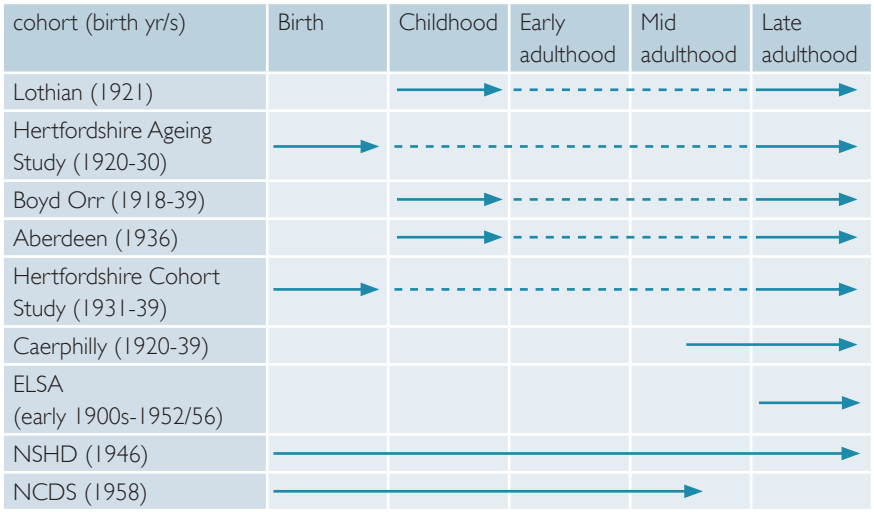
"I have enjoyed the participation, the regular birthday cards, and the feeling of doing something different and special to help the community."

Healthy Ageing across the Life Course study (HALCyon)

Whilst most life course studies focus on factors linked to age-related disease and ill health, a research programme called HALCyon seeks to use life course studies to understand healthy ageing across the life course. This programme, which began in 2008, includes data from 30,000 participants, all born between 1918 and 1958, who were 50 years or older at the start of the programme. HALCyon's power comes from the fact that the researchers pool data from 9 or more different life course studies, making its findings more robust and reliable (see figure). HALCyon includes a rich biosocial archive of data from childhood and adulthood. Key findings to date include the influence of childhood socioeconomic position and body weight on later adult health.

The Halcyon is a fabled bird akin to the kingfisher, that calmed the winds and the waves during the winter solstice as it nested on the sea. 'Halcyon days' refer to a period of peace and prosperity.

Original HALCyon cohorts



+ other cohorts now joined: Whitehall II, LASA

English Longitudinal Study of Ageing (ELSA), National Survey of Health and Development (NSHD)
National Child Development Study (NCDS), Longitudinal Ageing Study of Amsterdam (LASA)

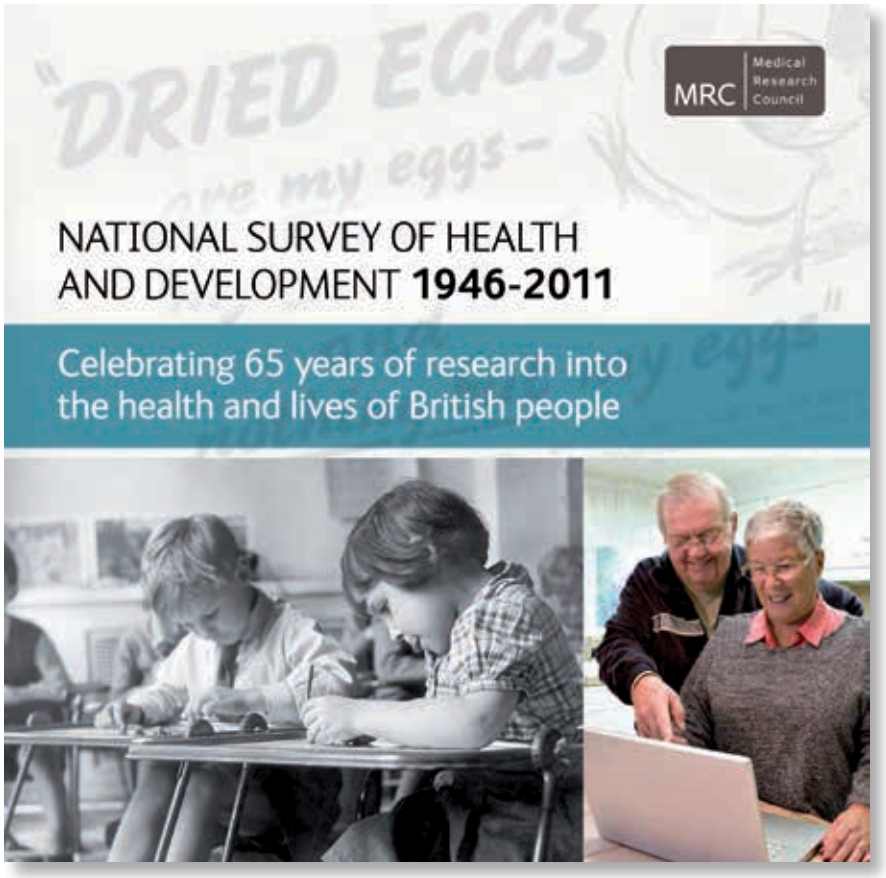
Life course studies

"I've always been very proud to belong to the study."

Images from the Hertfordshire Cohort Study and the Lothian Birth Cohort Study.

The MRC National Survey of Health and Development

The MRC National Survey of Health and Development is the longest continuously running life course study. It has followed the progress of over 5000 participants from their birth, in March 1946, to present day. As study members head towards 70, it now provides an ideal opportunity to see how factors throughout life have contributed to their health in old age. So far, the study has yielded around 700 scientific papers. It has stressed the power of lifetime socioeconomic conditions to influence health, and shown how childhood health and the environment we grow up in can influence physical and cognitive capabilities and many other aspects of adult health decades later.



"I remember as a child being taken out of class at school to do tests, then being given a sticky bun and a glass of milk, which always made me feel more important than anyone else."

"When the medical tests came they were like human MOTs!"

What have we learned from life course studies?

Life course studies reveal that we all age differently. Biologically, we're different. We're born into, grow and live in diverse physical and social environments. It all contributes to the way we age. People may live similar lives yet age differently, or live different lives but end up with similar levels of health. Only life course studies can capture and unravel this complexity. At present our knowledge of these different pathways raises more questions than it answers, but research strongly suggests that the way we age is not predestined. You can influence the way you age.

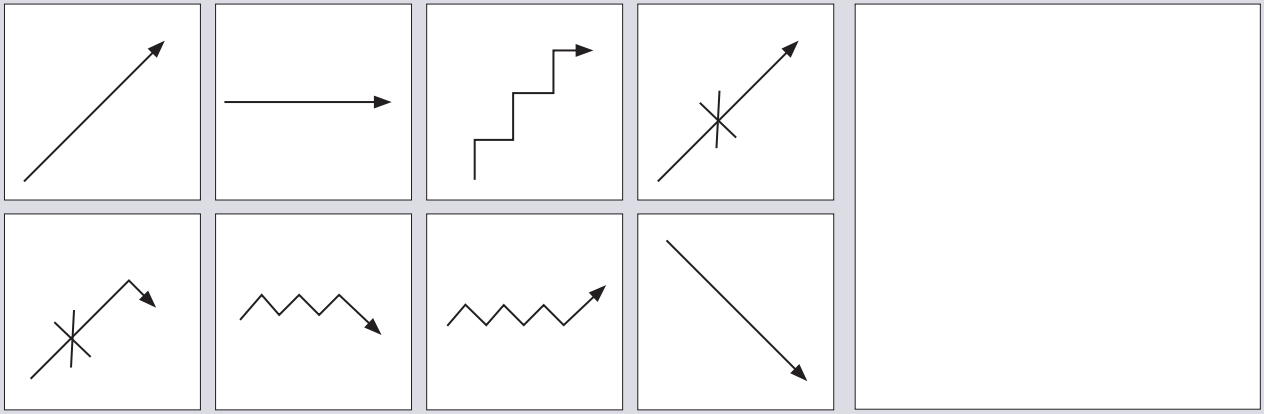
Changes in how we function and feel

Ageing happens from birth. Overall, it's a familiar picture. Physical development starts with an intense period of growth, in the womb and through childhood which plateaus in early adulthood. Grip strength, an excellent measure of physical capability, increases through childhood, peaks in adulthood, then starts to decline in our 50s or 60s. Healthy ageing is about achieving the greatest level of physical capability possible, and maintaining it for as long as possible, to delay the onset and rate of functional decline. This means we are less likely to suffer ill health, and more likely to stay independent for longer. By the time we're in our 60s, most of us will have one or two common health problems, such as high blood pressure, diabetes or osteoporosis (thinning bones). But despite that, 60% of people in their 80s report being in good health and physically able to carry out the tasks of daily living.

"I've enjoyed the time since I retired probably even more than my working years. It's been such a delight to have time to do some of the things that you want to do."

Draw your own life story

If you had to depict your life up to now by means of a diagram, which of these diagrams would you choose? If none of these apply, draw a more representative pattern in the blank box.



Our cognitive capabilities – the way we reason, multi-task, learn and remember – develop throughout life, and are strongly influenced by our early years, home environment, educational and work life, and lifestyle choices. In later life, some but not all thinking skills start to decline. The ability to make new memories, think quickly and solve problems can become more difficult, whilst our vocabulary and general knowledge tend to hold up well; some cognitive skills, such as ability to see the gist of an argument, can even improve with age.

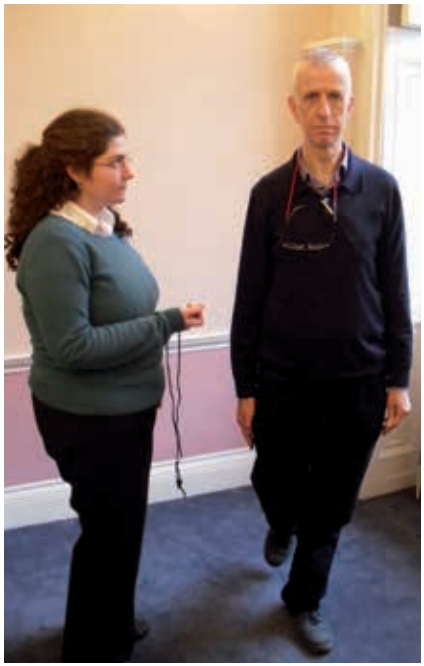
Wellbeing, considered a crucial part of healthy ageing, follows a different course again. Happiness and life satisfaction decline through adulthood to around age 50, then climb for the next few decades. This period of wellbeing often coincides with retirement, grandchildren, and having the time to take life easy, and often lasts long after ill health has begun to sneak in. Wellbeing in later life might even promote longevity and help protect against cognitive decline, life course studies suggest. Old age can be a positive and rewarding experience.

Life course participants are sometimes asked to draw their life story on a piece of paper. It helps researchers identify key events in their lives. What's your life story?

What have we learned from life course studies?

Indications of future ageing

Certain measurements can give an indication of how we might age in the future. These can be measures of organs or systems, such as lung function or the thickening of blood vessels. Or they can be changes at the level of cells and molecules. Simple objective tests of physical capability, for example, can give a hint of future health and lifespan; people with stronger muscles in adolescence, midlife or later life, are likely to live longer. Older people who score highly on measures of grip strength, chair rising, walking speed and balance, also subsequently experience higher levels of wellbeing and are less likely to experience ill health than people with lower scores. Even with the advent of sophisticated imaging and cellular techniques, it's often the simplest measurements, such as grip strength, that give the best yardstick of future ageing.



Change on the inside

As we age, changes in how we feel and how we function are underpinned by changes in our internal biology. Cells, such as neurons and muscle cells, organs, such as the heart and liver, and body systems, such as the cardiovascular and hormonal systems, also change with age. To understand the ageing process fully, researchers need to track and understand these changes.

The bone story

Our bones, and the muscles that support them, age through life. At present, in the UK, one in two women, and one in five men over 50 will suffer a fracture at some point. But it doesn't have to be this way. Using innovative scanning methods, life course studies have revealed how our bones and muscles change, and how their health in adulthood is influenced by early events.

Early life, in the womb and in childhood, is a sensitive period for our bones as they grow rapidly, but other time points are also important. Adolescents gain up to 40% of their total bone mass during puberty, making their bones temporarily fragile. By our early 30s the bone we have is the bone we have for life. So it's crucial we build up a reserve of strong healthy bone before then to weather the years of wear and tear that follow.

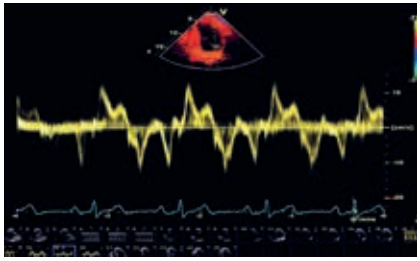
In adulthood, menopause is another sensitive time for women. Falling hormone levels trigger a rapid loss of bone mass and from then on they lose around 3-5% of their bone per year. In both men and women, fragile bones, weaker muscles and, cognitive decline all increase the risk of falls and fractures. This can reduce physical activity and independence, which in turn further weaken bone and muscle. Without intervention, the cycle continues. Life course studies offer the opportunity to study these changes and the factors that underpin them, offering pointers about the nature and timing of possible interventions.

What have we learned from life course studies?

The heart story

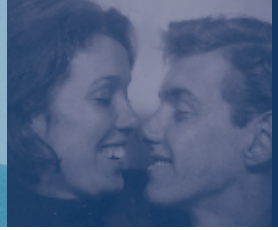
A healthy heart and a healthy metabolism (how the body converts food into energy) are essential for healthy ageing. Cardio-metabolic diseases, such as coronary heart disease, stroke and type 2 diabetes are still major causes of death and ill-health. Understanding how markers of cardio-metabolic function, such as blood pressure, lipids, glucose, and insulin, change across life, and the characteristics associated with typical and less typical changes, may allow us to prevent future disease.

For example, by combining information from life course studies, researchers have been able to track the lifetime blood pressure of large groups of people, revealing important health-relevant information. Blood pressure changes through life. It rises rapidly in childhood, levels off in early adulthood then increases again in midlife. This middle age rise has been observed in almost every population studied, but the extent of the rise varies considerably across populations. The discrepancy suggests that midlife high blood pressure is not inevitable, and that Western lifestyle factors, such as inactivity and obesity contribute to adult high blood pressure. This is good news because these are things that can be changed.

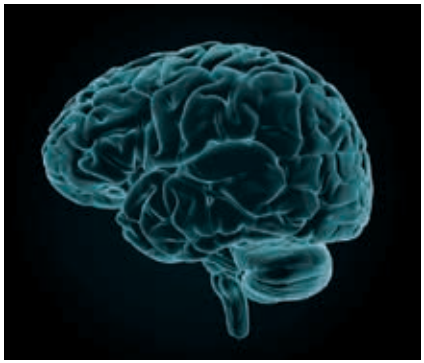


For a small group of people the trajectory of increasing blood pressure is particularly pronounced. A recent study of midlife adults highlighted a small subgroup whose rate of blood pressure increase was three to four times greater than the norm. These people were more likely to have grown less well and lived in poorer circumstances in childhood, and to have become obese earlier in adult life. They were also more prone to poorer heart function ten years later, indicating increased risk of heart disease.

It's possible that childhood blood pressure may contribute to later life heart disease, but studies have not yet followed people up for long enough to look at this. Instead some studies have focussed on interim



changes. For example, higher blood pressure in childhood has been shown to be related to a thicker inner lining of the carotid artery, which in turn increases the risk of heart disease. So using these life course trajectories of blood pressure and other cardio-metabolic risk factors, we may be able to identify those at risk at a much earlier stage in life.



The hormone story

Various hormones and the systems that control their release have been implicated in the ageing process. The neuroendocrine system, which connects the nervous system with hormone-secreting glands, is particularly interesting because it helps control the way we deal with stress. Acute stress, say public speaking, initiates a chain reaction that starts in the brain and culminates in the release of a hormone called cortisol that helps us cope with the situation – a normal and healthy response.

Chronic stress, such as that caused by poverty, extremely poor mother-child attachments or long term ill health, can skew the pattern of cortisol release. Abnormal cortisol patterns have been linked to various age-related disorders including osteoporosis and heart disease.

Life course studies suggest that stressful life experiences, at any time in life, can have long lasting effects on cortisol release years later and possible health repercussions. People who are old or who have suffered chronic stress, such as prolonged illness or disability, show less variation in daily cortisol levels and score worse on measures of physical and cognitive capability.

It's unclear how much of this stress-related damage can be undone, but there's evidence to suggest that behavioural and psychological interventions can sometimes help restore cortisol production to its normal levels. The value of knowing your cortisol level is yet to be proven, but life course studies suggest a possible positive role for the measurement – a means to highlight those suffering the effects of chronic stress in order that they can be helped.

Factors that influence healthy ageing

There are many varied factors that influence the way we age. They are described in detail in the book, but some of the most important ones are explained in this section. The factors operate at different levels, from the societal and individual, right down to the level of body systems, cells and molecules. None of them act in isolation, rather are influenced by and interact with each other. Ageing is a complex story, but life course studies are helping us to understand the factors that shape it, and the ways in which we might intervene.

Social and economic factors

It's an uncomfortable truth, but the way we age is influenced enormously by our social and economic circumstances. The most privileged among us can expect longer, healthier lives than those from more disadvantaged backgrounds. In the UK, the gap between the richest and poorest equates to a staggering extra 7 years of life and 17 years of health.

Life course studies document these inequalities, and show us that social and economic factors influence age from very early in life. Advantaged children grow into adults with access to more stimulating and well-paid jobs, healthier blood pressure, better physical and cognitive capabilities and higher levels of wellbeing than those from worse off homes. If your mother received a good education, you're more likely to be physically capable in midlife.

Where we live also has an effect. Children and adults who live in wealthier areas score better on tests of cognitive capability and on later life tests of physical capability, such as grip strength, chair rise time and balance.

Quite how socioeconomic circumstances influence the ageing process is unclear. It likely involves many factors including childhood infection, early life nutrition, environmental pollutants, lifestyles, psychological responses, and the development of chronic diseases. Socioeconomic effects build across life, with better or poorer circumstances at any point influencing the way we age.

Like it or not, the wealthiest are the healthiest.

Factors that influence healthy ageing

Social relationships

Friendships and social relationships are part of the fabric of life, but there's evidence to suggest they can positively influence the way you age. Rat studies have shown how maternal care early in life helps the offspring develop the requisite, perfectly-tailored hormonal system needed to deal with stress. Neglect, on the other hand, causes subtle changes to the genes that see 'unloved' offspring less able to deal with chronic stress when they are fully grown, itself a risk factor for later illness. Happily, some of the biological changes and related behaviours can be reversed by providing the neglected pup with the care and attention of a devoted rat foster mother.

There's a huge amount of evidence confirming the value of warm relationships and secure attachments in human childhood. Life course studies can help inform how best to intervene when help is needed. Many children in long-term foster care display an unusual response to stress in the form of altered patterns of stress hormone release. But behavioural interventions can help to redress these patterns, helping the children to cope with stress and hopefully boosting their chances of healthy ageing.

Relationships and social engagement continue to be of value throughout life, and are integral to our sense of wellbeing and happiness. Parenting styles influence wellbeing in later life. There is some evidence that children who experience good quality relationships with their siblings and parents are more likely to flourish psychologically in adulthood. Later in life, social relationships are equally important. Not having them is a major risk factor for ill health, on a par with the effects of smoking, inactivity and obesity. As well as influencing health and longevity, social relationships can also help maintain cognitive capabilities. People who are socially engaged are likely to have a slower rate of decline in perceptual speed, a lower risk of cognitive decline and are less likely to develop dementia.

Body weight and growth

Healthy ageing is influenced by the rate at which we grow. The advice from life course studies is don't be too fat or too thin, all through your life. Normal weight babies and children that grow at a healthy rate are more likely to age well. As adults, they score better on certain measures of physical and cognitive capability, such as grip strength and memory tests. They're less likely to develop high blood pressure or become obese. They have stronger muscle, healthier bones, and are less likely to suffer ill health including heart disease, diabetes and osteoporosis.

"Being in good health? It means everything. It means everything."

Weight, through life, is a delicate balance. Babies born very big or very little age less well. Low birth weight babies tend to have poorer physical and cognitive capabilities and more ill health in adulthood; whilst very high weight babies are at increased risk of some types of cancers. Being a little or very big baby increases the risk of type 2 diabetes. Before puberty, weight gain may be a good thing, after puberty it's more likely to cause health problems. In midlife, obesity is generally regarded as a risk factor for physical and cognitive problems, including heat disease and dementia; then in old age, it's unintentional weight loss rather than weight gain that's linked to poor health and frailty.

Don't be too fat or too thin – all through your life.

Factors that influence healthy ageing

Health histories

Our health histories, including our own past health and our family history, provide clues about our chances of maintaining physical and cognitive capabilities as we grow older. Timely and effective medical care and treatment of health problems, long-term health monitoring, and support to help people manage chronic conditions can help us to feel better and positively influence our quality of life. For example, keeping your blood pressure within the normal range increases the chance of healthy ageing. Exercise, cutting down on salt, losing weight and certain prescription medications are some of the strategies for controlling blood pressure.

Personality

Wellbeing, a sense of satisfaction and happiness with life, isn't just nice to experience it's good for you too. Happier people are less likely to die prematurely, and less likely to develop mobility problems and become frail in old age. But what drives our sense of wellbeing?

Personality is a strong influence. Itself determined by genes and the environment, personality tends to track through life. Personality in our teenage years strongly predicts wellbeing at age 60, with the most extrovert and emotionally stable of us feeling happiest in later life. Although wellbeing often persists long after ill health has set in, physical capabilities have been shown to influence happiness in older people. Staying physically able may help you keep your spirits up.

Lifestyle factors

Lifestyle factors, such as smoking, drinking, diet and exercise, all contribute to the ageing process. Smokers for example are more likely to experience cognitive problems and dementia in later life, or to develop cancer, cardiac and respiratory problems. We cannot change our birth weight, and may feel powerless to influence our social and economic position, but lifestyle factors are one thing that, with motivation, we can all change, and in the process, increase our chances of healthy ageing.

"I'm like everybody else. I should eat more healthily. I should take more exercise. I stopped smoking around 5 years ago. I should have stopped earlier."

Physical activity

Physical activity improves the quality and length of life. Physically active people have healthier hearts, stronger bone and muscle, and slower rates of physical and cognitive decline. They're also less likely to develop high blood pressure, coronary heart disease, stroke, type 2 diabetes and depression. The benefits also extend beyond physical health. Regular physical exercise has been linked to improved sleep, reduced stress, and better self-rated quality of life. In short, physical activity adds years to your life and life to your years.

Physical activity adds years to your life and life to your years.

Factors that influence healthy ageing

Couch potato or fitness fan?

What makes some people exercise addicts and others couch potatoes? Healthy birth weight babies grow into more active children than low birth weight ones. And active children tend to grow into active adults. But it's not cast in stone. Many different factors influence physical activity, including socioeconomic position, ill health, where you live, your upbringing, diet and job. Understanding how these factors interact to shape our activity preferences is important, as it will help to mould and drive effective health and policy interventions.

Diet

What we eat affects our health and wellbeing and the ageing process, but it is quite challenging for researchers to work out which nutrients and foods are linked to which particular ageing outcomes. This can result in inconsistent or contradictory messages. What we do know is this. In our early years, what we eat is mainly our parent's responsibility. This includes eating well during pregnancy, bestowing the benefits of breastfeeding, and providing a healthy diet through childhood. For example, folic acid is needed in pregnancy to reduce the risk of birth defects. What we feed our children, at home and at school, affects their physical capabilities and bone health, which then serves as a baseline to protect them against physical decline later on.

In adulthood, diet influences physical and cognitive capabilities. For example, exposure to nutrients that are important for cognitive capability, particularly the omega-3 fatty acids and B vitamins, can be optimised by choosing a diet rich in fresh fruit, fibre, fish and vegetables, and low in animal protein and saturated fats.

Did you know?...

- It's a racket: Professional tennis players who started training in childhood have around 30% more bone in their serving arm compared to their idle limb.
- Mental workout: Exercise triggers the production of new nerve cells in the brain, and so may help protect against cognitive decline in old age.
- The average 70 year old distance runner has the same level of cardiovascular fitness as a 45 year old.

As whole diets go, the Mediterranean diet, which combines many of these potentially protective elements, appears to promote healthy ageing. One study, of over a million people, found people who stuck tightly to the diet were less likely to develop cancer, Parkinson's and Alzheimer's disease, and less likely to die than those who followed it more loosely.

Life course studies show us that diet is influenced by a range of social and economic factors that influence the availability and popularity of particular foods. But one of the biggest influences on what we eat as adults is what we eat as children. It sets the stage for the way we eat and what we eat in later life, highlighting childhood as an important time when dietary interventions could have lifelong health effects.

"I watch my diet now more than I've done before. Crisps are a thing of the past!"

The Mediterranean diet has been linked to slowed rates of physical and cognitive decline.

Factors that influence healthy ageing

Genetics

We can't change the genes that we're born with. Genetic factors do influence the ageing process, but their effects are small in comparison to the role that environmental factors play. Twin studies, which enable researchers to tease out the relative importance of genetic and environmental factors, suggest that around a quarter of life expectancy, and a third of physical and cognitive capabilities can be ascribed to heritable factors – which means that the vast majority of age-related change is under our control.

There is no 'gene for ageing,' rather a collection of genetic variants that, on their own, have small effects on ageing, but which interact with each other to influence multiple biological pathways and in turn affect the way we function and feel during ageing. This may, in part explain why there are families whose members regularly survive to their 80s and 90s, and offer clues to the biological processes that underpin ageing.

Human life span is expanding. In the laboratory, researchers have dramatically extended the life spans of mice and worms by drastically slashing the amount of calories they eat. They then devised alternate methods, including genetic manipulation, to tweak the underlying biological pathways and achieve the same end. So it is, in theory, possible to extend life by altering gene function, at least in laboratory animals.

But whilst regenerative medicine and gene-based therapies offer hope of ameliorating disease and prolonging life, human therapies are still some way off. In the meantime, the modification of environmental factors, such as diet and exercise, is likely to offer a cheaper, more accessible and realistic way to influence the way we age.

Twin studies help researchers understand the influence of genetic and environmental factors on ageing.

Changes in gene activity

Although our genes stay the same throughout our lives, their levels of activity can change. Environmental factors such as pollution, lifestyle factors such as diet, supplement use, smoking and drinking, societal factors such as socioeconomic position and even age itself, all influence the activity of our genes, without ever changing the letters that make up our unique genetic codes.

Known as epigenetic factors, they exert their effects by altering the way the DNA is packaged and used. The best studied example is when tiny bundles of chemicals called methyl groups bind to DNA. Epigenetic marks determine where, when and how genes make their protein products, and ultimately this influences the ways cells, organs and the body function. Many epigenetic changes are 'remembered' when the cell divides, so can last for years. They could explain, for example, the time lag between exposure to risk factors, such as poor diet and smoking, and age-related outcomes, such as cancer.

Indeed, the persistence of epigenetic marks may offer an explanation for one of the central tenets of life course studies – that early life experiences can influence health and disease decades later. Even genetically identical twins have subtly different epigenetic marks at birth, likely caused by environmental differences experienced by the foetus in the womb, or even before implantation of the embryo. Factors such as poor maternal diet, or alcohol exposure in pregnancy, may also trigger epigenetic changes in the offspring in ways that have the potential to influence susceptibility to disease.

The good news is that some epigenetic marks may be reversible in later life. This field of research is still in its infancy but we already know that epigenetic states can be modified by environmental factors, such as diet and exercise. This means that simple interventions may have far reaching effects, right down to the molecular level.

What can we do?

It's never too late to do something to improve your chances of healthy ageing. Some changes, such as diet and exercise, are within our own reach. Whilst others, such as housing and health care, remain the focus of policy makers and healthcare professionals. Life course studies can help to frame the debate around healthy ageing, and inform these interventions, at the personal, social, and political level.

Listen to life stories

Life course studies demonstrate the value of people's life stories. Our unique autobiographies hold the key to understanding our present and future health and the way we age. Details matter. Socioeconomic circumstances, lifestyle factors and disability play a role, but so too do relationships, holidays and hobbies. Life course studies pay attention to detail through life, and in doing so, show us how these subtexts contribute to the bigger narrative. It's with a deep sense of privilege that life course researchers watch these stories unfold. People and their stories should be valued and treated with dignity.

Nowadays it is less likely that the same GP is able to provide continuity of care through life. Time constraints may restrict the consultation to 'one problem at a time' which can impede a holistic approach to health care. Health care has become fragmented, and somewhere along the way, the life story, with its vital reserves of information, is becoming lost. Today's health practitioners are privy but to a slice of our narrative, and make their decisions accordingly.

The best care will come from an integrated approach that bases its decisions on evidence collected prospectively across life. This requires health systems capable of regularly monitoring people over time. In the future, life course measures of healthy ageing, such as grip strength, chair rise time and cognitive tests could be used by GPs to identify those likely to experience ill health and age rapidly. Life course studies can be used to highlight the risk factors with the biggest impact on ageing – that affect the largest numbers of people, are most detrimental to health or that are getting worse – and used by decision makers to devise interventions that are targeted and timely.

This could lead to improved 'anticipatory care' where those flagged 'at risk' of later life ill health are helped long before symptoms set in. Relatively small, often low budget early life interventions have the potential to offset adverse ageing, reduce hospital admissions and cut healthcare costs later in life. But further research is needed to assess the validity of these potential markers in a clinical setting, and to make the leap from life course study findings to public policy.

Invest in early life

Early life lays the foundations for lifelong health. Life course studies consistently show how factors operating in early life – in the womb and through childhood – influence ageing all our lives. So investment in this time period can have positive long term effects.

'Investing' means caring for youngsters at the individual level, through our own actions, and at the societal level, through health care and policy. It includes a focus not just on children, but also on pregnant and breastfeeding women, who influence the health of their babies through their own lifestyle and behaviour.

As individuals, we need to take responsibility for the future health of our children by giving them the best possible start in life – helping them to form secure social attachments, encouraging them to eat well, exercise and adopt a healthy lifestyle. Many adult preferences, including those for diet and physical activity, are shaped in childhood and track through life. So good habits learned early in life contribute to healthy ageing in adulthood.

At the societal level, interventions made during this time period – to prevent injuries or reduce tobacco exposure for example – do change behaviour. There are good practice models for these early interventions that show improved social, educational and healthy outcomes decades later. These should be used by health professionals and policy makers to guide the development of new interventions.

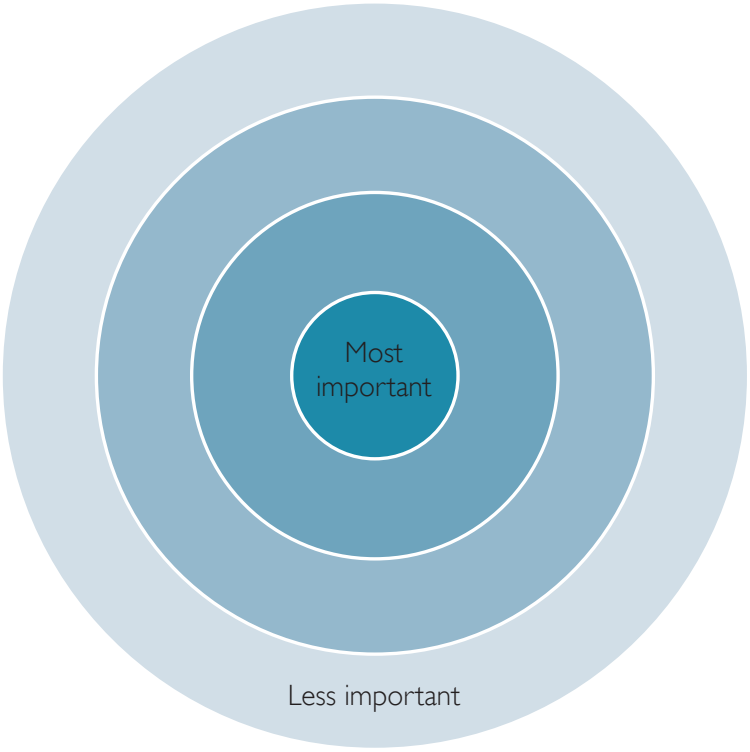
Investing in children is also about providing them with a good education. People with higher levels of education tend to have greater life opportunities, a richer mental life, and better physical health.

What can we do?

Care throughout life

Relationships change with age. To illustrate this, study members are sometimes asked to highlight how important key people in their lives are. 'Most important' is the bullseye, 'less important' is further out. Draw who's important in your life.

Who matters to you?



Early life is important, but so is care throughout life. Adolescence is a vulnerable period of social and biological transition, where non-family influences play an increasing role and bad habits, such as smoking and drinking, are often established. Life course studies have been used to inform the development of prevention policies and programmes, which have been shown to reduce adolescent behaviour problems.

There are also times in adulthood – becoming a parent, menopause or retirement – when interventions to promote health may have long term benefits for healthy ageing. But there is not much research in this area and more studies are needed to underpin future adult health prevention programmes and policies. In old age, interventions can still make a difference. Fitness training can boost cognition, wellbeing and physical capabilities. Multi-faceted interventions that include medical, behavioural and exercise modification can reduce the risk of falls.

Care is needed to recognise the changing needs of people throughout life. This includes an emphasis on the importance of friendship and social relationships, and their changing nature over time. We form different relationships with different people at different ages. Our sense of who is most important changes – from the parental adoration of early years to the grandchildren-focussed love of later life. But across the board, social engagement and caring relationships can improve wellbeing, and with wellbeing linked to lower mortality, that's no bad thing at all.

What can we do?

Tackle social inequalities

Policies are needed to redress social inequality, which is creating shorter, unhealthier lives. If everyone in the population enjoyed the same health as university graduates, up to 200,000 early deaths could be avoided, the influential 2010 Marmot report revealed. Doing nothing costs the economy around £33 billion in lost productivity per year. Life course studies can be used to understand the link between deprivation and ill health, and to inform and guide relevant social policy.

Seemingly small steps can have big effects on ageing. The way an area is designed – how close or connected it is to local amenities – can influence the activity of the children living there, which in turn can affect their physical capabilities in adulthood. The resources in an area – schools, libraries, community centres – can change the way children behave, influence their patterns of school attendance and educational achievement, which in turn can influence their lifestyle choices, and their chances of healthy ageing. It's a similar story for adults. The world we live in helps to shape our lifestyle choices and behaviours, which can then influence the way we age.

Life course studies have a respectable track record of influencing social policy. For example, the findings of the first national maternity survey in 1946 (from which NSHD participants were chosen for lifetime follow-up) reported that most women had no access to pain relief during childbirth. It caused an outcry and the study's first policy impact: a private member's bill in the House of Commons that changed regulations for administering anaesthesia. Today, life course studies continue to influence decision makers; for example, via the Marmot Review and the recent UK Foresight reports on obesity, mental capital and wellbeing.

Life course studies can aid the design and implementation of clinical trials and intervention strategies, but government bodies and research funders are concerned that the relevant findings are not reaching policy makers, practitioners or the general public. Work is needed to ensure that policy and practices are underpinned by evidence-based science, with life course studies providing a rigorous, insightful, high quality and relevant body of knowledge.

Take a long hard look at your lifestyle

Widespread change may be the remit of health care professionals and policy makers, but giving your lifestyle a makeover can improve your chances of healthy ageing. This is harder to do if life is tough, so support and encouragement from others is helpful. Life course studies provide pointers on how to keep moving, keep thinking and keep your spirits up. Here are a few of them:

- **Keep physically active** – If you're an adult aged between 18 and 64, 150 minutes of moderate-intensity aerobic exercise per week should do it, or shorter bursts of higher intensity exercise. If you're older, postural and resistive exercise, such as Tai Chi, may be more beneficial.

- **Eat healthily** – Avoid too much salt, sugar and foods rich in saturated fat. Eat plenty of fruit and vegetables. Oily fish is good for you. Some milk, dairy, meat and the odd glass of alcohol is ok. Government guidelines offer current thinking on the healthiest diet

- **Don't take unnecessary risks** – Smoking, for example, will take years off your life.

- **Enjoy the company of others** – This helps maintain cognitive capabilities in later life. Friendship and secure relationships are vital role throughout our lives.

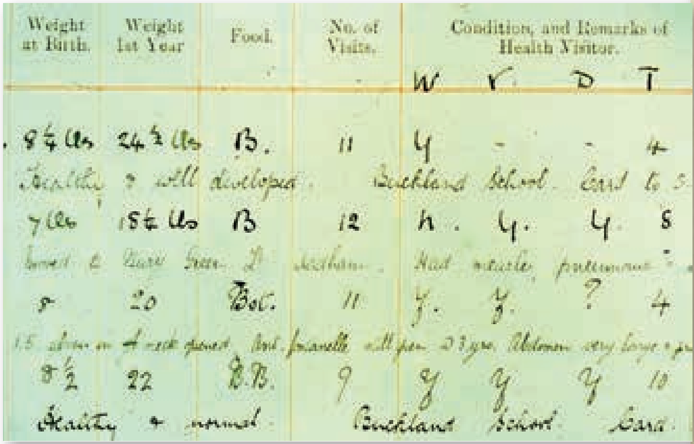
- **Stay engaged** – Find activities that interest you, give life meaning, and enhance wellbeing. People with greater wellbeing are likely to live longer than those who are less happy. Keep interested and stay involved in decisions about your own life.

No one's life story is quite like yours. Live it to the full.

The challenges of life course studies

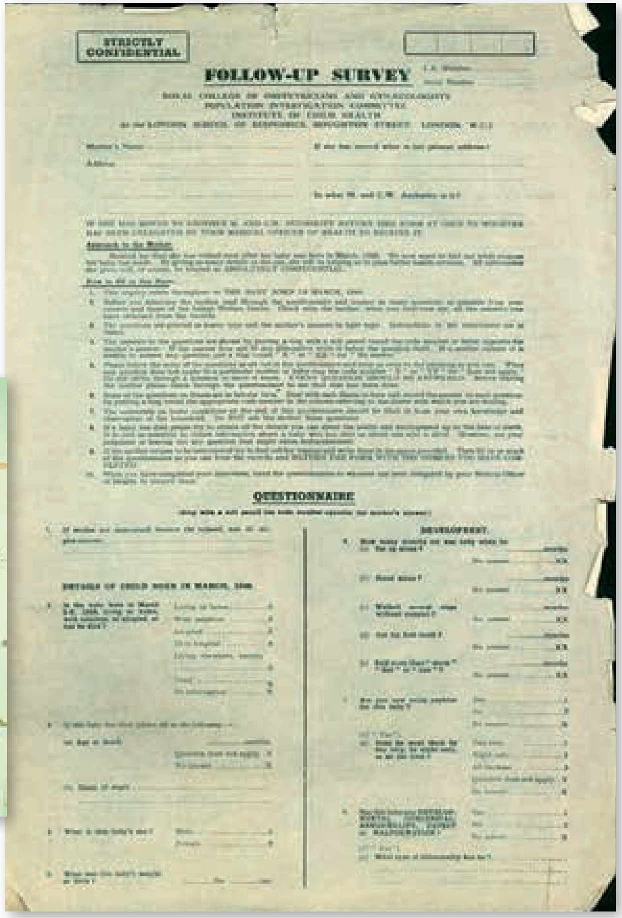
Life course studies, by their sheer ambition and scale, offer many challenges. They involve a huge level of commitment from the participants and researchers alike, not to mention funding. Given that a full life course study can last almost a century, it's not surprising that the technology and ideas underpinning them can change.

When the NSHD started in 1946, for example, researchers didn't collect information about smoking, because it wasn't perceived as important. Methods to visualise the inner workings of our bodies and cells, such as CT scans and molecular methods, weren't around. Life moves forwards so missing data can't be added retrospectively, making careful design and forward planning essential to the success of a life course study.



Weight at Birth.	Weight 1st Year	Food.	No. of Visits.	Condition, and Remarks of Health Visitor.

An extract from the Hertfordshire Cohort Study health visitor records.



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FOLLOW-UP SURVEY

QUESTIONNAIRE

DEVELOPMENT.

An early questionnaire from the MRC National Survey of Health and Development.

New technology is superseding old. Blood pressure, for example, is now measured with an electric meter rather than a mercury column. New measures need to be validated against old ones, so that comparisons can be drawn across the life course.

Life course studies are increasingly recognising the value of participants' personal recollections to highlight valuable information that simple measurement misses. These narratives, transcribed by researchers, may be hard to quantify but the qualitative information they offer is priceless, and show the importance of social relationships and the health of all family members.

Any scientific finding, from a life course or any type of study, needs to be replicated to increase its validity. We can't rerun people's lives over, but we can compare data from one life course study with that from others. However studies often use different techniques to measure the same outcome – one study might use grip strength to measure physical capability, whilst another might use chair rise time. So care needs to be taken when drawing comparisons.

Life course studies highlight associations between a particular factor and an outcome and, through innovative study design and analysis, they are helping to tell us if one causes the other. The associations highlighted by life course studies, can indicate potential causal links and guide further research. A deeper understanding of causation often lies in the realms of other types of studies such as natural experiments, clinical and public health intervention trials where associations are more likely to represent causal effects.

Final thoughts

Life course studies are changing the way we think about ageing – for the better. They show us that ageing occurs throughout life, that it's malleable and influenced by a variety of factors, many of which are under our control. They highlight the value of early life as a time when we can steer our children on a trajectory to healthy ageing, but point out that the way we age can be modified, whatever our age, and that it's possible to live most of your life in good health.

Since their inception over sixty years ago, life course studies have contributed enormously to our understanding of human development and ageing. They've yielded thousands of scientific research papers, influenced popular thinking and directly contributed to public policy. Policies should strive for health and wellbeing across life, but with people living longer, initiatives that help them enjoy health and independence for as long as possible will enhance individual wellbeing and ease the burden of care.

There is a growing consensus from international health organisations, national policymakers, research funders and scientists that ageing is best studied from an interdisciplinary, life course perspective. We've learned a great deal, but further research is needed to translate the knowledge from life course studies into practical evidence-based intervention and public policy. Research into ageing remains a political and scientific priority.

Finally, a word to the many hundreds of thousands of people who have offered their life stories to help life course studies unravel the complexities of human ageing. Thank you for your time, your support and your generosity. You contribution goes beyond words. Through your continued participation, life course studies are helping to improve health, social care and public policy, but most of all, they're improving the improving the quality of life – for everyone.

As a way of saying thank you to the cohort members many studies send out a birthday card every year.

Links to some of the key UK life course studies

Healthy Ageing across the Life Course
http://www.halcyon.ac.uk/

1970 British Cohort Study
http://www.cls.ioe.ac.uk/

Aberdeen Birth Cohorts
http://www.abdn.ac.uk/aberdeen-birth-cohort/

Avon Longitudinal Study of Parents and Children
http://www.bristol.ac.uk/alspac/

Boyd Orr Cohort Study
http://www.bris.ac.uk/social-community-medicine/projects/boyd-orr/

Caerphilly Prospective Study
http://www.bris.ac.uk/social-community-medicine/projects/caerphilly/

English Longitudinal Study of Ageing
http://www.ifs.org.uk/ELSA

Hertfordshire Cohort Study
http://www.mrc.soton.ac.uk/herts

Lothian Birth Cohorts
http://www.lothianbirthcohort.ed.ac.uk/

Millennium Cohort Study
http://www.cls.ioe.ac.uk/

MRC National Survey of Health and Development
http://www.nshd.mrc.ac.uk/

National Child Development Study (the 1958 cohort):
http://www.cls.ioe.ac.uk/

Whitehall II Study
http://www.ucl.ac.uk/whitehallII

To maximise our chance of keeping moving, keeping thinking, and keeping our spirits up in later life, we need to look after each other from an early age.

HALCyon

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