Almshouse Longevity Study

CAN LIVING IN AN ALMSHOUSE LEAD TO A LONGER LIFE?

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Foreword

The almshouse model was established a thousand years ago by philanthropists to provide a place of warmth, safety and sanctuary to those in need.

This community spirit is reflected in the architectural design of almshouses – often a three-sided quadrangle with doors and windows facing each other over a courtyard or community area - enabling a sense of community and companionship, yet still allowing independence. These design features are still commonly replicated in almshouses being built today.

A report published in 2017 investigating life expectancy in Whiteley Village shows that the average resident included in the study lives longer in the almshouse than the average citizen of England and Wales of the same age, gender and socio-economic grouping. We therefore commissioned a follow-up study to investigate whether this effect is seen across the almshouse movement more generally.

This report represents a review of decades, and in some cases, a century of data, considering the mortality rates of those who have lived in almshouses. It is clear that, in many cases, almshouse residents are receiving a similar type of longevity boost to that experienced by Whiteley Village residents. We should note, however, that the sample is limited to those charities who were able to supply sufficient data.

This latest research builds on past research pointing, perhaps, to the great value of companionship and strong micro-communities that this unique housing model embodies. I would like to suggest that, if we were to design a housing model which is the epitome of a good living environment today, it would include companionship, community and independent living in almshouses which are designed to underpin these values.

I thank all those who gave up their time to capture and share data, the very professional and dedicated team who carried out the data gathering, research and analysis and The Dunhill Medical Trust and the Justham Trust for funding the report. Special thanks to Ben, David, Alison and Anastasia for gallantly working to see this happen.

Nick Phillips

Chief Executive, The Almshouse Association

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Executive Summary

There is currently a great deal of discussion about the continuing gap in both health and life expectancy between the different socio-economic status groups in the UK. Previous work in connection with a particular almshouse site within Whiteley Village has shown that it is possible to combat this inequality in people from lower socio-economic groups moving to Whiteley Village in their later lives. This report extends the work to investigate whether moving into other almshouses has a similar effect, i.e., in general, does living in an almshouse boost the life expectancy of someone from a low socio-economic group to that of a general member of the population?

Our results demonstrate that a longevity boost does indeed occur generally amongst almshouses, although we ascertain that the effect varies from almshouse to almshouse. In the best cases, we find that some almshouses in our study are replicating the previous result of increasing the life expectancy of a resident from that of the lowest-socio economic quintile to one enjoyed by a person in the second-highest quintile. The almshouses in this study are not homogenous and neither is the population from which their residents are drawn. It is therefore difficult to reach a single conclusion as to how much benefit an almshouse gives or what are the most important factors that contribute to any longevity boost. However, we do find that almshouses provide some ‘longevity boost’ to their residents.

We conclude by arguing that more research needs to be carried out into what it is about the experience of living in an almshouse that causes residents to receive a longevity boost, though we postulate that it is the sense of community that is the most powerful force. We would encourage the Government to invest in retirement communities such as almshouses, which would be in keeping with their levelling up agenda and should help with the social care problems that the UK is currently experiencing.

1. Introduction

In 2017, the research team at Bayes Business School, City University of London, was commissioned to conduct a study devoted to the 100th anniversary of Whiteley Village – one of the largest retirement communities in the UK (Mayhew, Rickayzen and Smith, 2017). Established in 1914 (with the first resident moving in 1917), Whiteley Village has almshouses within their village setting - a charitable purpose-built community, which provides accommodation for older people on low income. The interest in researching the residents was sparked by remarkable anecdotal evidence, which the researchers then confirmed empirically: it appeared that people living in this community get something that the researchers termed 'a longevity boost'. In other words, the population of Whiteley Village had a higher life expectancy than an average citizen of England and Wales of the same age and gender. This result was particularly surprising given the common finding that people with lower socio-economic status (SES) tend to have a lower life expectancy than their counterparts in the general population (see, for example, Chetty et al., 2016; Meara, Richards & Cutler, 2008). This phenomenon is often assumed to be due to two of the major psychosocial determinants, poverty and inequality, which contribute to health inequality and high mortality rates both between and within countries (Marmot, 2005). However, Mayhew, Rickayzen and Smith (2017) discovered that the residents of Whiteley Village were receiving a longevity boost of up to 5 years.

These findings attracted a large amount of interest from researchers, practitioners, retirement communities and media outlets around the world. Nevertheless, two key questions remained: (1) is this longevity boost present in almshouse communities, other than Whiteley Village? If the answer is yes, then (2) what are the factors that increase life expectancy for those living in almshouse communities compared to people of a similar SES who are not living in such communities? There have been some recent developments regarding the answer to the latter question. For example, a large longitudinal study in China has recently discovered that older people who regularly engage in social activity see a boost of longevity, with the frequency of social engagement (e.g., those who took part in daily social activities) being associated with larger survival rates (Wang et al., 2023).

To date, in the UK, there has been a lack of literature looking into the benefits of living in retirement communities or villages, social support housing or any other types of community living. Previous research in Asia, Europe and the US generally found that lower SES can lead to social isolation (Dykstra & de Jong Gierveld, 1999; Röhr et al., 2022), with loneliness being a major contributor to lower life expectancy (Raymo & Wang, 2022). Likewise, older adults from particularly disadvantaged backgrounds experience a significant health decline with increased loneliness, which in turn impacts their activities of daily living (Shankar et al., 2017). This might suggest that loneliness creates a perpetuating cycle for older people from lower SES, where they initially lack both physical and social activity due to having few social interactions. Low levels of activity then lead to more physical as well as mental health problems (Gerino et al., 2017), which all contribute to reduced life expectancy. However, very few studies have assessed loneliness in older adults in residential care, and the results are inconclusive (Grenade & Boldy, 2008).

In this study we are interested in answering the first question, namely expanding on our findings in Whiteley Village to see if they also apply to other almshouses across England. To do this, we collected the data from 15 almshouses to investigate whether their residents have an increased life expectancy compared to the general population of England and Wales. In the following, we outline each almshouse’s history, their eligibility criteria, payment structure, community and support structure and what they offer to the residents. It is important to explore the differences in structures of the almshouses included in the study since the characteristics of the different communities and the outline of their social support structure could provide further insights into why or how some almshouses benefit from certain longevity boosts. In other words, this may lead us to speculate on the second question about why almshouses may give this longevity boost, though we recognise this will only be conjecture.

2. Almshouses – history, eligibility and structures

2.1 History

Almshouses comprise charitable housing, the oldest form of social housing, often provided to local people in housing need, generally, but not limited to the older generation. The first ever almshouse was established in the UK in the 10th century, and since then they have often been affiliated with the church. Although modern almshouses are quite different, some continue with their traditions, and many have chapels within the residency. Currently, over 36,000 people live in almost 2,600 almshouses in the UK (The Almshouse Association, 2023). The sizes of these communities vary widely from a few dozen to several hundred residents. Over half of the independent almshouse charities across the UK (1,600) are represented by The Almshouse Association, which was established in 1946.

2.2 Eligibility criteria

Specific eligibility criteria vary from almshouse to almshouse, although the common criteria include being in need, be it financial, psychological or emotional. They may have little to no savings, limited financial means, in need of housing yet able to live independently or with minimal support whilst being in good health. Some almshouses offer accommodation only for one gender, whereas others are mixed gender and offer housing for couples or families too. More specific criteria for each charity are discussed below.

2.3 Payment structure and offerings

Residents of almshouses are usually not considered tenants and they do not pay rent per se. Instead, they are required to contribute something that is referred to as a weekly maintenance contribution. These may slightly vary from charity to charity, although most of these would be covered by full or partial housing benefit for residents who are retired; or the housing element of Universal Credit for residents under retirement age. Some almshouses also charge additional costs for council tax, bills, or internet, as well as any extracurricular activities that are provided within the community, such as day trips or holidays. There is often a considerable variation as to whether flats/houses come furnished or not, although charities usually refurbish properties before new residents move in.

2.4 Community and support structures

In return for their weekly contribution, residents enjoy a range of benefits while living in almshouses. Unlike other types of social housing, residents live in a supportive community, where events and activities are organized for them and by themselves. For example, many almshouses arrange coffee mornings, luncheons, celebrations, day trips, excursions, film and book clubs, gardening, fitness classes, bingo and sporting activities. In addition to this, Wardens may be present on the premises of the almshouses and provide some types of support for residents, for example, help with filling out forms or general health and well-being check-ups. In addition, medical support is available in some but not all almshouses. For example, some residencies have care homes located on the same site as the almshouses and/or have visiting GPs, whereas in other places residents are expected to arrange their own support if it is needed. Crucially, almshouses are provided to people who are able to live independently and are in overall good health at the point they arrive. However, there are many charities that accept people in poor health as long as they can live independently.

3. Almshouses that contributed to the study

In this project, we collected the data from 15 almshouses that primarily house people (men, women or couples) of state pension age. A survey was sent to all The Almshouse Association members enquiring whether they would like to participate and asking about the data held either in digital or hard copy form in respect of former residents. Due to concerns about collecting data related to current residents, the analysis was designed to be carried out on those residents who had died, meaning it was not necessary to obtain any information about current residents. As a result of the questionnaire, 15 almshouses agreed to allow the requisite data to be extracted from the former residents' records.

As with many old traditions and institutions, terminology has evolved over the years. Historically residents have been referred to as beneficiaries, brethren and pensioners to name a few. In this paper, we generally refer to people living in almshouses as residents.

We now provide a contextual narrative around each participating almshouse in turn.

3.1 Charterhouse

Originally built in the 14th century, Charterhouse became an almshouse in the 16th century following the death of its owner at that time, Thomas Sutton. Located in the heart of London, Charterhouse now houses over 40 Brothers (which is what the residents are known as). Up until 2018, only males were accepted. However, since then, females have been accepted too. To be eligible, an applicant needs to be over age 60, single, in need of financial, housing and social assistance, and need to have no significant financial debts. They also need to be able to live by themselves, have no serious significant physical or mental health problems (at the point of entry) and be keen to contribute to the Charterhouse community. In addition to private housing, there are 11 rooms available in their infirmary for those needing respite or longer-term care. A particular characteristic of the Charterhouse almshouse is that residents are allowed to come and go as they please, enjoying their life outside the walls of an almshouse. Many are often visited by their friends and family. However, they eat most of their meals with fellow residents in a communal dining hall, as well as enjoy a range of activities provided by staff members, such as exercise sessions and a book club.

3.2 Chelsea Pensioners (Royal Hospital Chelsea)

The Royal Hospital Chelsea is located in central London. It was founded by King Charles II in 1682 specifically to house war veterans. Slightly different to traditional almshouses, the Royal Hospital provides a range of services and resources, from independent living to nursing care. It offers an on-site GP service, a team of carers and nurses in the care home, physiotherapy and occupational therapy services. Chelsea Pensioners (as the residents are usually known) also enjoy a range of internal and external services and activities, such as their own club and cafe, gardening club, trips to the cinema and art projects with external partners amongst others. In turn, their eligibility criteria are somewhat stricter than for other almshouses: at the point of arrival, an applicant needs to be a former non-commissioned officer or soldier of the British army who is over age 65 or of state pension age (whichever one is greater), free of financial obligations to support family or a partner, and physically able to live independently. Those who receive an Army Service Pension or War Disability Pension would be required to surrender it to cover the living costs, otherwise candidates must make a weekly financial contribution. There are currently over 280 army veterans living in the Royal Hospital, most of whom are men. Since 2009, the Royal Hospital also opened its doors to female applicants.

3.3 Durham Aged Mineworkers Homes Association

Durham Aged Mineworkers Homes Association (DAMHA) almshouses are among the most ‘recently’ established almshouses, as it was endowed in 1898, originally providing homes for applicants working in mines. Now, it is the largest almshouse trust in the UK providing 1,783 homes (bungalows) for over 2,299 people across 144 sites in 85 villages. The trust does not have a specific eligibility criterion, and anyone aged over 50 can apply; however, additional points are awarded to ex-mineworkers and their widows. Although priority is given to less physically active or to disabled people willing to live independently. There is no longer a requirement for applicants to have worked in the mining industry. Due to the substantial size of this almshouse charity, and because it attracts a wider mix of residents when compared with other almshouses, fewer social activities are provided by the 28 members of DAMHA staff compared to the other almshouses, however, DAMHA still maintains a strong charity and community spirit. Nevertheless, residents are still involved in the community through focus groups, residents' forum, area meetings and gardening club membership. In the sheltered schemes, activities such as arts clubs, reading groups, computer skills, cards and bingo are available.

3.4 Hurst Consolidated Charity

Hurst Consolidated Charity is a relatively small community within Hurst Village, consisting of 20 apartments across three sites: two locations in St Nicholas Hurst and one in Twyford. The first site in Twyford was built in 1640 by Sir Richard Harrison of Hurst House and the first eight poor people entered in 1664. The eligibility criteria are (a) persons in need of affordable housing and (b) living in the parish of Hurst or adjacent parishes. The almshouse only expanded further in 1985 when four new apartments were added. In 1999, four further apartments originally built for nurses were created, and another apartment was built in 2019.

3.5 Morden College

Located in the suburban area of Southeast London, Morden College was established by a philanthropist Sir John Morden in 1695 to provide accommodation for poor older merchants who had lost their estates for various reasons. The original buildings were intended for 40 single or widowed men, but now Morden College comprises over 200 flats, 34 en-suite apartments and 60 en-suite bedrooms. Morden College is currently located across two sites: Blackheath in London and Beckenham in Kent. The former consists of Morden College – The Quadrangle (23 flats), Montague Graham Court (8 flats), Wells Court (20 flats), Alexander Court (30 flats), Graham Court (21 flats), and Peter Saunders Court (10 flats). In addition to almshouses, Morden College also has Cullum Welch Court, which is a residential care home comprising 60-beds with full-time nursing care. Aside from an extensive choice of accommodation, residents benefit from, amongst other things, a variety of clubs, social activities, trips, quiz nights, dinners, musical recitals, film shows and communal barbeque. Other facilities include a visiting GP, gardens, chapel, library, social club with bar facilities, cafes, pantries, traditional dining room where lunch is available for any resident and their guests. The Beckenham site consists of Ralph Perring Court, which offers 101 flats.

An eligible applicant/couple must be of retirement age, having worked in a managerial/leadership position in a trade, vocation or profession. They must also be in receipt of a UK state pension or be eligible for it, and be in financial and/or social need, such as loneliness or isolation.

3.6 Richard Watts Charity

The Richard Watts Charity was established following the death of its namesake in 1579, and supported the creation of The Poor Travellers House, which provided accommodation for six, as the name suggests, poor travellers. Now, the almshouse is spread across four sites in Rochester, providing in total 67 flats for single people. Watts Almshouses has 18 flats with an addition of two most recent houses: Donald Troup House, which has 15 flats and The Bungalows, which are ten easy-access properties. Hayward House consists of six flats in a two-story building. Reeves House provides residents with seven large flats. Lastly, St Catherine's Hospital offers 11 flats. Single people or couples who are no longer working are eligible to apply. They must be over age 65 and be residents within the ME1 or ME2 postcodes or be returning to be closer to their friends or family. Likewise, they should be in need of financial assistance and able to take care of themselves whilst having no serious health conditions upon entry. At the same time, the almshouse provides a 'home help service' for an additional charge of £12.50 per hour, whereby a helper can support residents with general house issues like cleaning and laundry, shopping and taking out rubbish. Those on a very low income might be eligible for this service free of charge. In addition to this, a Warden is available 24/7 at all flats for any emergencies, although they are not trained to provide medical or personal care.

3.7 Salisbury City Almshouse & Welfare Charities

The history of Salisbury City Almshouse dates to 1370, when Agnes Bottenham founded Trinity Hospital as an act of penance. Trinity Hospital, which back in the day was the only refuge for sick people in Salisbury, has now expanded into 11 almshouses with 190 sheltered flats (Brympton with 41 flats; Eyre House with eight flats; Hussey's Almshouse containing eight terraced houses and seven flats; Taylor's Almshouses with six flats; Hardy House with 16 double flats; Blechynden's Almshouses of three single flats; Trinity Hospital with 22 double flats; Brickett's Hospital containing seven houses; Gloucester House with 25 double flats; and Sarah

Hayter's Almshouses containing 11 double flats). In addition, there are 22 very sheltered studio flats, where 24-hour support from the Warden is provided. There is a slight variation in the eligibility criteria from house to house. All almshouses request that an applicant has been a resident in the Salisbury area for at least five years in their lifetime, is of retirement age and in need of sheltered housing from both a physical and financial perspective. The resident's total capital should not exceed £150,000 (or £180,000 for the very sheltered sites). Some almshouses, like Sarah Hayter's, only accept female applicants over the age of 50, whereas others also provide accommodation for young families in the area (not considered in this study). The majority of almshouses are, however, of mixed gender, including single men, single women and couples. As with other almshouses, residents enjoy their communal space and gardens, where a variety of activities are provided by the Warden or by other community members, including coffee mornings and other social events.

3.8 Sheppard Trust

Sheppard Trust almshouse, located in Holland Park in London, was first built in 1875 after being founded by Miss Elizabeth Sheppard in 1855 with the aim of providing low-cost housing for older women in receipt of small incomes. Renovated in 1999, Sheppard Trust now provides 29 flats (studios and one-bedroom apartments), although this is set to increase to 60 by 2024. The charity has modest eligibility criteria, and they accept female applicants of Christian faith aged 65 and over, in hardship or distress (e.g., enduring poor housing, receiving benefits and having no more than £75,000 in capital). They must also agree to the Statement of Community Values. In addition, it is expected that, upon entry, the applicants are able to live independently and are in generally good health. There are staff members available on site to provide advice, although no medical support is available. The Trust aims to create a sense of community and organises monthly events for their residents, such as tea parties, lunches and occasional daytrips. Each house is also equipped with a guest room to allow relatives and friends to visit. A weekly maintenance charge is usually fully covered by the resident's housing benefit, but residents are also expected to pay a small charge for hot water and heating.

3.9 St. Martin in the Fields Almshouse Charity

St. Martin in the Fields Almshouse Charity in North West London is a small modern almshouse, which consists of 19 unfurnished flats (16 one-bedroom and three studio flats). Established in 1597 by the parish of St. Martin in the Fields, the almshouse was originally providing accommodation to homeless, poor women who were over age 60 and spinsters, widows or divorced women of good character, residents in the City of Westminster. From 2008, the criteria were expanded to also allow applications from resident men and married couples over the age of 60. In addition, the charity provides accommodation to those employed in essential services, such as nurses and teachers working in Westminster, but such people are not considered in this project. As with other almshouses, at the point of entry, all applicants need to be able to live independently. Residents are offered a common room, where the Clerk and Warden often organise coffee mornings and other social activities for neighbours to socialise. Likewise, each flat is equipped with an emergency call system to assist residents with a 24-hour medical emergency support. From 2019, the Charity has also been working on the completion of a new block of 44 flats.

3.10 The Davenport Homes

The Davenport Homes is one of the youngest almshouses included in the study, having been formed in 1935. It operates 36 cottages and four flats located in Knowle, Solihull. The trust was founded by the director of the Davenport Brewery, Mr. Frank R. Davenport, to support current and former employees of the Davenport Brewery and their dependents, as well as poor people in need, retired nurses and other healthcare workers. The current eligibility criteria include anyone who is in need or requires housing regardless of whether they are single or a couple, but preference is given to those fulfilling the original criteria who can live independently, upon arrival. Residents enjoy a range of activities organized within the almshouse. The Resident's Liaison Officer coordinates coffee mornings, afternoon teas and other seasonal get togethers. The residents themselves are also active in their community and organize crafts and painting classes, bingo evenings and outings.

3.11 The Richmond Charities

The Richmond Charities has a long and diverse history. Started in 1600 by Sir George Wright, the almshouses have had several wealthy benefactors contributing property and land for building further almshouses. Currently, the charity owns and manages 145 almshouses over 12 estates in Richmond, Twickenham and Mortlake within the London Borough of Richmond upon Thames. These estates vary in size with the smallest providing three rooms, and the largest providing 50. These are as follows: Benn's Walk Almshouses (five one-bedroom bungalows); Bishop Duppa's Almshouses (ten one-bedroom cottages); Candler Almshouses (ten one-bedroom bungalows); Church Estate (10 one-bedroom cottage, 4 one-bedroom flats and four studios); Colstons' Almshouses (three one-bedroom bungalows); Hickey's Almshouses (50 one-bedroom cottages and bungalows and a guest room); Houblon's Almshouses (nine one-bedroom cottages); Juxon's Almshouses (three one-bedroom bungalows); Manning Place (three one-bedroom flats and six two-bedroom flats); Michel's Almshouses (17 one-bedroom cottages and a guest room); Queen Elizabeth's Almshouses (four one-bedroom cottages); and Wright's Almshouses (nine one-bedroom flats and a guest room). Despite being widespread, there is a strong sense of community present between the almshouse sites. Residents benefit from communal spaces, where members can exercise, do yoga, conduct their film clubs, quiz nights and other social events, which they are encouraged to organize for each other independently. Scheme Managers are present at every site and assist residents with independent living through regular visits and monitoring of their health and well-being, as well as each house being fitted with a careline connecting residents to emergency facilities. To be eligible to live in one of the twelve estates, applicants can be single or a couple, aged over 65, currently living in rented accommodation but be in need of housing. Applicants should have a low income, limited savings, be able to live independently and must be living within the London Borough of Richmond upon Thames for at least the last two years, although those who have family members living there can be considered in exceptional circumstances.

3.12 Trinity Hospital, West Retford

Trinity Hospital's history began in 1671, when John Darrel, a local doctor, left a will requesting that his estate be set up as an almshouse to support 15 poor bachelors or widowers of good character and at least 50 years old. Trinity Hospital still supports 15 men and has relatively strict eligibility criteria: only bachelors or widowers who are at least 50 years old can apply. They also must be of good character and have few savings and low income, as well as having a connection to Retford or the surrounding area. Additional criteria specify that a preference would be given to any descendants of John Darrel, the founder of the almshouse. As with other almshouses, applicants must be able to look after themselves, although staff members and the Matron are available on-site and do daily check-ups on residents' well-being and health. There is also an emergency call system available in each residence. Brethren (the official name of the occupants in the Trinity Hospital) are encouraged to live independently but within a supportive community, whereby a range of events is held throughout the year. For example, amongst other activities, residents can go on excursions, enjoy a biannual celebratory feast, communal barbeques and coffee mornings. Brethren are also encouraged to attend weekday and special services in a Hospital Chapel.

3.13 United St Saviour's Charity

United St Saviour's Charity currently manages two almshouses in London, one of which, Hopton Gardens Almshouses, was built in the 18th century and is located in central London, and the other is St Saviour's Court which is a much more modern residence built in 2006, located in Croydon. Across the two sites, United St Saviour's offers 75 homes, most of which are one-bedroom apartments, although a small number of two-bedroom apartments are also available. The charity is currently in the process of finishing their brand-new almshouse, Appley Blue, which will provide 51 one-bedroom and six two-bedroom flats. To be eligible, an applicant will usually be at least 65 years old, have lived in Southwark for at least three years, have low income, limited savings and be able to live independently. However, each apartment has an emergency cord system, which links residents with on-site managers or out-of-hours emergency services. Both almshouses provide communal space for residents to socialise, and charity staff members also organise activities for all who wish to be involved.

3.14 Walthamstow and Chingford Almshouse Charity

Walthamstow and Chingford Almshouse Charity consists of five sets of almshouses located within Greater London. It was first established in 1527 by Sir George Monoux, before being joined by Mary Squires Almshouses endowed in 1795, Jane Sabina Collard Almshouses established in 1881, Chingford Almshouses built in 1859 and Colby Lodge that opened in March 2018. The charity now operates 62 apartments available for individuals or couples who are usually well over age 60, but younger people with disabilities are also housed there. The majority of the residents will have lived in Walthamstow or Chingford for at least a year prior to their application, or for five consecutive years at any time. Applicants are assessed based on their housing, social and financial need. Residents benefit from a friendly and supportive almshouse community, which staff encourage through social activities, daytrips, and almshouse events. Staff provide support by assisting residents with accessing benefits and social care when required. Residents and their families are encouraged to seek help from social services when residents are seen to be facing difficulties with maintaining their independence. Staff keep an eye on residents' wellbeing, and care services are provided to residents in their own homes. The charity also adapts the properties to meet residents' mobility needs where appropriate; for example, fitting grab rails, and ensuring that the properties have low level showers/wet rooms.

3.15 Yardley Great Trust

Yardley Great Trust was established at the end of the 14th century by John De Yardley who surrendered his land to provide housing for poor local people. Now, the trust operates six sheltered housing properties: (1) Acocks Green, which consists of 46 one-bedroom flats and one two-bedroom flat; (2) Coleshill consisting of 11 one-bedroom bungalows; (3) Shard End consisting of 30 one-bedroom bungalows; (4) Stechford with 66 one-bedroom flats; (5) two developments in Yardley, one with eight bungalows and two flats and the other one consisting of 30 one-bedroom flats and one two-bedroom bungalow with a residents' lounge; (6) and lastly Yardley Wood, which has ten flats. In total, Yardley Great Trust provides accommodation to over 200 people. The almshouses do not have very strict eligibility criteria. Yardley accepts applications from anyone who is aged 60 and over, although in some exceptional cases those over age 50 will be considered if they have a severe disability. Applications are prioritised based on applicants’ circumstances; for example, those being threatened with homelessness will be given a priority compared to those who, for example, simply wish to move closer to their relatives or friends. As with other almshouses, staff members provide residents with a variety of activities to choose from depending on the houses, such as bingo, gardening club or dancing sessions, as well as day and weeklong trips. Almost all dwellings have an emergency service, which connects to the site manager during office hours, or to central control for out of hours emergencies.

4 Mortality analysis

As our data involves lives entering almshouses at different ages and in different calendar years, we need a method that allows the aggregation of all the lives for each almshouse and gender in one analysis. We carry this out by calculating the percentiles reached by the residents. For mortality data, actuaries use life tables that create model populations using the observed mortality rates. These life tables usually start with a radix of 100,000 lives at the initial age and the population then reduces in accordance with the observed mortality rates. Using these tables, we are able to calculate the ages by when a certain percentage of the population will have died or, equivalently, the ages when a certain percentage of the population is still alive.

In Figure 4.1 we show a survival curve for the England and Wales (E&W) male population starting with 100,000 lives at age 70 in the year 2020. We can see how the population reduces with age until the last life has died at age 111.

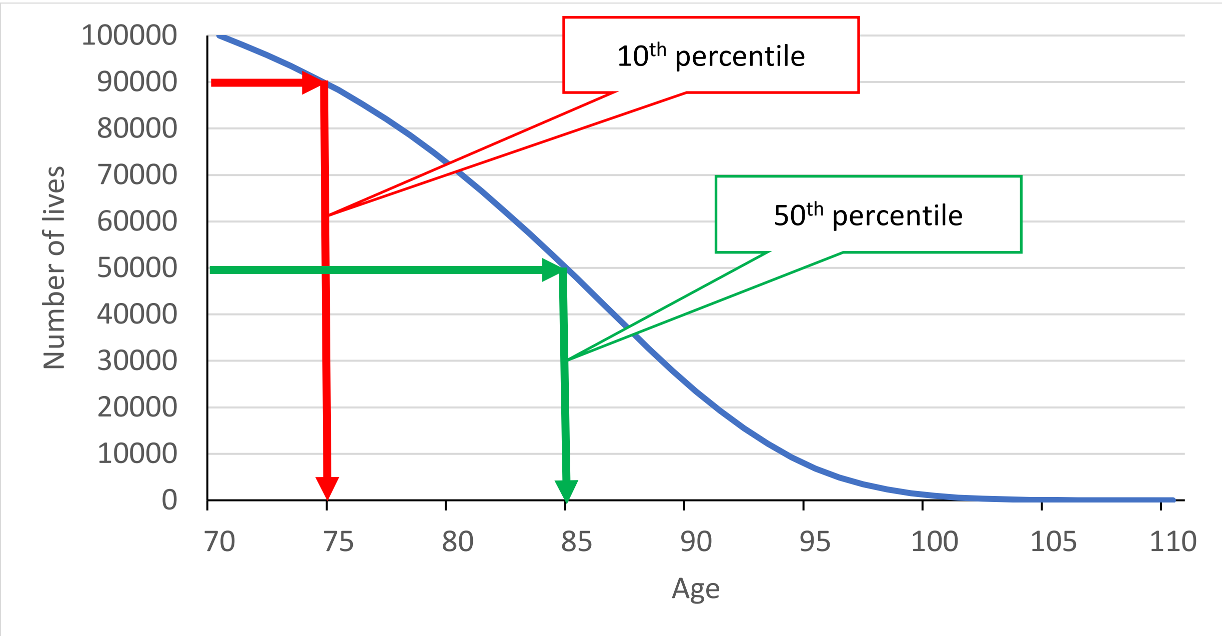

Fig 4.1 Survival curve for a 70 year old in 2020 (Source HMD, 2023)

In Figure 4.1 we have marked off two percentile points. The first one is the 10th percentile and this is the point at which 10% of the population have died and 90% are still alive. This age is calculated to be 74.3. The second percentile point shown is the 50th percentile at which point half the population has died. This age is calculated to be 84.5. Therefore, if a person dies after this age, then they have lived longer than 50% of the population under consideration.

Using this percentile approach, our analysis involves the testing of four hypotheses for residents at almshouses for which we had sufficient data. These four hypotheses are:

1) That the average almshouse resident does not survive to the 40th percentile of the general population;
2) That the average almshouse resident survives to beyond the 40th percentile of the general population;
3) That the average almshouse resident does not survive to the 50th percentile of the general population;
4) That the average almshouse resident survives to beyond the 50th percentile of the general population.

To carry out a mortality comparison we need to compare the almshouse population with a suitable external population. We have selected the general England and Wales (E&W) population as being the most appropriate in terms of the location of the almshouse residents' previous residence, as many of the almshouses in this study take residents from around the country. The 50th percentile was therefore chosen as this compares the almshouse resident population to that of the E&W population, i.e., if half the residents are surviving to the 50th percentile then the residents of the almshouse are living similar lifespans to those of the general public.

However, as the residents come from the lower socio-economic groups, we would assume that they would have lower life expectancy than the population as a whole. We therefore also compared the residents to the 40th percentile as we saw this as an approximate target for the lives from this socio-economic group.

It should be borne in mind in the analysis which follows that there could be a selection effect as people are generally only able to enter an almshouse if they can live independently, at least to start with. One notable exception to this in our sample is the Royal Hospital Chelsea who act as both an almshouse and a hospice. This was discussed in the contextual analysis and is revisited again when looking at the results.

We now describe our approach to comparing the mortality experience of our almshouse populations with the suitable general population.

4.1 Methodology

Due to data privacy concerns from many of the contributing almshouses, we agreed to only collect a minimal amount of data and only that which pertained to residents who had died, i.e., not current residents. The data we collected was:

- Name of resident (to enable data verification as detailed below);
- Date of birth;
- Gender;
- Date entered almshouse;
- Date left almshouse;
- Reason for leaving almshouse (death, withdrawal, ill-health, i.e., if the resident needed to move into end-of-life care).

We did not collect other data such as ethnicity or state of health at entry.

Since our data is restricted to deceased residents, our methodology is to consider each resident aged 60 and over who has died while living in the almshouse, moved into end-of-life care from the almshouse before death or who died within one year of leaving the almshouse. The idea here is to make sure that any longevity boost we record is due to living in an almshouse. For example, on the one hand, a resident who lives in an almshouse for three years, leaves and then lives for another 20 years in a different location cannot attribute their lifespan to living in the almshouse. On the other hand, a resident who lives in an almshouse for 12 years and then moves into an end-of-life care home due to failing health can be seen as having a lifespan based on their years in the almshouse. Once we have selected our qualifying residents, we then ascertain which percentile of the general population they reached upon death.

At this point, we should acknowledge the work of many volunteers at the various almshouses who have gathered the data and have given us access to their records. Due to the nature of the records, many were initially incomplete in terms of information such as dates of birth or death. Thus, we used a genealogy consultancy, Brother's Wish Genealogy Service, to fill in the missing information where possible. However, inevitably, it was not possible to complete all the records, and some were excluded from our analysis. We also note that a couple of almshouses in this study have data sets which are currently incomplete but which we believe we can "clean" further and add to our results in the future.

Once the data was cleaned, we set about determining the ages to which different population percentiles survive by using the l_x values set out in the life tables for the E&W population. These provide information on how many males or females are expected to survive to exact age x in the general population. We are then able to use this data to create a life table for any resident based on the age and year that they entered the almshouse using a radix of 100,000 individuals at the age they entered the almshouse. We then used linear interpolation between integer ages to obtain approximate ages for each percentile to allow us to calculate the percentile at which each individual died.

For example, one of the residents in our Royal Hospital Chelsea dataset entered the almshouse in 1986 at the age of 68. Regarding this age at entry, we rounded down so that someone entering at age 68.5 would be classed as entering at age 68. We then measured the duration of their life after entering the almshouse and compared this duration of life to the life table for, in this case, a 68 year old in 1986. In our example, the resident lived for 4.54 years which meant that they survived to the 19th percentile of the life table. In other words, according to the England & Wales Life Table, 19% of people aged 68 in 1986 died before reaching the age of 72.54. This approach is carried out for all lives who met our criteria as detailed above.

We should note that we are not able to consider records where an individual joined an almshouse only recently as to do so would severely skew the results. For example, if a person enters an almshouse at the age of 65 in 2010, then they are only able to reach a maximum age of 76 by the end of 2021. Since our methodology can only consider lives that have died, for this life to be included in our data, they must have died by the age of 76 which means, by definition, they could only have reached a low percentile before death, thereby suppressing the results. We therefore only considered residents who would be able to reach the age of at least 90 by the end of 2021 in order to give a fairly full range of percentiles that they could reach before death. While this approach still suppresses the results slightly, as some lives would still not be able to reach the highest percentiles, we wanted to include as much data as possible to reach firmer conclusions in our hypotheses tests. However, this does mean that an almshouse like DAMHA, which was only able to provide very recent data, will have its results skewed and hence will give a lower life expectancy than is actually the case.

Using this general concept, our testing procedure is as follows: for each almshouse and separately for each gender, we calculate all the percentiles for the lives which satisfy the above criteria. We are then able to look at the percentage of the almshouse residents who survived to the 40th percentile and the percentage who survived to the 50th percentile. These values can then be used as our test statistics for the hypothesis tests set out above. This will then allow a comparison between the percentage of almshouse residents who survive to these percentiles and the percentage surviving to those percentiles from the general population.

Our benchmark data on survival and life expectancy for males and females was extracted from the Human Mortality Database (HMD) for each year from 1917 to 2021 using data for the England and Wales civilian population (HMD, 2023).

In the next section we look at the results we obtained from the almshouses in the study.

5 Results

Using the methodology described in Section 4, we present our results below. We will set out our analysis for two almshouses in detail here and provide the analysis for the rest in the Appendix. However, we will summarise our findings for all the participating almshouses in the Conclusions. The two almshouses we will look at are Royal Hospital Chelsea and Charterhouse. We chose Royal Hospital Chelsea as it is the largest data set that we have and Charterhouse as it is the most historic and provides a contrast in outcomes to Royal Hospital Chelsea.

5.1 Royal Hospital Chelsea

Percentage of deaths from E&W population	10%	40%	50%	75%
Observed deaths from RHC	591	1,959	2,388	3,355
% of RHC population who have died	14.3%	47.3%	57.6%	80.9%

Total observed deaths = 4,145

Table 5.1: Observed number and proportion of male deaths by selected percentiles of E&W population

Table 5.1 shows the observed number of deaths by percentile of England & Wales (E&W) population. For example, for the 10% column we have observed 591 deaths. This number relates to the number of residents of Royal Hospital Chelsea who, when they died, were assigned a percentile lower than 10% when their age at death was compared to the standard E&W population for a person with the same age at entry. The value of 14.3% is derived by simply dividing the number of observed deaths, 591, by the total population, 4,145. The number 14.3% is therefore higher than we would expect if the population of Royal Hospital Chelsea had had the same future life expectancies as the standard E&W population. In other words, we would have expected to have seen 414 deaths at this point (i.e., 10% of our total population) not 591. For Royal Hospital Chelsea, it is not surprising that we are observing a higher percentage of deaths than 10% as Royal Hospital Chelsea operates with a dual function in both being a traditional almshouse and an end-of-life care provider (i.e., some residents will have decided to move into Royal Hospital Chelsea when in poor health to see out their remaining life with their peers).

Turning to the 40% column, we again see higher numbers of deaths than would be expected (47.3% rather than 40%), but this number obviously still includes those lives who came to Royal Hospital Chelsea already in poor health. At this point we can test our first two hypothesis tests, i.e., do lives survive to the 40th percentile with statistical significance? And do lives live beyond the 40th percentile with statistical significance? For both of these tests we will use the same test statistic, which is the percentage of the Royal Hospital Chelsea population who have died before reaching this percentile, i.e., 47.3%.

Does the average Royal Chelsea Hospital resident survive to the 40th percentile?

To calculate this test statistic, we will assume that half of the population die before reaching the 40th percentile, i.e., that the real value that we should observe is 50%, and we will look for evidence that the actual real value is higher than 50%.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

where p = true underlying probability of an almshouse resident dying before the specified percentile.

This gives a test statistic of:

$$z = \frac{\hat{p} - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{n}}}$$

where $\hat{p}$ is the observed proportion of deaths in the almshouse at the specified percentile (47.3% for this particular test) and *n* is the size of the population of the sample, i.e., the total number of residents for this almshouse in the study (4145 for Royal Hospital Chelsea).

The test statistic can then be compared to the normal distribution.

$$z = \frac{0.473 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{4145}}} = -3.526$$

We can see that the test statistic is negative and so there is very little evidence that the residents of Royal Hospital Chelsea are not reaching the 40th percentile. This can easily be seen by the fact that 52.7% of the residents of Royal Hospital Chelsea reached the 40th percentile so there is very little evidence that less than 50% of residents are surviving to this percentile.

Does the average resident of Royal Hospital Chelsea survive beyond the 40th percentile?

We have just noted that 52.7% of the residents of Royal Hospital Chelsea have survived beyond the 40th percentile, but is there statistical evidence that this is true? In other words, is the true underlying probability of surviving beyond the 40th percentile greater than 50% which is the same as asking whether the probability of dying before this point is less than 50%? We can test for this by changing the hypothesis test so that we are now looking for significant evidence that $p < 0.5$.

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

We have the same test statistic, as we are still looking at the 40th percentile, but for this second hypothesis test we are checking to see if the test statistic is less than -1.645. This is because we are trying to ensure that the conclusions we draw are statistically significant and observing a test statistic of less than -1.645 indicates that we would have only observed a proportion this far away from our assumed proportion by chance 5% of the time if the assumed proportion were true. As our test statistic is -3.526 we can clearly see that this is the case but we also want to calculate the p-value for this test, i.e., the probability that we are likely to have seen a probability this small (or smaller) by random chance if the true probability is 50%. This is calculated as:

$$\Pr(Z < -3.526) = 0.0002$$

So, the p-value for this test is 0.0002, i.e., the probability is much smaller than 0.05 and hence we can conclude that there is very strong evidence that the residents of Royal Hospital Chelsea on average are surviving beyond the 40th percentile of the E&W population.

Does the average resident of Royal Hospital Chelsea survive to the 50th percentile?

We can next proceed to asking whether the average resident of Royal Hospital Chelsea is surviving to the 50th percentile. The procedure is the same as above, but we are now using the test statistic derived from the 50th percentile, i.e., we are using the observed percentage of deaths by the 50th percentile which is 57.6%

$$H_0: p = p_0$$
$$H_a: p > p_0$$

with a test statistic of:

$$z = \frac{0.576 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{4145}}} = 9.801$$

The value of the test statistic is 9.801 which is a lot greater than the critical value of 1.645. We therefore have very strong evidence that the average resident of Royal Hospital Chelsea is not surviving to the 50th percentile as the p-value of this test, i.e., the probability of seeing a result this far away from 0.5 by chance, if the true underlying probability is 0.5, is close to 0.

Does the average resident of Royal Hospital Chelsea survive to beyond the 50th percentile?

Our final hypothesis test does not have to be carried out for Royal Hospital Chelsea as we have already shown that the residents are not surviving to the 50th percentile, and so there is clearly no evidence that they are surviving to beyond the 50th percentile.

Summary for Royal Hospital Chelsea

In summary, we have strong evidence that the residents of Royal Hospital Chelsea are surviving to the 40th percentile of the E&W population but are not surviving to the 50th percentile. Whilst, at first glance, this may seem a disappointing result, we must remember that the residents of this almshouse are ex-military (i.e., an occupation which takes its toll on physical health) and also that the almshouse, more than the others, is acting partly as an end-of-life care facility. Therefore, not only are the almshouse residents facing the usual implications of coming from the lower socio-economic status of the population but also have to contend with these additional factors. It could therefore be argued that comfortably reaching the 40th percentile is a good result. It is also noteworthy that the average percentile reached for this population is the 45th percentile (which fits in with our conclusions).

5.2 Charterhouse

We now consider the residents of Charterhouse who in the data set are all male.

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	32	148	185	263
% of population who have died	8.4%	39.1%	48.8%	69.4%

Total observed deaths = 379

Table 5.2: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the same four hypothesis tests as we have just carried out for Royal Hospital Chelsea using the data set out in Table 5.2.

Does the average resident of Charterhouse survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.391 - 0.5}{\sqrt{\dfrac{0.5 \times (1 - 0.5)}{379}}} = -4.263$$

As with Royal Hospital Chelsea, we can see that this test statistic is negative and that there is therefore no evidence that residents of Charterhouse are not surviving to the 40th percentile.

Does the average resident of Charterhouse survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645 and so we have evidence that the male residents of Charterhouse are living beyond the 40th percentile on average. The p-value for this statistic is less than 0.0001 so we have very strong evidence that this is true.

Does the average resident of Charterhouse survive to the 50th percentile?

We can next proceed to asking whether the average resident of Charterhouse is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.488 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{379}}} = -0.462$$

As this test statistic is negative, we cannot reject the null hypothesis and therefore there is no evidence that residents of Charterhouse are not surviving to the 50th percentile on average. This makes intuitive sense as more than 50% of the residents survived to the 50th percentile.

Does the average resident of Charterhouse survive to beyond the 50th percentile?

Our test statistic here is -0.462. As this is greater than -1.645, we have little evidence that the residents of Charterhouse are living beyond the 50th percentile on average. The actual p-value of this test is 32.2% (and we would normally consider 5% as demonstrating statistical evidence).

Summary of Charterhouse

The results for Charterhouse look good as, for each of the four percentiles we are analysing, the observed residents had higher observed percentages of reaching those percentiles than the E&W population, i.e., the residents of Charterhouse are observed to be living longer than the standard population. However, as this is a small dataset, we needed to test for proof and while we certainly have no evidence that the residents are not surviving to the 50th percentile, unfortunately we do not have the statistical evidence that they are surviving to beyond the 50th percentile. For the residents of Charterhouse, the average percentile reached is 53, again showing evidence that the average resident is doing better than the standard population of E&W.

5.3 Summary of analysis for the larger almshouses

The Appendix provides details of the observed data and how we tested the hypotheses for the almshouses, other than Royal Hospital Chelsea and Charterhouse, where there were 75 or more residents for a given gender. Tables 5.3a and 5.3b show the distribution of lives dying before the key percentiles, together with the average percentile reached by the population, expressed in terms of both observed numbers (Table 5.3a) and percentage of population (Table 5.3b).

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Royal Hospital Chelsea	591	1,959	2,388	3,355	4,145	45
DAMHA Males	33	191	239	356	440	48
DAMHA Females	66	360	460	673	767	44
Morden College Males	53	181	238	402	591	57
Morden College Females	35	159	214	353	487	55
Charterhouse	32	148	185	263	379	53
Salisbury Males	15	65	90	132	174	52
Salisbury Females	39	164	213	326	422	51
Trinity Males	14	62	81	117	165	52
Richmond Males	10	45	52	74	94	47
Richmond Females	19	95	123	181	254	53
Richard Watts Females	6	30	40	59	75	48
Davenport Females	10	29	37	55	78	53

Table 5.3a – The observed number of deaths by selected percentiles for each almshouse population where the number of residents in the data set is 75 or more

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Royal Hospital Chelsea	14.3%	47.3%	57.6%	80.9%	100.0%	45
DAMHA Males	7.5%	43.4%	54.3%	80.9%	100.0%	48
DAMHA Females	8.6%	46.9%	60.0%	87.7%	100.0%	44
Morden College Males	9.0%	30.6%	40.3%	68.0%	100.0%	57
Morden College Females	7.2%	32.6%	43.9%	72.5%	100.0%	55
Charterhouse	8.4%	39.1%	48.8%	69.4%	100.0%	53
Salisbury Males	8.6%	37.4%	51.7%	75.9%	100.0%	52
Salisbury Females	9.2%	38.9%	50.5%	77.3%	100.0%	51
Trinity Males	8.5%	37.6%	49.1%	70.9%	100.0%	52
Richmond Males	10.6%	47.9%	55.3%	78.7%	100.0%	47
Richmond Females	7.5%	37.4%	48.4%	71.3%	100.0%	53
Richard Watts Females	8.0%	40.0%	53.3%	78.7%	100.0%	48
Davenport Females	12.8%	37.2%	47.4%	70.5%	100.0%	53

Table 5.3b – The observed proportion of deaths by selected percentiles for each almshouse population where the number of residents in the data set is 75 or more

The methodology for testing the four hypotheses for the other large almshouses is the same as that used for Royal Hospital Chelsea and Charterhouse described in Sections 5.1 and 5.2. Table 5.4 provides a summary of the conclusions reached for each of the four tests.

Almshouse Population	Evidence residents are not surviving on average to the 40th percentile?	Evidence residents are surviving on average beyond the 40th percentile?	Evidence residents are not surviving on average to the 50th percentile?	Evidence residents are surviving on average beyond the 50th percentile?
Royal Hospital Chelsea	No	Yes	Yes	No
DAMHA Males	No	Yes	Yes	No
DAMHA Females	No	Yes	Yes	No
Morden College Males	No	Yes	No	Yes
Morden College Females	No	Yes	No	Yes
Charterhouse	No	Yes	No	No
Salisbury Males	No	Yes	No	No
Salisbury Females	No	Yes	No	No
Trinity Males	No	Yes	No	No
Richmond Males	No	No	No	No
Richmond Females	No	Yes	No	No
Richard Watts Females	No	Yes	No	No
Davenport Females	No	Yes	No	No

Table 5.4: Summary of the hypothesis tests carried out on almshouses with 75 or more residents in the data set

5.4 Summary of analysis for the smaller almshouses

As for the larger almshouses above, the following two tables show the distribution of lives dying before the key percentiles, together with the average percentile reached by the population, expressed in terms of both observed numbers (Table 5.5a) and percentage of population (Table 5.5b). Due to the size of the populations, we did not carry out the hypothesis tests as the results would not be statistically conclusive.

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Hurst Females	2	7	7	13	20	55
Hurst Males	2	6	7	11	16	55
Leicester Females	0	9	13	21	34	61
Leicester males	0	4	4	8	15	68
Richard Watts Males	4	21	27	36	44	53
Sheppard Trust Females	1	4	7	14	18	55
St Martins Females	0	2	3	7	9	61
United St Saviour’s Charity Females	1	5	7	9	10	39
United St Saviour’s Charity Males	0	1	1	3	5	63

Table 5.5a – The observed number of deaths by selected percentiles for each almshouse population where the number of residents in the data set is below 75

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Hurst Females	10.0%	35.0%	35.0%	65.0%	100.0%	55
Hurst Males	12.5%	37.5%	43.8%	68.8%	100.0%	55
Leicester Females	0.0%	26.5%	38.2%	61.8%	100.0%	61
Leicester males	0.0%	26.7%	26.7%	53.3%	100.0%	68
Richard Watts Males	9.1%	47.7%	61.4%	81.8%	100.0%	53
Sheppard Trust Females	5.6%	22.2%	38.9%	77.8%	100.0%	55
St Martins Females	0.0%	22.2%	33.3%	77.8%	100.0%	61
United St Saviour’s Charity Females	10.0%	50.0%	70.0%	90.0%	100.0%	39
United St Saviour’s Charity Males	0.0%	20.0%	20.0%	60.0%	100.0%	63

Table 5.5b – The observed proportion of deaths by selected percentiles for each almshouse population where the number of residents in the data set is below 75

Table 5.6a and Table 5.6b give the distribution for two almshouses where we hope to be able to retrieve more data in the future and hence carry out a more thorough analysis.

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Walthamstow Males	0	13	15	26	31	53
Walthamstow Females	4	18	22	27	31	40
Yardley Males	0	4	5	10	10	49
Yardley Females	1	5	6	13	13	48

Table 5.6a – The observed number of deaths by selected percentiles for each almshouse population where the data set is currently incomplete

Almshouse	10th	40th	50th	75th	Total	Average Percentile
Walthamstow Males	0.0%	41.9%	48.4%	83.9%	100.0%	53
Walthamstow Females	12.9%	58.1%	71.0%	87.1%	100.0%	40
Yardley Males	0.0%	40.0%	50.0%	100.0%	100.0%	49
Yardley Females	7.7%	38.5%	46.2%	100.0%	100.0%	48

Table 5.6b – The observed proportion of deaths by selected percentiles for each almshouse population where the data set is currently incomplete

Having analysed the percentiles that the residents of the different almshouses have reached, in the next section we quantify the longevity boost that the residents of two of the almshouses have received.

6 Determining the longevity boost from living in Charterhouse and Royal Chelsea Hospital

In Section 5, we analysed, for each participating almshouse, the percentile of survival reached when compared to the general population of E&W. We have seen that the percentile of survival varies between almshouses, but we have not yet quantified what the apparent longevity boost seen in some of the almshouses actually means in terms of extra years. For this study, separately for each gender, we have examined a number of different almshouses over a number of years and over a wide variety of entry ages. We now wish to quantify the number of extra years of life that living in an almshouse may give a resident. To be able to this, we need to make some assumptions to simplify the calculations.

Firstly, we have to pick an almshouse. We have initially chosen Charterhouse and acknowledge that this is one of the better performing almshouses. However, we have chosen it as it has a detailed history of the lives of its residents. Also, as most residents live there until they die, or until shortly before their death, the data are very complete. We can therefore ascribe the increase in life expectancy to the resident's time in the almshouse rather than any care they received after they left. In addition, the criteria for entering Charterhouse are very much in keeping with how most people see almshouses, i.e., the residents of Charterhouse are generally from the lower socio-economic groups. While it has been, until recently, a male-only almshouse, this in itself is interesting, as a lot of the literature implies that male lives are the hardest to reach in terms of sociability, which we argue could be one of the key driving forces behind why almshouses increase the longevity of its residents.

The second set of assumptions we have to make is to enable us to turn the 100 years of history and various entry ages into one figure. We provide the details below.

6.1 Charterhouse

To calculate the difference in longevity between the residents of Charterhouse, and the general population, our methodology uses the percentiles of the population which we have introduced in the previous section.

Our first assumption is that the average percentile to which the Charterhouse residents live has remained constant over the 100-year period over which we have collected the data; our second assumption is that this average percentile is the same for all entry ages. We have analysed these assumptions and determined them to be true, allowing for the fact that our data set is small.

With these assumptions in place, we can use the average percentile that our recorded lives reached over the investigation, which is 53. We therefore assume all new entrants to Charterhouse reach the 53rd percentile. We have also calculated the average age of a Charterhouse resident at entry to be 73. We therefore assume that the increase in life expectancy that a resident can expect can be represented by an assumed new entrant in 2023, aged 73 who will reach the age equivalent to the 53rd percentile of the E&W population.

Using the mortality rates for 2023, which were calculated by Villegas and Haberman (2014), we have calculated that the median future life expectancy in E&W for a 73 year old in 2023 is 16.92 years. We have also calculated that the age at death for a life aged 73 who survives to the 53rd percentile is 17.58 years. We can therefore say that the boost in future life expectancy for the average new resident at Charterhouse when compared to the general population of E&W is 17.58-16.92 = 0.66 years.

However, we would argue that this number understates the benefit that a resident gets in terms of life expectancy from being a resident at Charterhouse. As we have noted before, life expectancy is strongly correlated to a person’s socio-economic status, and we would argue that the average resident moving into Charterhouse is from the lowest of the socio-economic quintiles. From the same study by Villegas and Haberman (2014), life expectancy is broken down by socio-economic quintile, and the future life expectancy for someone from the lowest quintile in 2023 is 15.17 years. We therefore argue that the boost in life expectancy from living in Charterhouse is made up of two components which we call the “hidden boost” and the “transparent boost”. The “hidden boost” is that obtained from increasing the life expectancy of a resident from that of the lowest socio-economic quintile to an average resident of E&W which is equal to 16.92-15.17 = 1.75 years. The “transparent boost” comes from increasing the life expectancy to the 53rd percentile which is calculated above as 0.66 years. Therefore, the total boost of future life expectancy is 0.66 + 1.75 = 2.41 years. This equates to a boost in life expectancy of 15.9%.

It is interesting to note that if we calculate the future life expectancy of people in the second highest socio-economic quintile in E&W, their life expectancy is 17.53 years. This can be compared to the figure of 17.58 years for the new Charterhouse resident quoted above. In other words, living in Charterhouse appears to transform the residents' life expectancy from that of someone from the lowest socio-economic group to that of someone from the second highest, a remarkable achievement.

If we look more closely at the average age of a resident when they enter Charterhouse, then post-1950 the average age has been closer to 76 rather than 73 as we had assumed above. We can repeat our analysis using this new assumed entry age which gives the following. The implied life expectancy of a resident entering Charterhouse at 76 is 15.13 years compared to a life expectancy for the average citizen of E&W of 14.52 years. This gives us the equivalent "transparent boost" of 0.61 years, which can be compared to the 0.66 years for entry age 73. We find that the life expectancy of a 76-year-old in the lowest quintile is 13.19 years and so the "hidden boost" is 14.52 – 13.19 = 1.33 years. The total boost is therefore 1.94 years which is an increase in life expectancy of 14.7%. When we look at the future life expectancy of a 76-year-old from the second highest socio-economic quintile of the E&W population, we find that it is 15.01 years and so, once again, we conclude that being a resident of Charterhouse has boosted their future expected lifetime from that of someone in the lowest socio-economic quintile to that of the second highest.

6.2 Royal Hospital Chelsea

As we discussed earlier, the residents of Royal Hospital Chelsea had results which, at first glance, were disappointing in that the residents were not, on average, reaching the 50th percentile. However, we noted that Royal Hospital Chelsea residents have two factors working against them – that some of the residents may be using the hospital more as an end-of-life care facility than a traditional almshouse, and also that the residents are ex-servicemen, which is likely to affect their wellbeing.

We have now established a method that analyses how an almshouse can give both a "transparent boost" when compared to the standard E&W population, and a “hidden boost” when we look at lives taken from the lowest socio-economic quintile. We now use the method to consider whether residents of Royal Hospital Chelsea appear to be getting any “hidden boost”.

When analysing the data, we find that the average age of entry for a resident at Royal Hospital Chelsea is 73 and, as we have noted previously, their average percentile is 45. Repeating the methodology, we determine that the life expectancy of a new entrant into Royal Hospital Chelsea at age 73 as 16.46 years. This is below the average life expectancy of E&W for a 73 year old of 16.92 years; however, as we have also seen above, the average future life expectancy of someone from the lowest socio economics quintile is 15.17 years. Therefore, Royal Hospital Chelsea is indeed providing a boost to life expectancy when compared to this lowest quintile.

We can then carry out the same calculation looking at the second lowest quintile and we calculate this to be 16.36 years, which is just less than the 16.46 years value found for our assumed new Royal Hospital Chelsea resident. Therefore, we can see that a resident of Royal Hospital Chelsea has had their life expectancy increased from that of the lowest socio-economic quintile to that of the next highest. Whilst not as impressive as that seen at Charterhouse, it is still noteworthy given the headwinds that Royal Hospital Chelsea residents in aggregate face.

7 Conclusion

The aim of this project was to expand on previous work which focused on one particular almshouse, Whiteley Village, and showed that female residents received a 'longevity boost', i.e., they had longer life expectancy compared to both the general E&W population and to the population from the lowest socio-economic quintile (Mayhew, Rickayzen and Smith, 2017). We have investigated whether a similar boost is achieved by residents in other almshouses throughout England. A secondary goal was exploring whether any potential underlying causes of this longevity boost may be proposed based on the structures of the almshouses (social support and activity) where residents particularly benefit from this said boost.

When examining the data from several almshouses, and assuming that the residents are drawn from the lowest socio-economic quintile, we have found that residents are getting a boost relative to their peers who are not living in almshouses. Many of the almshouses appear to confer a longevity boost that increases their residents' life expectancy to that of a level achieved by an average member of the general population, which itself is a notable outcome. Furthermore, the best performing almshouses (Morden College and Charterhouse) have shown a boost which increases life expectancy to that of a life in the second highest socio-economic group. This finding is consistent with the results that Mayhew, Rickayzen and Smith (2017) obtained for the female residents of Whiteley Village.

To meet the secondary goal of this project, we have conducted a contextual analysis exploring the potential causes of longevity boosts in the best performing almshouses. It is important to note that we can only speculate on such causes, especially in light of substantial differences in the socio-economic, lifestyle, psychosocial and other backgrounds of the residents. Our suggestions here warrant further research which should include involvement and conversation with the current residents themselves.

As noted above, two of the best performing almshouses, in terms of longevity boost, were Charterhouse and Morden College. These two almshouses have a very focused centre physically as they are both based in one or two main buildings, and also communally as, for example, Charterhouse and Morden College both have community dining rooms where residents can eat and socialise together. We speculate that this strong sense of community and interaction is combatting the loneliness ‘epidemic' that previous research has identified as being especially prominent among older age groups, with those aged 70-79 most affected by social isolation (Röhr et al., 2022). The presence of this social component in Charterhouse and Morden College might then support the idea of a reduction in loneliness among residents, which could then lead to better physical and mental health (Gerino et al., 2017). Having said that, it is also important to note that Morden College residents may be of a more privileged background when compared to most other almshouse residents since, although now in financial hardship, they (or their spouse) tend to have come from a managerial background.

Our study includes data for some of the almshouses where residents come from industrial or military backgrounds which could have a significant detrimental impact on their quality and length of life. For example, we believe the outcome for the Royal Hospital Chelsea to be excellent given the ex-military status of the residents, as well as the fact that many of them might have moved directly into the hospital facilities rather than the almshouse itself. Unfortunately, the data with which we were provided did not enable us to distinguish between the two types of entrants. Similarly, it could be pointed out that DAMHA, which has some of the least positive results, is a physically much more dispersed almshouse set-up and so will find it harder to generate the same sense of community. This is compounded by the fact that more residents seem to move from the almshouse either back to the community or to another almshouse when compared to the residents in the other almshouses of this study. We also believe it is important to consider their prior heavy industry involvement, which could be leading to a shorter life expectancy. In addition, it should be noted that as we discussed in the methodology, we were only provided with data for DAMHA for 1997 onwards. This means the results for this almshouse are skewed against showing any longevity boost since it is impossible to include long-lived lives in our calculations for the younger entrants.

If we consider all the almshouses that participated in the study, a common theme is that they have all created a strong sense of community. We believe that this is one of the major contributors to the boost in life expectancy of almshouse residents when compared to similar people from the same socio-economic groupings. For example, a recent systematic review compiled the findings of 17 studies that investigated loneliness in older people living in care homes and found alarming rates of loneliness – a mean of 61% participants experienced moderate levels of social isolation (Gardiner et al., 2020). By contrast, as we have noted in the contextual analysis, all of the almshouses have some form of social activity and involvement, which makes them different to other types of standard sheltered housing, as well as regular care homes. We should highlight once more that the current study can only speculate about the benefits of community living, and further research is required to determine a full outline of the factors that may be contributing to the longevity boost.

We are not suggesting that living in an almshouse would suit everybody, nor that it would provide an automatic boost in longevity to everyone. The social interaction that we believe could be a significant reason why living in an almshouse might boost longevity will only work if residents enjoy this type of environment. In fact, it could be argued that almshouses attract sociable people who may not have suffered from the same isolation even if they had not lived in an almshouse, i.e., they would have lived longer anyway. However, the almshouse set up guarantees access to a community where the resident feels safe and connected and hence provides a way for such a person to gain in life expectancy, and in their standard of living. Without living in an almshouse, circumstances could conspire against them, and they might become socially isolated (with a consequent reduction in life expectancy).

Another reason that the longevity boost may not all be due to living in an almshouse is that there is a selection effect caused by those in poorer health and those unable to live independently generally being ineligible to enter the almshouse in the first place. Once admitted, however, a resident is likely to be provided with the care support they need if their health deteriorates, allowing them to remain at the almshouse until they require specialist end-of-life care.

As well as providing a longevity boost, an additional benefit of an almshouse community is that it helps to reduce delays in hospital discharges for almshouse residents (Housing LIN, 2021). This is because an almshouse can provide the necessary support to enable a hospitalised resident to be discharged as soon as they are physically ready. This is in contrast to a patient who lives in social isolation who may not be well or confident enough to look after themselves without further support, and therefore cannot be discharged from hospital. We believe, therefore, that a government policy to increase the number of almshouses (or equivalent), could save money from other parts of the welfare budget, as well as improving the standard of life of the recipients. Further investigation of the potential benefits of socialising could lead to government policy being directed appropriately in terms of maximising the benefits from all forms of sheltered housing and can be seen as part of the levelling up agenda.

8 Key Findings

- Our analysis has shown that residents in almshouses in England are receiving a longevity boost relative to people of the same socio-economic group from the wider population.
- The best performing almshouses in the study, Charterhouse and Morden College, have shown a longevity boost which increases life expectancy to that of a life in the second highest socio-economic group, which is a remarkable outcome.
- We estimate that a 73 year old male entering Charterhouse today would receive a longevity boost of 2.4 years (an extra 15% of future lifetime at the point of joining) compared to his peers from the same socio-economic group, and 0.7 years when compared to an average 73 year old from the general population.
- This longevity boost could be due to the strong sense of community and social interaction within almshouses which leads to better physical and mental health and helps combat the loneliness epidemic amongst older age groups.
- For the almshouses in the study which, at first glance, did not appear to perform so well, we postulate that this could be due to their residents' background of working in heavy industry or serving in the military. In other words, any boost could be masked by these additional negative factors which tend to have the effect of reducing life expectancy.
- An additional benefit of an almshouse community is that it provides the necessary support to enable hospitalised residents to be discharged as soon as they are physically ready.
- We recognise that further research is needed to fully understand the factors contributing to the longevity boost in almshouses so that the effects can be maximised and replicated in sheltered housing more generally.
- Our conclusion is that almshouses (or their equivalents) could help in the Government's aim to reduce mortality inequalities experienced in lower socio-economic groups.

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APPENDIX

We present here the details of our statistical analysis in respect of the almshouses with 75 residents or more in our data set.

A.1 Durham Aged Mineworkers Homes Association (DAMHA)

We now consider the residents of DAMHA. As noted in Section 4, the DAMHA dataset that was made available to us is very recent with data only starting in 1997. The effect of this on our data is that the newer residents skew the results slightly as they are unable to reach the highest percentiles.

DAMHA male residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	33	191	239	356
% of population who have died	7.5%	43.4%	54.3%	80.9%

Total observed deaths = 440

Table A.1a: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before. As the methodology is the same as for the Royal Hospital Chelsea and Charterhouse in Section 5, we will just consider the statistics.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.434 - 0.5}{\sqrt{\frac{0.5 \times (1-0.5)}{440}}} = -2.765$$

We can see that as this test statistic is negative that there is no evidence that male residents of DAMHA are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645 and so we have evidence that the male residents of DAMHA are living beyond the 40th percentile on average. The p-value for this statistic is 0.0028 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average male resident of DAMHA is surviving to the 50th percentile.

$$H_0: p = p_0$$
$$H_a: p > p_0$$

with a test statistic of:

$$z = \frac{0.543 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{440}}} = 1.812$$

The value of the test statistic is 1.812. As this statistic is greater than 1.645, we have sufficient evidence to reject this claim at the 5% significance level. The actual p-value of this test is 3.50% and so we have statistical proof that male residents at DAMHA are not making it to the 50th percentile on average.

Does the average male resident of DAMHA make it beyond the 50th percentile?

Our final hypothesis test does not have to be carried out for male DAMHA residents as we have already proven that the residents are not making it to the 50th percentile so there is no evidence that they are making it beyond the 50th percentile.

DAMHA female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	66	360	460	673
% of population who have died	8.6%	46.9%	60.0%	87.7%

Total observed deaths = 767

Table A.1b: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.469 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{767}}} = -1.697$$

Similar to previously, we can see that as this test statistic is negative that there is no evidence that female residents of DAMHA are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is only just less than -1.645 and so the evidence is not as clear as for our previous datasets that the female residents of DAMHA are living beyond the 40th percentile on average. The p-value for this statistic is 0.0448 so we still have evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average female resident of DAMHA is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.600 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{767}}} = 5.525$$

The value of the test statistic is 5.525. As this statistic is much greater than 1.645, we have strong evidence to reject this claim at the 5% significance level. The actual p-value of this test is much less than 0.0001.

Does the average female resident of DAMHA make it beyond the 50th percentile?

Our final hypothesis test does not have to be carried out for female DAMHA residents as we have already proven that the residents are not making it to the 50th percentile so there is no evidence that they are making it beyond the 50th percentile.

Summary for DAMHA residents

In a similar way to Royal Hospital Chelsea, the results for DAMHA residents are at first glance somewhat disappointing. However, the male residents have significant evidence that they are living to beyond the 40th percentile and as historically DAMHA residents were involved with the mining industry, the impact of this on their health will be hard to combat through living in an almshouse. For the female residents, our evidence of them living beyond the 40th percentile was only just significant at the 5% level. However, as we have noted before, as we only have access to very recent data this skews the results particularly for females as to reach the higher percentiles and be recorded in our analysis lives need to die beyond the age of 90 which is not always possible in the period of observation. For the residents of DAMHA, the average percentile reached 48 for males and 44 for females which is consistent with the statistical results described above.

A.2 Morden College

We now consider the residents of Morden College.

Morden College male residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	53	181	238	402
% of population who have died	9.0%	30.6%	40.3%	68.0%

Total observed deaths = 591

Table A.2a: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40^{th} percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.403 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{591}}} = -9.420$$

As for our previous almshouse, we can see that as this test statistic is negative that there is no evidence that male residents of Morden College are not making it to the 40^{th} percentile.

Do lives survive beyond the 40^{th} percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645 and so we have very significant evidence that the male residents of Morden College are living beyond the 40^{th} percentile on average. The p-value for this statistic is less than 0.0001 so we have very strong evidence that this is true.

Do lives survive to the 50^{th} percentile?

We can next proceed to asking whether the average male resident of Morden College is surviving to the 50^{th} percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.403 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{591}}} = -4.730$$

The value of the test statistic is -4.730. As this statistic is negative, we cannot reject the null hypothesis and therefore there is no evidence that male residents of Morden

College are not making it to the 50th percentile on average. This makes intuitive sense as more than 50% of the residents survived to the 50th percentile.

Does the average male resident of Morden College make it beyond the 50th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

Our test statistic here is -4.730. As this is significantly less than -1.645, we have very strong evidence that the male residents of Morden College are living beyond the 50th percentile on average. The actual p-value of this test is less than 0.0001.

Morden College female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	35	159	214	353
% of population who have died	7.2%	32.6%	43.9%	72.5%

Total observed deaths = 487

Table A.2b: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.326 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{487}}} = -7.658$$

As for our previous almshouse, we can see that as this test statistic is negative that there is no evidence that female residents of Morden College are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the female residents of Morden College are living beyond the 40th percentile on average. The p-value for this statistic is less than 0.0001 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average female resident of Morden College is surviving to the 50th percentile.

$$H_0: p = 0.5$$
$$H_a: p > 0.5$$

with a test statistic of:

$$z = \frac{0.439 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{487}}} = -2.674$$

The value of the test statistic is -2.674. As this statistic is negative, we cannot reject the null hypothesis and therefore there is no evidence that female residents of Morden College are not making it to the 50th percentile on average. This makes intuitive sense as more than 50% of the residents survived to the 50th percentile.

Does the average female resident of Morden College make it beyond the 50th percentile?

$$H_0: p = 0.5$$
$$H_a: p < 0.5$$

Our test statistic here is -2.674. As this is significantly less than -1.645, we have very strong evidence that the female residents of Morden College are living beyond the 50th percentile on average. The actual p-value of this test is 0.0037.

Summary of Morden College

The results for Morden College look good as for each of the four percentiles for both genders we are analysing, the observed residents had higher observed percentages of reaching those percentiles than the E&W population, i.e., the residents of Morden

College are observed to be living longer than the standard population. However, as this is a small dataset we needed to test for proof. For this almshouse we have very strong statistical evidence that the average resident for both genders is living beyond the 50th percentile. For the residents of Morden, the average percentile reached 57 for males and 55 for females again showing evidence that the average resident is doing better than the standard population of E&W.

A.3 Salisbury City Almshouse

We now consider the residents of Salisbury City Almshouse.

Salisbury City Almshouse male residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	15	65	90	132
% of population who have died	8.6%	37.4%	51.7%	75.9%

Total observed deaths = 174

Table A.3a: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.374 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{174}}} = -3.336$$

As for our previous almshouses, we can see that as this test statistic is negative that there is no evidence that male residents of Salisbury City Almshouses are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the male residents of Salisbury City Almshouse are living beyond the 40th percentile on average. The p-value for this statistic is 0.0004 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average male resident of Salisbury City Almshouse is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.517 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{174}}} = 0.455$$

The value of the test statistic is 0.455. As this statistic is less than 1.645, there is insufficient evidence to reject the null hypothesis, i.e., that there is little evidence that the male residents of Salisbury are not making it to the 50th percentile. The p-value for this statistic is 0.3246.

Does the average male resident of Salisbury City Almshouse make it beyond the 50th percentile?

Our test statistic here is positive so we have no evidence that the male residents of Salisbury City Almshouse are on average making it beyond the 50th percentile.

Salisbury City Almshouse female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	39	164	213	326
% of population who have died	9.2%	38.9%	50.5%	77.3%

Total observed deaths = 422

Table A.3b: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.389 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{422}}} = -4.576$$

As for our previous almshouse, we can see that as this test statistic is negative that there is no evidence that female residents of Salisbury City Almshouse are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the female residents of Salisbury City Almshouses are living beyond the 40th percentile on average. The p-value for this statistic is less than 0.0001 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average female resident of Salisbury City Almshouse is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.505 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{422}}} = 0.195$$

The value of the test statistic is 0.195. As this statistic is less than 1.645, there is insufficient evidence to reject the null hypothesis, i.e., that there is little evidence that the female residents of Salisbury City Almshouse are not making it to the 50th percentile. The p-value for this statistic is 0.4228.

Does the average female resident of Salisbury City Almshouse make it beyond the 50th percentile?

Our test statistic here is positive so we have no evidence that the female residents of Salisbury City Almshouse are on average making it beyond the 50th percentile.

Summary of Salisbury City Almshouse

The results for Salisbury City Almshouse look good as for each of the four percentiles for both genders we are analysing, the observed residents had similar observed percentages of reaching those percentiles as the E&W population, i.e., the residents of Salisbury City Almshouse are observed to be living similar lives to the standard population. This is backed up by the hypotheses tests as for both genders there was strong evidence that the average resident was living beyond the 40th percentile while the evidence for the 50th percentile was that there was no evidence that they were not reaching it nor exceeding it, i.e., it is likely that they were similar to the standard population. For the residents of Salisbury City Almshouse, the average percentile reached 52 for males and 51 for females again showing evidence that the average resident is similar to the standard population of E&W.

A.4 Trinity Hospital

We now consider the residents of Trinity Hospital.

Trinity Hospital male residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	14	62	81	117
% of population who have died	8.5%	37.6%	49.1%	70.9%

Total observed deaths = 165

Table A.4: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.376 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{165}}} = -3.192$$

As for our previous almshouses, we can see that as this test statistic is negative that there is no evidence that male residents of Salisbury City Almshouse are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the male residents of Trinity Hospital are living beyond the 40th percentile on average. The p-value for this statistic is 0.0007 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average male resident of Trinity Hospital is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

with a test statistic of:

$$z = \frac{0.491 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{165}}} = -0.234$$

The value of the test statistic is -0.234. As this statistic is negative, we cannot reject the null hypothesis and therefore there is no evidence that residents of Trinity

Hospital are not making it to the 50th percentile on average. This makes intuitive sense as more than 50% of the residents survived to the 50th percentile.

Does the average resident of Trinity Hospital make it beyond the 50th percentile?

Our test statistic here is -0.234. As this is greater than -1.645, we have little evidence that the residents of Trinity Hospital are living beyond the 50th percentile on average. The actual p-value of this test is 40.77%.

Summary of Trinity Hospital

The results for Trinity Hospital look good as for each of the four percentiles we are analysing, the observed residents had higher observed percentages of reaching those percentiles than the E&W population, i.e., the residents of Trinity Hospital are observed to be living longer than the standard population. However, as this is a small dataset we needed to test for proof and while we certainly have no evidence that the residents are not making it to the 50th percentile, unfortunately we do not have the statistical evidence that they are making it beyond the 50th percentile. For the residents of Trinity Hospital, the average percentile reached is 52 again showing that the average resident is similar to that of the standard population of E&W.

A.5 Richmond Charities

We now consider the residents of Richmond Charities.

Richmond Charities male residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	10	45	52	74
% of population who have died	10.6%	47.9%	55.3%	78.7%

Total observed deaths = 94

Table A.5a: Observed number and proportion of male deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.479 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{94}}} = -0.413$$

As for our previous almshouses, we can see that as this test statistic is negative that there is no evidence that male residents of Richmond Charities are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is greater than -1.645, and so we little evidence that the male residents of Richmond Charities are living beyond the 40th percentile on average. The p-value for this statistic is 0.3400 showing that we have very little evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average male resident of Salisbury City Almshouse is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.553 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{94}}} = 1.031$$

The value of the test statistic is 1.031. As this statistic is less than 1.645 there is insufficient evidence to reject the null hypothesis, i.e., that there is little evidence that the male residents of Richmond are not making it to the 50th percentile. The p-value for this statistic is 0.1512.

Does the average male resident of Richmond Charities make it beyond the 50th percentile?

Our test statistic here is positive so we have no evidence that the male residents of Richmond Charities are on average making it beyond the 50th percentile.

Richmond Charities female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	19	95	123	181
% of population who have died	7.5%	37.4%	48.4%	71.3%

Total observed deaths = 254

Table A.5b: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.374 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{254}}} = -4.016$$

As for our previous almshouse, we can see that as this test statistic is negative that there is no evidence that female residents of Richmond Charities are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the female residents of Richmond Charities are living beyond the 40th percentile on average. The p-value for this statistic is less than 0.0001 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average female resident of Richmond Charities is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.484 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{254}}} = -0.502$$

The value of the test statistic is -0.502. As this statistic is negative there is no evidence to reject the null hypothesis, i.e., that there is no evidence that the female residents of Richmond Charities are not making it to the 50th percentile.

Does the average female resident of Richmond Charities make it beyond the 50th percentile?

Our test statistic here is greater than -1.645, so we have little evidence that the female residents of Richmond Charities are on average making it beyond the 50th percentile. The p-value of the test is 0.3078.

Summary of Richmond Charities

The results for Richmond Charities show a difference between the two genders. For males, the observed deaths were higher than for the standard population but still there was no evidence that the average male resident wasn't reaching the 40th percentile. However, there was some but not enough evidence that they might not be reaching the 50th percentile but the relatively small data set for males means that conclusions are hard to reach. For females, we had strong evidence that the average resident was living beyond the 40th percentile and some evidence, though not statistically significant, that they were living beyond the 50th percentile. To support these conclusions, we can note that the average percentile for the male residents was 47 whereas the females reached the 53rd percentile.

A.6 Richard Watts Charity

We now consider the female residents of Richard Watts Charity as the number of male residents is too small for a more thorough analysis.

Richard Watts Charity female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	6	30	40	59
% of population who have died	8.0%	40.0%	53.3%	78.7%

Total observed deaths = 75

Table A.6: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.400 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{75}}} = -1.732$$

As for our previous almshouse, we can see that as this test statistic is negative that there is no evidence that female residents of Richard Watts Charity are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is less than -1.645, and so we have significant evidence that the female residents of Richard Watts Charity are living beyond the 40th percentile on average. The p-value for this statistic is 0.0416 so we have significant evidence that this is true.

Do lives survive to the 50^{th} percentile?

We can next proceed to asking whether the average female resident of Richard Watts Charity is surviving to the 50^{th} percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.533 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{75}}} = 0.577$$

The value of the test statistic is 0.577. As this statistic is less than 1.645 there is insufficient evidence to reject the null hypothesis, i.e., that there is no evidence that the female residents of Richard Watts Charity are not making it to the 50^{th} percentile. The p-value of the test is 0.2819.

Does the average female resident of Richard Watts Charity make it beyond the 50^{th} percentile?

Our test statistic here is positive and so we have no evidence that the female residents of Richard Watts Charity are on average making it beyond the 50^{th} percentile.

Summary of Richard Watts Charity

For the female residents of Richard Watts Charity, we had strong evidence that the average resident was living beyond the 40^{th} percentile little evidence supporting the assumption they were not making it to the 50^{th} percentile but no evidence that they were making it beyond the 50^{th} percentile. To support these conclusions, we can note that the average percentile for the female residents reached the 48^{th} percentile.

A.7 Davenport Homes

We now consider the residents of Davenport Homes.

Davenport Homes female residents

Percentage of deaths from EW population	10%	40%	50%	75%
Observed deaths	10	29	37	55
% of population who have died	12.8%	37.2%	47.4%	70.5%

Total observed deaths = 78

Table A.7: Observed number and proportion of female deaths by selected percentiles of E&W population

We will now carry out the four hypothesis tests as before.

Do lives survive to the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.372 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{78}}} = -2.265$$

As for our previous almshouses, we can see that as this test statistic is negative that there is no evidence that female residents of Davenport Homes are not making it to the 40th percentile.

Do lives survive beyond the 40th percentile?

$$H_0 : p = 0.5$$
$$H_a : p < 0.5$$

The test statistic here is clearly less than -1.645, and so we have very significant evidence that the female residents of Davenport Homes are living beyond the 40th percentile on average. The p-value for this statistic is 0.0118 so we have very strong evidence that this is true.

Do lives survive to the 50th percentile?

We can next proceed to asking whether the average female resident of Davenport Homes is surviving to the 50th percentile.

$$H_0 : p = 0.5$$
$$H_a : p > 0.5$$

Test statistic

$$z = \frac{0.474 - 0.5}{\sqrt{\frac{0.5 \times (1 - 0.5)}{78}}} = -0.453$$

The value of the test statistic is -0.453. As this statistic is negative, we cannot reject the null hypothesis and therefore there is no evidence that residents of Davenport Homes are not making it to the 50th percentile on average. This makes intuitive sense as more than 50% of the residents survived to the 50th percentile.

Does the average resident of Davenport Homes make it beyond the 50th percentile?

Our test statistic here is -0.453. As this is greater than -1.645, we have little evidence that the residents of Davenport Homes are living beyond the 50th percentile on average. The actual p-value of this test is 32.53%.

Summary of Davenport Homes

The results for Davenport Homes look good as for each of the four percentiles we are analysing, the observed residents had higher observed percentages of reaching those percentiles than the E&W population, i.e., the residents of Davenport Homes are observed to be living longer than the standard population. However, as this is a small dataset we needed to test for proof and while we certainly have no evidence that the residents are not making it to the 50th percentile, unfortunately we do not have the statistical evidence that they are making it beyond the 50th percentile. For the residents of Davenport Homes, the average percentile reached is 53 again showing that the average resident is similar or slightly better when compared to the standard population of E&W.

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