Historical Analysis of the UK Population after age 65

by

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This is the third article in the series exploring the progression of the UK population; the previous ones dealt with the effect of mortality rate and the population progression up to age 65 from 1953 to 2015/2060, this one deals with the progression into old age. As the population progresses into elderly age, it moves into a regime of rapidly rising mortality rates which dominate the progress thereafter leading to high mortality and fast population decline.

This historical analysis study of the UK population with age over time has been carried out as a part of the population progression over the past 80 years and its effect on the current problem of the ageing population and future population trends. It shows a simple picture of population increasing in waves through age until it meets the final mortality barrier of old age, where it finally expires.

Increased population flow and its implications were identified in an earlier publication (Marshall et al, Radstats), but at that time were confused with the WWII baby boom, whose main significance was the persistence with time, due to higher survival, in the under 65 population, although it was part of these changes and still persist today. It was followed by the first of this series on the effect of mortality rate changes on the UK population (Read, Radstats 111) and the historical analysis of UK population up to age 65.

The ageing population was considered as a function of time with forward projections assessing the economic problems of the redistribution over the ages and emphasis on the growth of the elderly. The latest 2015 life tables show a slowing down of this trend with the 2015/2014 mortality rate ratio becoming constant over the age range, suggesting the transition to new steady state conditions

This could give a simpler explanation on the effect of the population changes now occurring, the presence of a reduced mortality wave progressing with age is that of a cumulative population wave meeting

the resistance of the mortality attrition barrier of rapidly rising mortality rates of old age or even just the penetration of rate change into this barrier.

More simply, the population is increasing due to improved lifestyles and this builds up steadily with age and time to form a tidal wave of larger population which meets the resistance of old age, where it dies out. This is now occurring but has some 20 odd years before the flow passes age 75, reaches age 85 and finally subsides after 95, as shown in the population projections, which stabilise at a new higher level at lower ages.

Population Progression with Age

It should be emphasised that the results are based on actual historical basic data of births, deaths and population published by ONS (use is fully acknowledged), they therefore reflect what is actually happening without assumption modification, although any interpretation, represents the author's opinion.

The earlier paper showed four population increase waves, two from world war baby booms, the important one of population survival and the just started latest nett migration wave; in this paper we are mainly interested in the survival wave as it move into retirement.

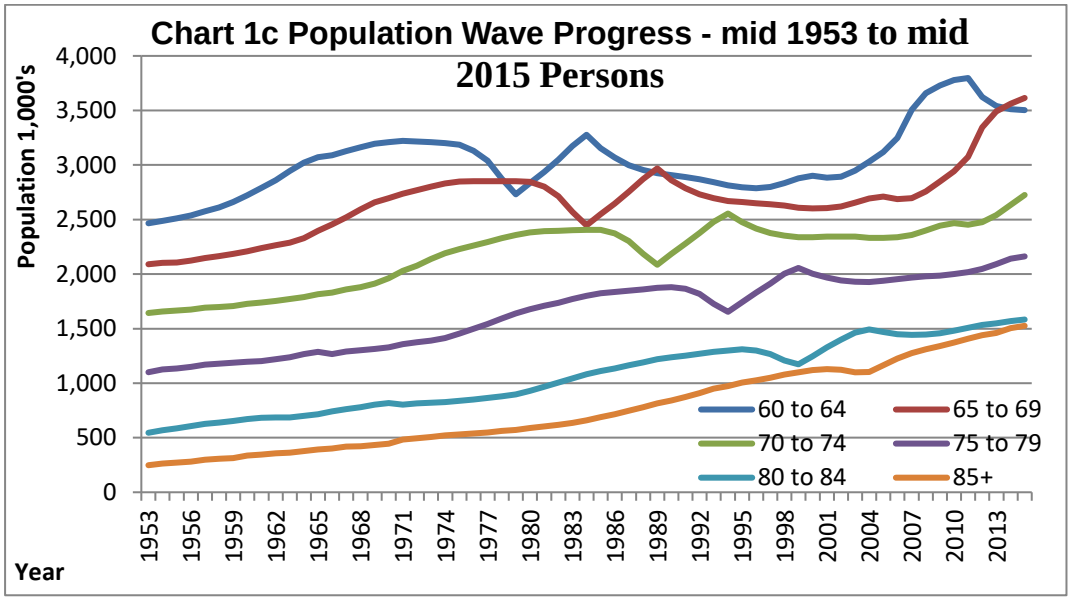
This wave stated in 1940 at birth, the increase progressed steadily for 10 years and then reduced over the next 15 years back to a new steady state and has moved with age in time, where it has continued to date reaching the age of 65, where it hit the mortality attrition barrier and is decaying with the population.

Chart 1c gives the population progression from age 60-64 in five year groups up to 80-84 and then 85+, the first curve (blue 60-64) shows the WWI peak at 1980 to 1984, which then proceeds on to the survival and WWII peak starting in 2000 and peaking in 2011. The next WWI peak starts five years later and the following population years follow on from this, with the WWII peak and survival peaks not having yet arrived; the WWI peaks start to decay after 1986 and have disappeared by 2005.

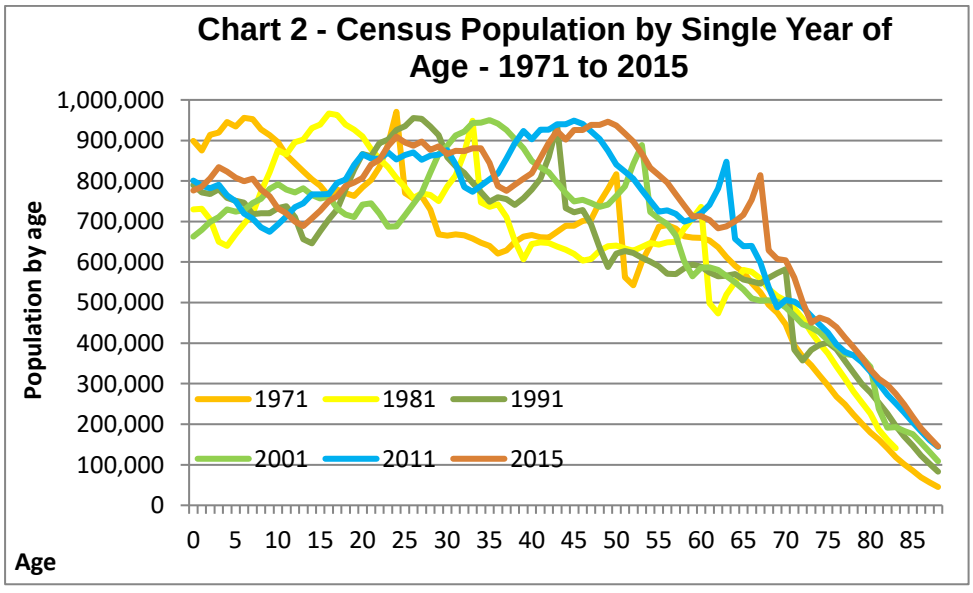
Looking at these in more detail, in age order, we can see the decline in numbers that is occurring and the early 1920 first peak that decays

from 3,300 at age 65 in 1984 to 1500 at 84, some 40%, 20 years later in 2004. At the same time the WWII baby boom is reaching its peak in 2011 numbering 3,800 and is just passing through age 60 to 64.

These charts can be used for projecting forward and backward in time for any event, trough or peak and used to confirm forward projections in time. The 1980-84 graph shows the first indication of decay of the first wave size, although all show the decline in population numbers after age 55, in addition the change after 65 between wave additions remain virtually unaltered for many years.



The survival curve started in 1940 and continues on to 1977 over some 34 years, peaking in the 35-39 series in 2000 and will have passed 65 by 2030.



The next chart 2 gives the variation of population by age for the ten year Census period from 1971 to 2011 and 2015 and again emphasises the rapid decline after age 65, with a six-fold decrease in population numbers by age 85. This gives discrepancies of a factor 2 to 4 in the actual population decline from age 65 against the predicted life expectancy values, dealt with later.

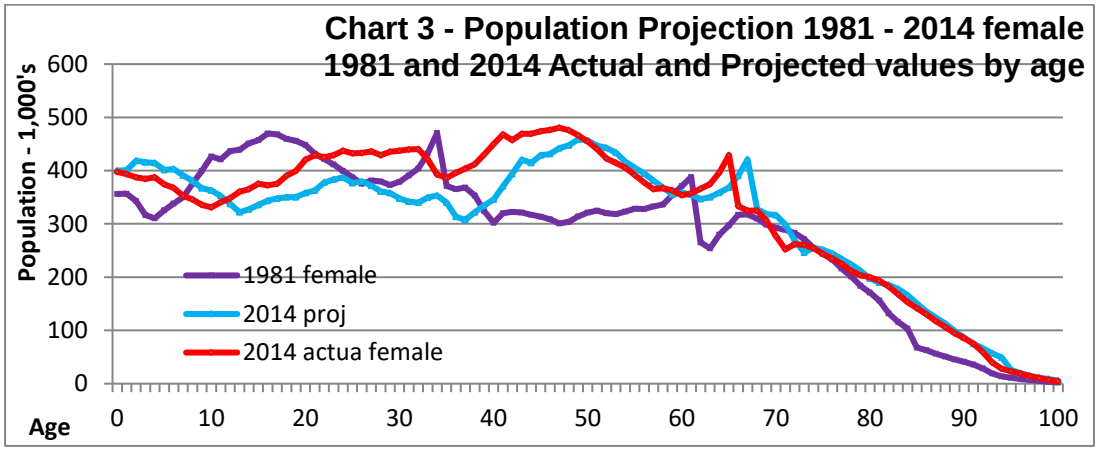
When the population passes age 50, it moves into the mortality attrition zone, by 65 it is well into this major change in population, where mortality rates start to rise exponentially, for males at 50 it is 0.00032, by 65 it has risen to 0.0123 by 85 equals 0.100; females give 0.0022, 0.008 and 0.086. These are large changes, a factor 8 to 10 from age 65, having major effects on population and its decline.

This confrontation raised several new anomalies which need clarifying, including reductions in mortality rates moving with age, plus questions on mortality rates themselves.

Projections versus Actual Population.

The standard cohort projections were carried out for the population from 1971 to 2015 using actual data and the results showed in chart for females (males similar) an increase of actual against projected probably associated with nett migration.

Using the actual ONS data of population and qx distribution, this was an attempt to explore any discrepancies between standard projection techniques and the actual 2014 population distribution by single year of age, the aim being to look for any time discrepancies.



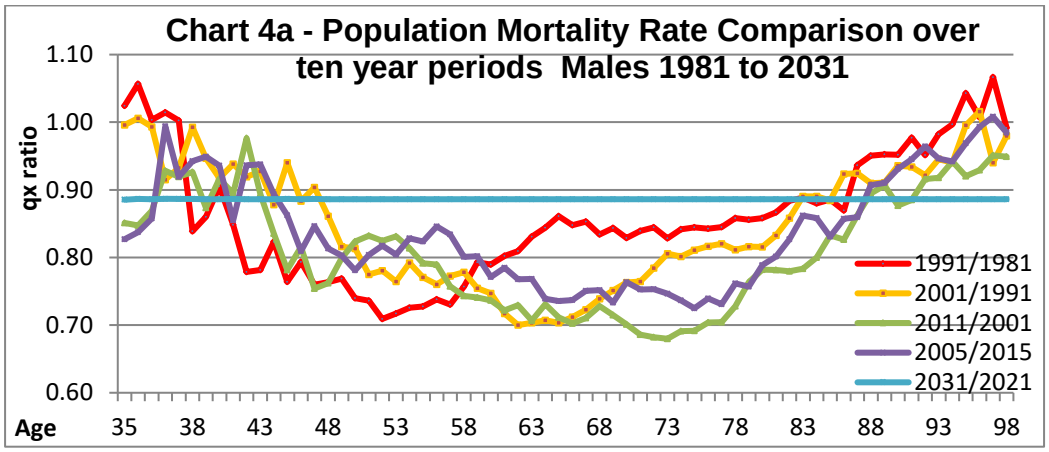
The population comparisons shown in chart 3, actually diverge from projected, being higher from age 10 to 48, which could be associated

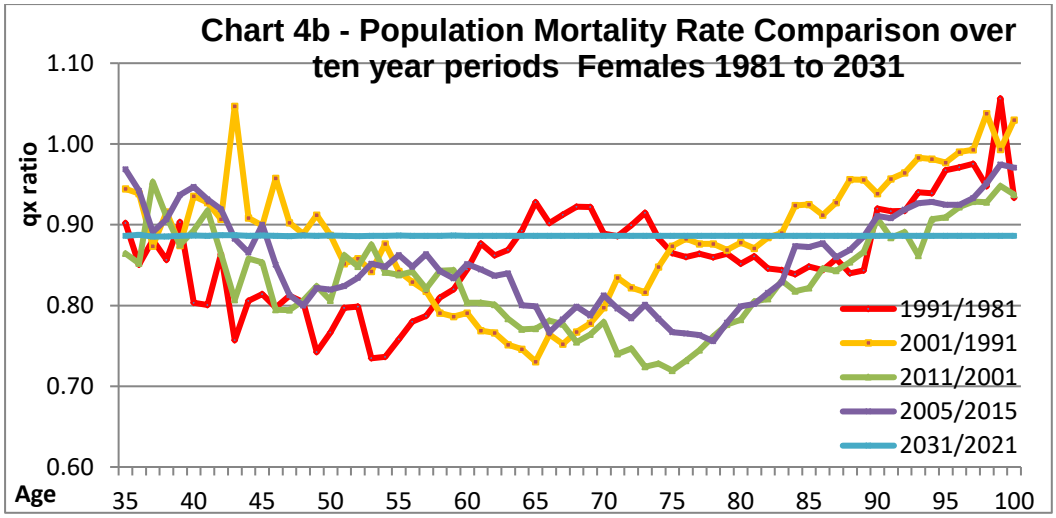
with migration that is not included in the projections but then appear to suffer an age/time lag between 48 and 75 of some 2 years, plus any nett migration, with female less pronounced than male, which is unlikely to be due to migration and possibly indicative of a time lag in actual results.

Mortality Rate Study Results

There is uncertainty on the progression of mortality rate (qx) change beyond 65 and the current conception of the ageing population. Consideration of the qx ratio over a period of ten years shows some significant features not apparent in lower ratios and these values were taken from the available UK National Life Tables from 1981 to 2014 and recently 2015, with earlier data awaited.

The results are given in the charts 4a &b for male and female over the age range 35 to 100 and show a wave of reduced mortality which progresses with age in time from age 55 in 1981/1971 to age 78 by 2015/2005. The small values at lower ages lead to wide fluctuations (noise) which is confusing, but the trends are clearly apparent at higher ages.



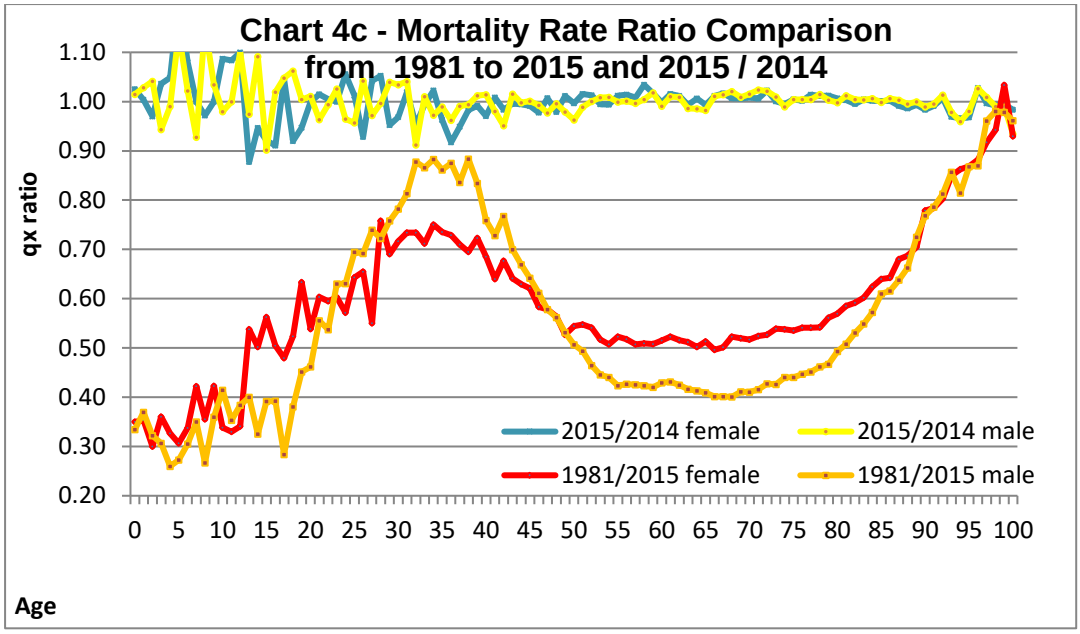


This was initially interpreted as a wave of reduced mortality, with an age bandwidth of some 25 years, passing through the population with age, but why it should do so was assumed to be the way medical and social advances had developed. However access to 1971 EW life tables showed no sign of the wave starting in the 1981/1971 ratios and it appears associated with the approach to elderly population older age.

The 2015/2005 curve shows a slowing down of the wave with a four year age difference in the minimum value at 78 for females and virtually nothing for males and all ratios return to constant mortality rate by age 100.

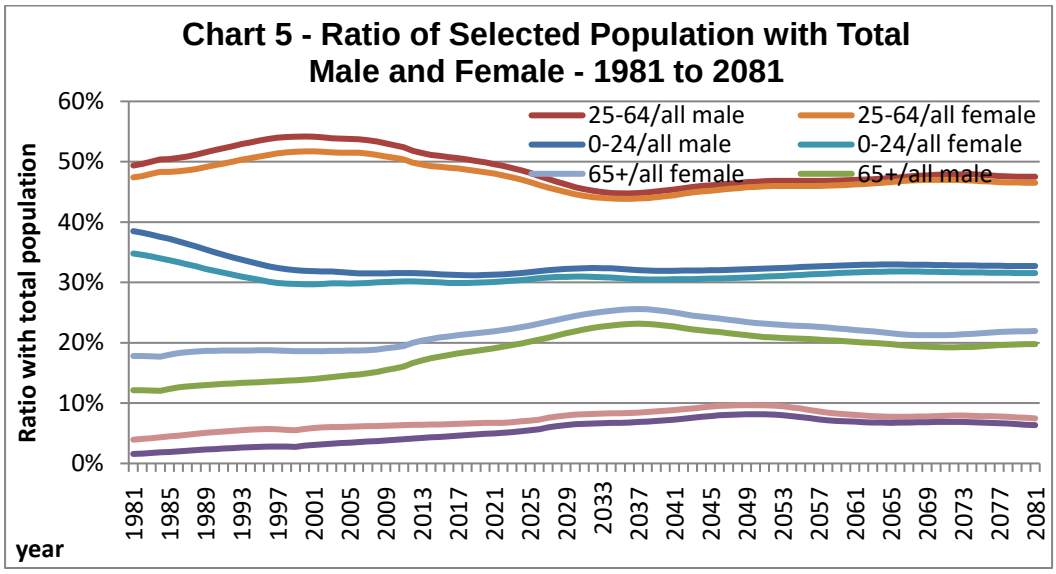
This is shown in the next chart 4c, which shows the relationship with age for the survival wave increase and mortality rate projections. The 1981/2015 ratio shows the overall changes that have occurred over this period, with the rapid rise from birth to age 40 from 1940 to 1981, the current drop from 1981 to 2015 to age 75 and the rise to come from age 75 to 100 over the next 25 years.

The 2015/2014 ratio shows constant mortality rate at all ages, with virtually no changes occurring, indicating the approach to a new steady state.



Population Projections to 2081

The projection from 1981 to 2081 is given in chart 5, which shows the ratio of male and female population to the overall total, emphasising the dependency of the young and older population on those in work and how this varies with time.



The working population 25-64 drops from a peak of over 50% in 2001 to 44% by 2038, the young remain fairly constant, whilst the 65+ rise from under 20% to 25% of the total population and the 80+ rise to almost 10% . This underlines the urgent need for this part of the population to become self sufficient.

Life Expectancy Discrepancy with Population Decline from 65+.

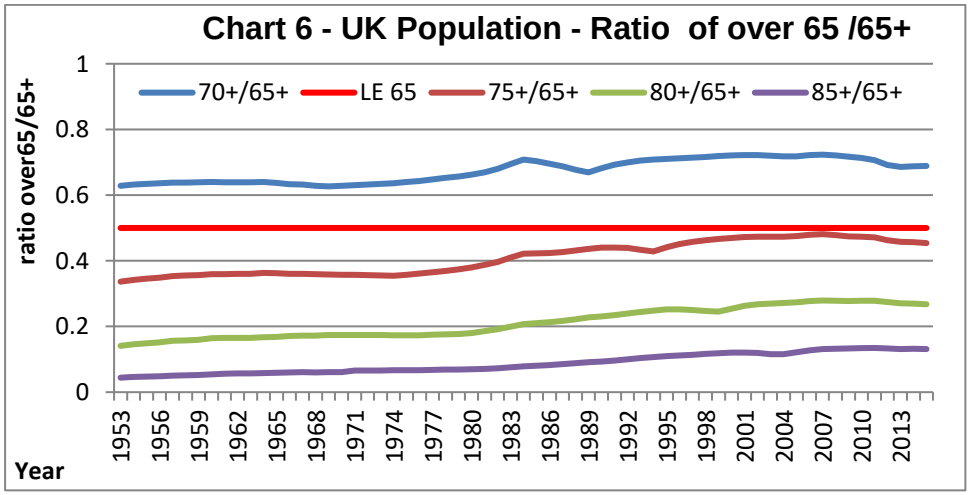
Life expectancy is another area where interpretation errors appear to be occurring and this factor is given great importance in the economic assessment of provision for the elderly and decisions being made on affordability, retirement age and pensions generally.

The latest 2015 Life Table review makes the following statement :- "Life expectancy at age 65 for men in the UK was 18.5 years in 2013–2015 and for women it was 20.9 years. This means that a man aged 65 could now expect to live to age 83.5 and a woman to age 85.9".

This appears to be the generally accepted interpretation of life expectancy of 100% survival to age 85, which is wrong, it is in fact the population half life at that age clearly supported by the lx predicted decline of 100,000 births and defined in the early life tables, which also gave median values. Only half the population at age 65 will reach age 85 but in addition there is a divergence of this predicted data from the actual decline of the 65+ population.

Life expectancy is therefore only pertinent to the individual at that age, who represent only 7% of the total over 65 population, the over 65 group population decline at a much faster rate, with average lifespan of 10 years and only 27% or less at age 85 and over.

This was raised in the earlier paper (Radstats 111), showing the rapid fall off in population numbers above age 65 and confirmed in chart 6, which gives the ratio of population above 65 with 65+. The 85+/65+ ratio of actual population is 13.1% as opposed to 50% for life expectancy predictions, which equals the75+ ratio, almost a factor 4 out, a much larger speed of decline.



Elderly health does not appear to be improving dramatically in old age and the indications are that the mortality attrition barrier will continue its dominance and adjust to the new increased flow conditions to create a new steady state in th elderly population or even a return to earlier states. There are also signs that new flow surges are occurring, particularly positive mortality rate changes.

However the position could be more complex with a time delay between cause and effect, mortality may not react instantly to rapidly rising population rates, which would depress derived mortality rates, effectively a temporary distortion, as introduced earlier. This is only a transitional effect.

In the condition where a rising mortality wave reaches the mortality attrition barrier of increasing mortality rates, what if we accept a time lag between life and mortality in the equation mx =px*qx with respect to population px and time. This suggests a drop in mortality rate at such a boundary interchange, observed earlier in this paper considering mortality rate ratios around the 65+ age group, possibly explaining the inconsistency. This needs much further investigation!

The simple explanations for the presence of a reduced mortality wave progressing with age is that of a rising cumulative population wave made up of the survival wave plus the WWII fertility wave meeting the resistance of the mortality attrition barrier of falling population due to rapidly rising mortality rates of old age or even just the penetration of this rate change into this barrier.

The picture emerges of a population flow moving unimpeded and progressively with age until it meets the resistance of rapidly rising mortality rates of old age where it start to react and decline; the question then arises on whether the apparent drop in mortality rate observed exists or is a reaction to this collision.
This could partially explain the divergence of life expectancy prediction from the actual over 65 population decline, the elderly population will still rise rapidly due to flow momentum penetration and survival probability but its persistence depend on which is the stronger effect.
The latest results suggest the wave is dying out and returning to a constant mortality situation until the next major wave, positive or negative arrives.

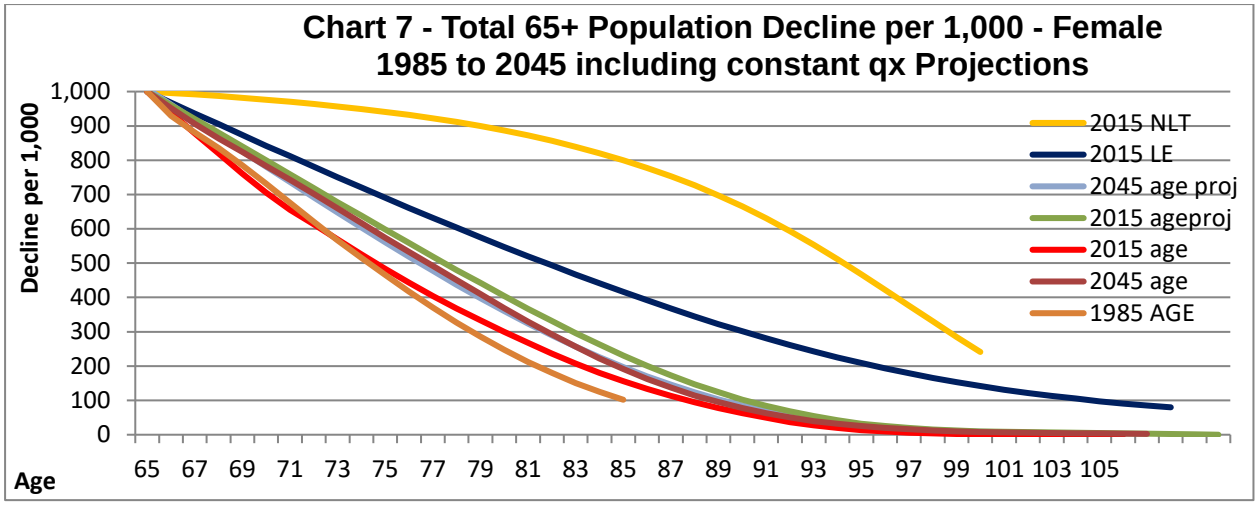
This has a major impact, a factor two or more on pension provision costs and with other considerations exaggerating these and the population numbers reaching older age. In fact present contribution levels, efficiently managed, adequately meet elderly needs and could actually save money on NI contributed State pensions. The discrepancy between actual 65+ population decline and predicted life expectancy is large enough to question the reliance on LE as an economic factor in the care and economic costs of the elderly.

Chart 7 clearly shows the difference in these decline curves, the yellow curve shows the predicted life expectancy curve for 2015 with a slow decline, this contrasts with the age and projection curves spaced close together showing a much faster decline, which has been carried through the population for generations.

It gives the age decline from 1985 carried through to 2045, followed by the 2015 and 2045 age projection curves all showing sharp declines with average50% life spans from age 65 of 10 to 14 years, the projections take data up to 2060 and 2090 respectively.

In the projections, if one tracks the progress of the population age 65 alone with time and age through 66, 67 etc., one obtains a tracked decline close to the life table one, suggesting this is a characteristic of the individual alone. The projected curves therefore reflect the total population or group characteristics and are more meaningful from economic considerations and a practical viewpoint.

The age curves are closely spaced in one group and show the slower decline of females, with an average lifespan (50%) of 11 years to 2076; the forward projections from 2014 to 2059 and 2064 to 2111 show this has increased to 14 years at age 79 and for 2064 to 2111 to 13 years to age 78, the curves have reversed due to stabilising out into a new steady state with age 85+ population dropping off. The life tables showing life expectancy at 20 years for male and 23 years for female, give completely different predicted decline curves, which is emphasised by the LE curve showing much faster decline with age, reaching 40% by age 85.



There is a difference between the group total population over a given age at any given time and its behaviour and decline and the individual cohort of a given age tracked over time as treated in survival figures and life tables and this is illustrated in the table below (in 1,000's):-

The first part of the table shows the overall group 60+ and 65+ population for 2015 with the first column giving the total UK population for comparison, the next columns are taken from the forward projections to 2114 (given in the UK population chapter).

Group	**Total/Age**	**60+**	**65+**	**70+**	**75+**	**85+**	**95+**
2015 age	65,110	15,113	11,611	7,997	5,271	1,526	116
% of 65+			100%	68.9%	45.4%	13.1%	1.0%
2015 proj	65,110	19,640	11,611	9,203	6,768	2,462	61
% of 65+			100%	74.9%	50.3%	15.6%	1.5%
2045 age	67,603	19,938	15,897	12,284	8,747	2,635	306
% of 65+			100%	77.3%	55.0%	16.6%	1.9%
Individual	Life Tables		65/ 2015	70/ 2020	75/ 2025	85/ 2035	95/ 2045
Male			100%	92.9%	82.0%	45.9%	7.4%
Female			100%	97.6%	94,1%	80%	46.8%

Male	65/2014		100%	92.8%	81.8%	45.7%	7.5%
Female			100%	95.2%	87.6%	57.7%	13.6%

These show the decline of the population to over 70 in 2019; over 75+ in 2024; over 85 in 2034 and over 95 in 2044; the 2064 values show the similar decline projected that occurs in 50 years, although the numbers are higher the decline is just as rapid and similar results occurred for 2034.

Nett Migration

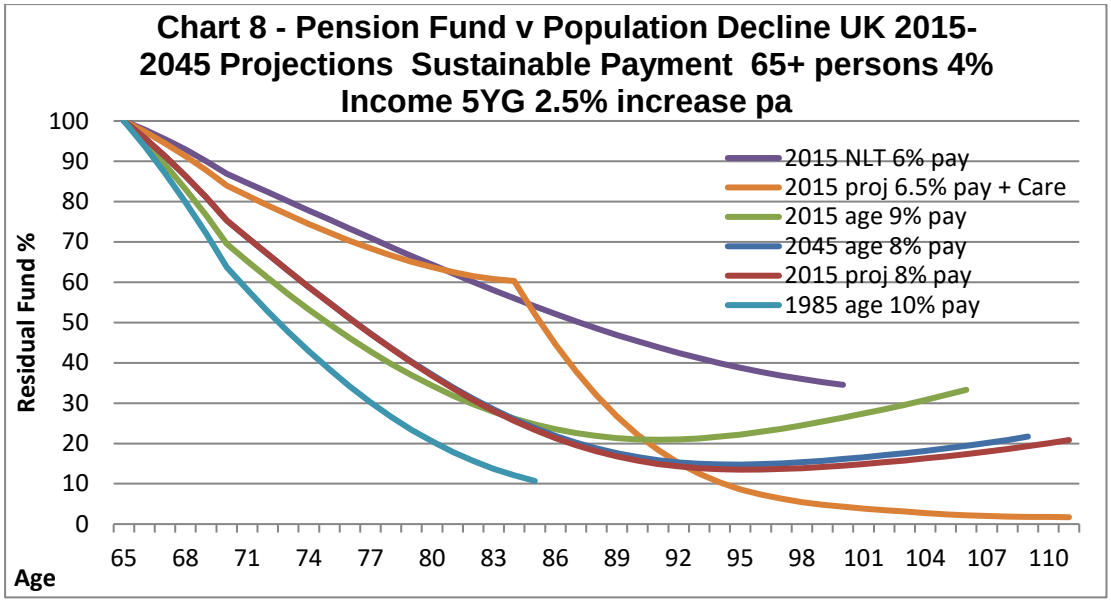
This hardly affects the over 65 population as currently it occurs in a narrow age bandwidth, 18 to 32, peaking sharply at age 25 and will not reach age 65 for some 30 to 40 years, net emigration occurs but pensions are still paid by the UK government, although savings can occur in benefits. Nett migration can increase the population in work and hence decrease the dependency ratio over this period.

Pensions and Social Care

The model, based on these decline curves, with the higher female data given, follows the standard annuity practice of payment guaranteed for 5 years and increasing by inflation annually by 2.5%, the latest forward population projections (2014) are used to determine the total over population decline per 1,000 from age 65 and the model run at a given investment income over a range of payment options to determine the Fund decline from 100% with time to determine the sustainable situation where fund and population reach zero together.

Results are given in chart 8 for a modest investment income of 4% and the population decline of 2015, projected for 2015 and 2045, also the decline shown by Life tables, and an example of care costs being allowed from age 85. They only apply to the most economic group funded schemes.

The calculations were shown to be very sensitive to change and therefore a good indicator of reasonable sustainable payments and it was therefore surprising how close the forward projection were to each other.



The 2015 to 2045 age 65 to 110 projection readily sustained an 8% payment level, which was maintained in the forward projections from 2015 and increased in the 2045 projections, even life tables (life expectancy) projections, valid for individual pension schemes, sustained a 6% payment level.

A simple elderly care model was run in which care costs at 3 times pension value (total 4 times pension overall) was paid from age 85 to all surviving pensioners, sustainable payments of 6.5% from retirement were needed. These gave total pension payments of £32,000 at current State pension and £48,000 per year at the expected pension values of £12,000 basic for the pensioners surviving.

Conclusions

The over 65 UK population is more complex than originally anticipated, dominated by the pressures from the increasing survival of lower ages with the rising flow and the mortality attrition barrier of rapidly rising mortality rates and their conflict and interaction as they meet in the elderly population.

In 1940, the UK population changed dramatically as a result of 25 years of austerity with an increase due entirely to increased survival, independent of fertility changes, it started surprisingly at pregnancy/ birth and progressed steadily with age through the population, currently reaching age 75.

This was confused with the WWII baby boom which started in 1945 as an addition, however the survival wave cumulatively increased the UK population and although decreasing now in magnitude will continue until 2038, affecting the higher ages and referred to as the current problem of ageing.

It is not ageing as such, which is proceeding normally but delayed from age 65+, but is due to the survival aspect of increasing numbers entering retirement and surviving longer; it nevertheless causes balance problems due to the existing dependence of the elderly population on those in work. There is also the nett migration increases and obesity/indolence decrease wave which are just appearing.

Differences also occurred at the mortality rate interface with old age, leading to an apparent transitional age related drop in ratios, which was part of the overall discrepancy between life expectancy and average lifespan. This was associated with the population decline from age 65.

The predicted 65+ decline is much slower from life tables than that associated with age and projected age decline taken from historical population data by a factor four or more, which has a major effect on decisions made on economic costs on pensions and social care. This means that State action on retirement age relating this to predicted life expectancy are not justified and have little relevance.

Overall the population balance is changing and by 2038 the 80+ population will have increased by a factor 3 due to the survival wave, although numbers are lower it makes a major difference to dependency on those in work and this needs relieving by making the over 65's independent and self-sufficient.

This can only be done by dramatic changes to the State pension scheme, still the main pension provider in the UK. The present pay as you go is economically inefficient with Funds not existing, allowed to accumulate or grow or even keep up with inflation, pensions should also include elderly care.

References and Acknowledgements

ONS reports used :- copy of nltuk1315life table 2015; UK Population Estimates 1838 – 2015

The Elderly Population in 2014 John Read -Radstats 111 2016

Historical Analysis of Population/Mortality Rate Changes in UK

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