Allowing for COVID-19 in CV22 US VitaCurves

This note sets out the approach we have taken in the CV22 edition of Club Vita's US VitaCurves ("CV22") to allow for the impact of the COVID-19 pandemic. It should be read alongside our *Calibrating CV22 VitaCurves* paper, which sets out details of the calibration approach, as well as our *Data underpinning CV22 VitaCurves* paper which covers the data underpinning the calibration.

1 Background

The CV22 calibration of VitaCurves is calibrated over the 2018 to 2020 period. It is the first version of VitaCurves to include the COVID-19 period. COVID-19 had a material impact on mortality rates in 2020, with mortality rates in the Club Vita data around 9% higher for men and around 14% higher for women than predicted[1].

It is our view that simply reflecting the latest data in the calibration (under a 'business as usual' ('BAU') approach) would not be viewed as a credible best estimate of future mortality rates **when used in combination with a 'conventional' mortality improvement assumption**. Based on our consultation with users, we have therefore made available two distinct versions of the CV22 VitaCurves:

- The 'BAU' VitaCurves, labelled as v1, constructed using the usual calibration process;
- Adjusted VitaCurves, labelled as v2, where adjustments have been applied to 'strip out' excess mortality

Different users of VitaCurves are likely to have differing views on the appropriate level of adjustment to make to baseline mortality in light of the pandemic, and how to combine these base tables with improvements to estimate mortality rates during the pandemic and post-pandemic periods. Users may therefore wish to apply their own adjustments to the BAU v1 VitaCurves depending on their exact approach.

Details of how we have derived the adjustments that we applied to generate our adjusted (v2) Curves are set out in this paper, along with details of the key underlying assumptions.

2 Adjustment Factors applied to 'BAU' VitaCurves

The charts below show the final Adjustment Factors required to remove our estimate of the excess mortality due to COVID-19 at each age, for men and women, from the BAU (v1) VitaCurves.

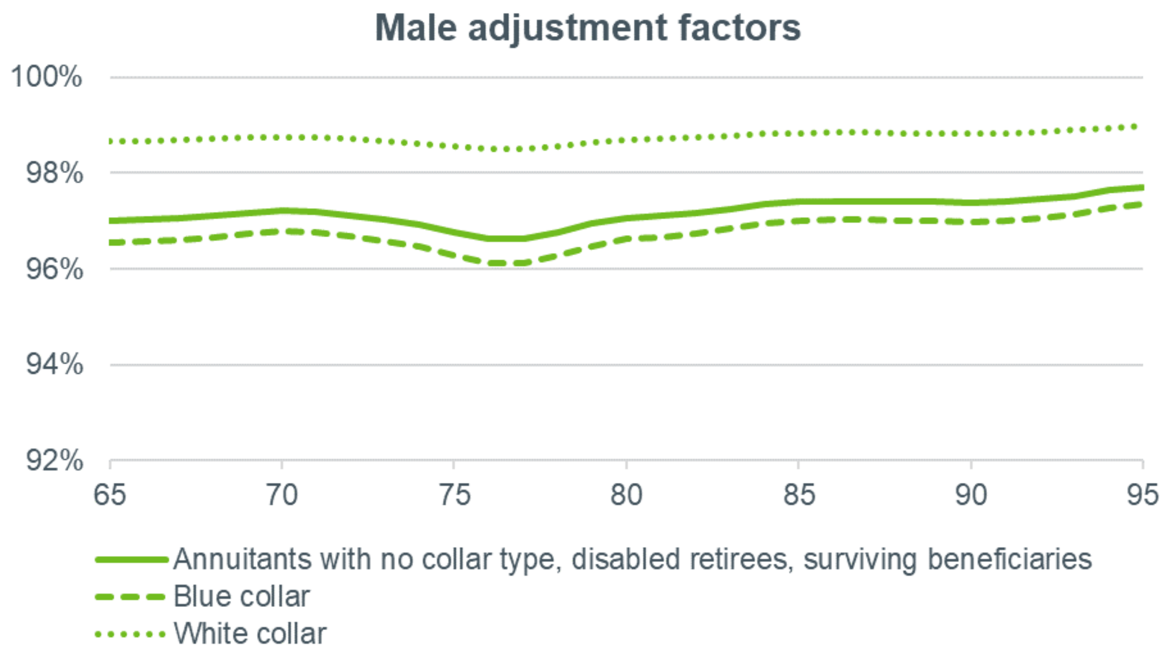
For men, there are three sets of factors, which apply to the following groups of curves:

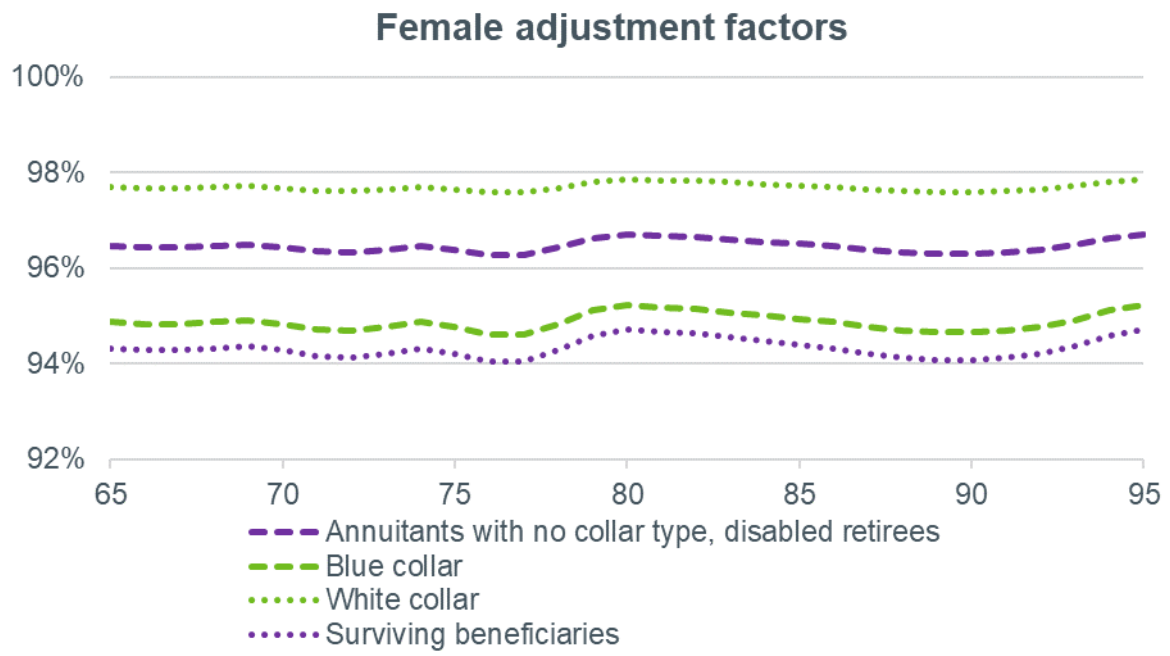
- annuitant curves with no collar type, disabled retirees curves, and surviving beneficiaries;
- annuitant blue collar curves; and
- annuitant white collar curves.

For women, there are four sets of factors, which apply to the following groups of curves:

- annuitant curves with no collar type, and disabled retirees curves;
- surviving beneficiaries curves;
- annuitant blue collar curves; and
- annuitant white collar curves.

[1] Based on fitting to 2017-2019 and rolling forward from 2018 to 2020 using MP-2021 improvements


Male adjustment factors
100%
98%
96%
94%
92%
65
70
75
80
85
90
95
Annuitants with no collar type, disabled retirees, surviving beneficiaries
Blue collar
White collar


Female adjustment factors
100%
98%
96%
94%
92%
65
70
75
80
85
90
95
Annuitants with no collar type, disabled retirees
Blue collar
White collar
Surviving beneficiaries

3 Summary of approach

The adjustment factors were derived using the following process:

- The first step is to determine the level of 'excess' mortality seen in the Club Vita data during 2020. We have chosen to define this as the ratio of the actual to expected age standardised mortality rate, based on experience in the Club Vita data in 2020 (where the 'expected' value is based on rolling forward fitted 2017-2019 mortality rates in line with the Society of Actuaries MP-2021 improvement rates);
- There was no clear indication of a strong age-based component of the excess mortality in 2020 in the Club Vita data. There was however a discernible shape by age to the excess 2020 mortality in the U.S population[2]. We therefore applied the same shape by age seen in the population data in 2020 to the Club Vita figures, after adjustment for the relative overall levels of excess mortality. This approach gave excess mortality figures which provided a better fit to the Club Vita data by age than an age-invariant adjustment for both men and women.
- This 'excess' mortality in 2020 can then be converted to an adjustment factor applying to the BAU curves (fitted over 2018-20), reflecting the fact that VitaCurves are, in essence, three-year averages;
- Having settled on this general methodology, we explored whether there was sufficient evidence in the data to support adjustment factors which varied by socio-economic group (e.g. longevity group, pension, occupation, pension form) or across our different retirement status types (normal health annuitants; disabled retirees and surviving beneficiaries).

  There were significant differences in the excess mortality of female annuitants and female surviving beneficiaries, and also between collar types (for both genders). It was agreed, therefore, to have separate adjustment factors for female annuitants and beneficiaries and collar types (both genders).

We set out more details of each of these steps in the following section.

4 Detailed approach

4.1 Deriving adjustment factors

The first step in deriving adjustment factors was to define the level of 'excess' mortality that was seen in 2020. There are a number of ways in which this could be done – for example by comparing actual and expected numbers of deaths. However, our analysis focused on the ratio of standardised mortality rates ('SMRs)', on the grounds that this was a pragmatic approach, which distilled variances down to a single figure and removed the distorting effects of the age structure, which might vary between populations and subgroups.

In generating the SMR values, in each case we standardised using the ACS Decennial 2010 population. For the standardisation we combined the Males and Females to create a single non-gendered Standard Population.

[2] See https://www.soa.org/resources/research-reports/2022/rpec-mortality-improvement/

The calculations were based on the 65-95 age range, which is consistent with the age range used in calibrating CV22 VitaCurves for annuitants and surviving beneficiary data. Details of the method of extending to younger and older ages are set out in Appendix 2. Disabled retirees and unknown health retirees were both excluded from the calculations.

4.1.1 Determining excess mortality in 2020

The calculation of excess mortality in 2020 was carried out as follows:

- Exposures and deaths at each age in 2020 were aggregated from the Club Vita data set (on a lives basis, split by gender, and any subgroups being investigated).
- Expected deaths at each age in 2020 were calculated based on observed exposures in the Club Vita data set and expected mortality rates. These expected rates were found by deriving mortality rates fitted over 2017 to 2019 period (so applying to 2018), using the same data used to calibrate CV22 and retaining the same modelling decisions as adopted for BAU CV22 VitaCurves. The mortality rates obtained were then rolled forward to 2020 (from 2018) using Society of Actuaries MP-2021 improvement rates.

  In calculating expected deaths, each participant was 'mapped' to the most granular curve, based on their available characteristics, again in a consistent manner to BAU CV22 v1 VitaCurves.
- Crude mortality rates were calculated at each age, based on dividing observed and expected deaths by exposures;
- Actual and expected SMR values were then found, based on weighting the corresponding crude rates by the standard population.
- The ratio of these actual and expected SMR values then gave the level of 'excess' mortality in 2020.

Using this approach, the excess 2020 mortality was found to be **9.0% for men** and **14.0% for women**.

4.1.2 Converting excess mortality to adjustment factors

The next step is to derive adjustment factors which remove the 'excess' 2020 mortality from the BAU VitaCurves. Given that VitaCurves are, in essence, three-year averages, and if we assume that all of the 'excess' mortality in 2020 is due to COVID-19, and that mortality in 2018 and 2019 is in line with expectations, we can then adopt a simplified approach to deriving the appropriate scaling factors of:

$$\frac{3}{3 + \text{Excess mortality in 2020}}$$

Under this approach the excess mortality of 9% for men and 14% for women would result in adjustment factors of **97.1% for men** and **95.5% for women**.

4.2 Varying adjustment factors

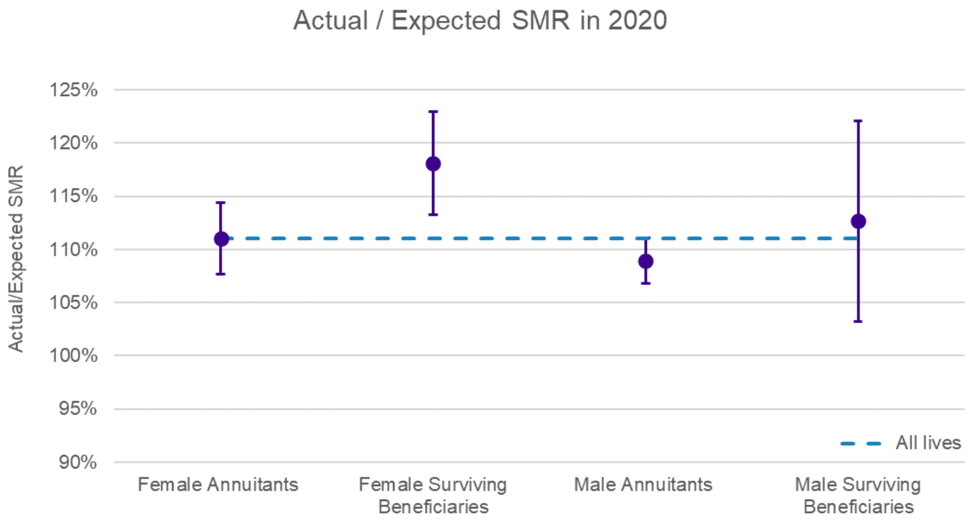
This simplified approach outlined in Section 4.1 results in adjustment factors that only vary by gender, and are applied across all affluence measures (e.g. longevity group, pension band, collar type, form of pension) and retirement statuses (normal-health and disabled retirements plus surviving beneficiaries).

We explored whether it would be justifiable to have adjustment factors that varied by other attributes (i.e. status, longevity group; collar type; pension form), by following a similar approach to that set out above, and comparing the resultant excess mortality rates, as defined by the ratio of actual to expected SMRs.

We explore each of these options below.

4.2.1 Variation by retirement status

The chart below illustrates the results of splitting the analysis by status. The dashed line shows the overall average, and the 'whiskers' on each point show the confidence intervals around the resultant ratios of actual over expected SMR values.

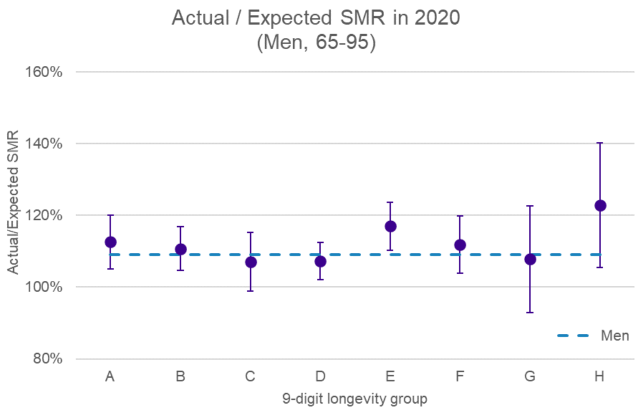


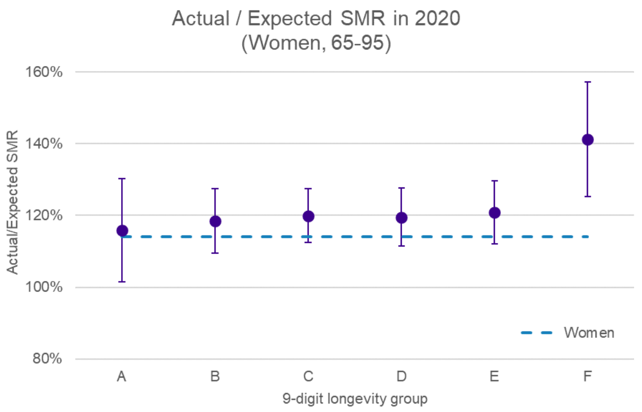
Female surviving beneficiaries have a materially higher A/E ratio (118.1%) than female annuitants (111.0%). While there is some overlap of confidence intervals, there was sufficient evidence to support treating female annuitants and surviving beneficiaries separately. Given the potential materiality of the difference in adjustment factors, we took the view that it would be appropriate to have different adjustment factors for these two groups.

For men, while again surviving beneficiaries have a materially higher A/E ratio (112.7%) than male annuitants (108.9%), the confidence interval for surviving beneficiaries is very wide (as a result of there being relatively few male surviving beneficiaries in the Club Vita data). Therefore there is no credible evidence to support treating male annuitants and surviving beneficiaries separately.

4.2.2 Variation by longevity group

We next explored whether there was sufficient variation in excess mortality when splitting by our longevity groups (combining normal health annuitants and surviving beneficiaries). The results for the ZIP+4 based (9-digit) longevity groups (separately for men and women) are shown below.

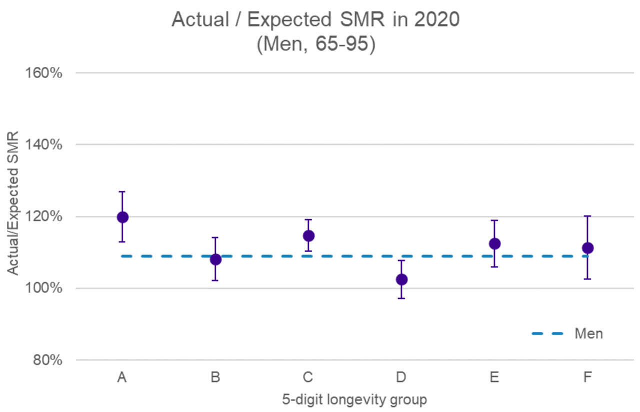


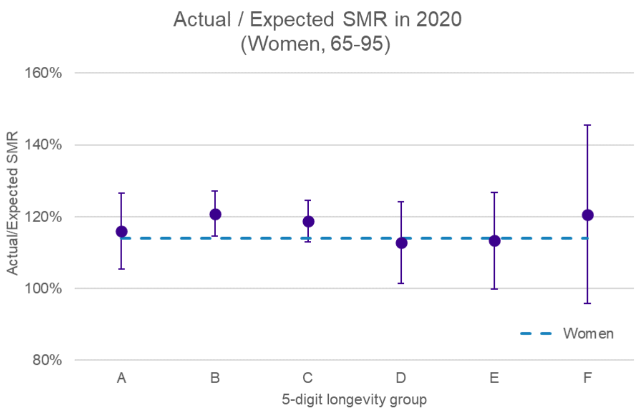


There is no clear pattern by longevity group shown, with most groups having fairly similar results. The one exception is the longest-lived longevity group for women, which has seen markedly high ‘excess’ mortality. Therefore we could potentially have derived separate adjustment factors for the highest longevity group for women.

However, given this is a relatively small group, the lack of similar experience in men (where the longest lived group saw slightly elevated excess, but not to the same extent), and the somewhat counter-intuitive result (we might expect the longest lived, and so most affluent, lives to be less impacted by the pandemic), we decided not to use a separate adjustment factor for 9-digit longevity group.

The corresponding splits by ZIP based (5-digit) longevity groups are shown below:

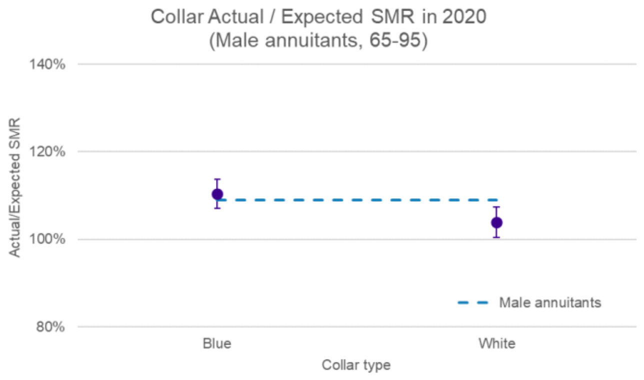


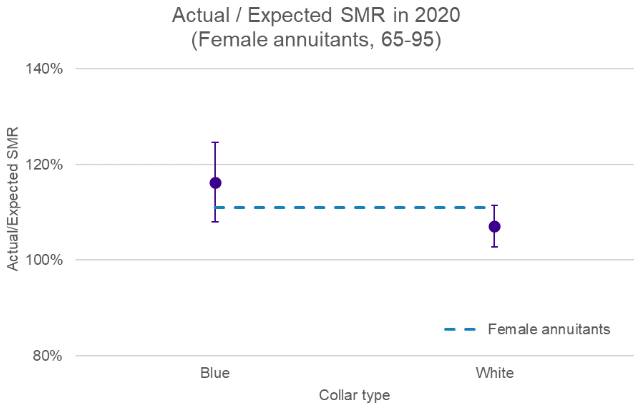


Again there is no clear pattern, therefore we decided not to use a separate adjustment factor for 5-digit longevity group.

4.2.3 Variation by collar type

The excess 2020 mortality calculations for annuitants, split between blue and white collar type (separately for male and female annuitants) are shown below.



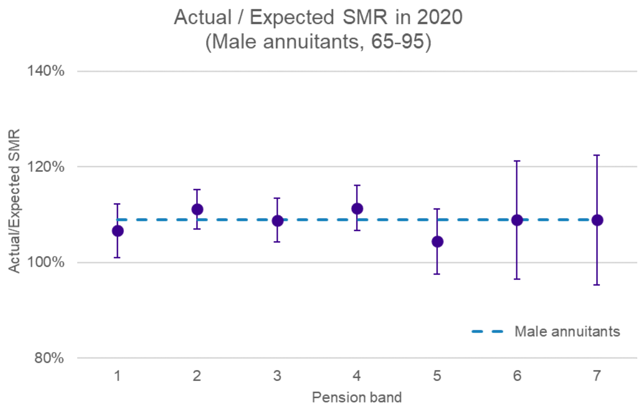


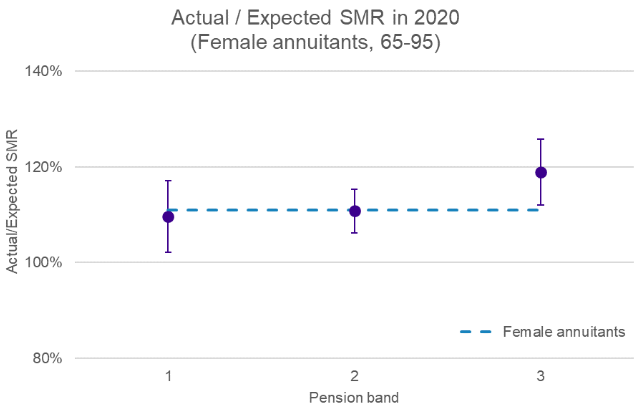
Male blue collar annuitants have a higher ASMR ratio (110.4%) than white collar annuitants (104.0%). Similarly female blue collar annuitants have a higher ASMR ratio (116.3%) than white collar annuitants (107.1%).

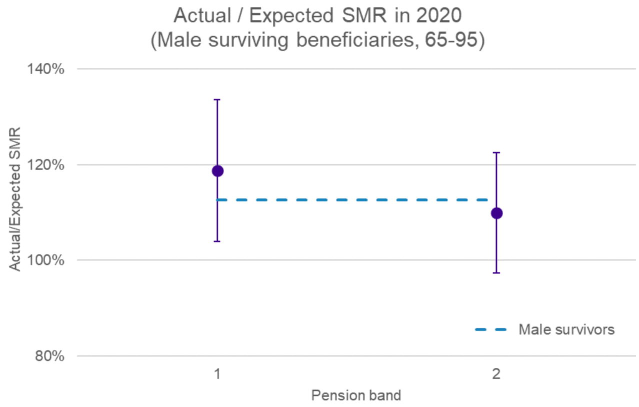
While there is some overlap of confidence intervals, we nevertheless believe that there is sufficient evidence to justify generating separate adjustment factors by collar type, for men and women.

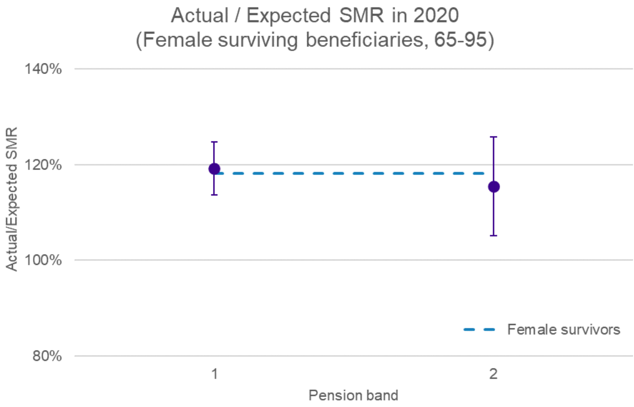
4.2.4 Variation by pension band

The excess 2020 mortality calculations split by pension band (separately for each status and gender) are shown below.





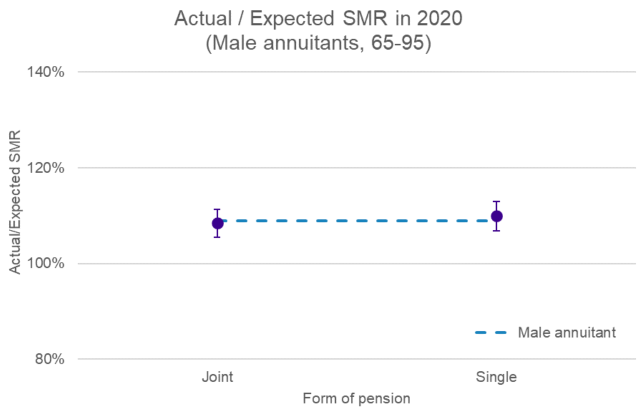


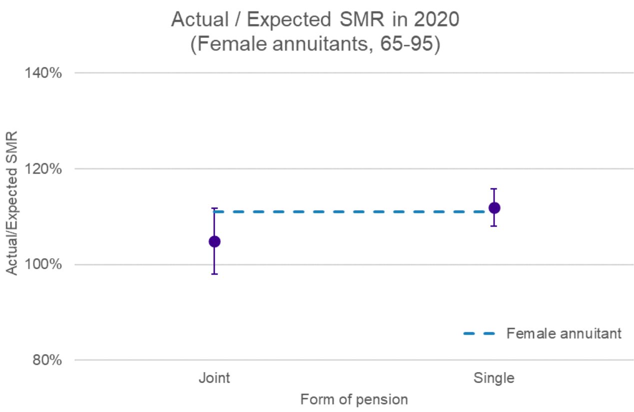


There is no clear pattern by pension band across any of the groups shown, so we have decided not to support adjustment factors varying by pension band for any group.

4.2.5 Variation by pension form

The excess 2020 mortality calculations for annuitants, split by pension form and gender, are shown below.



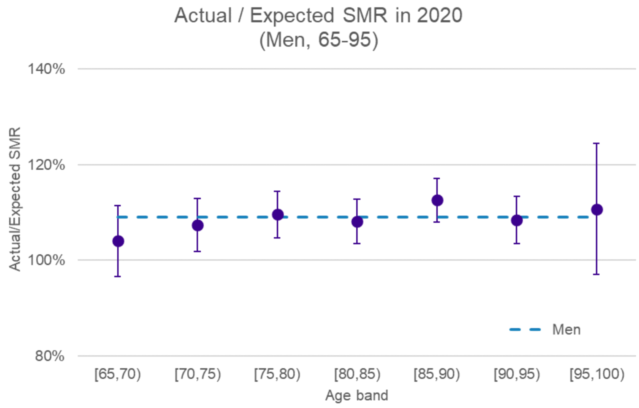


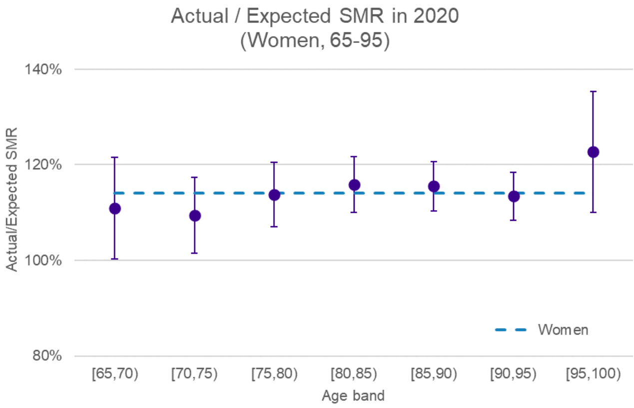
Male joint life annuitants have a similar ASMR ratio (108.4%) than single life annuitants (109.9%). However female joint life annuitants have a lower ASMR ratio (104.9%) than single life annuitants (111.9%).

The ratios indicate a possible justification for separating the adjustment factors for pension form for women only. However, the levels of exposures for joint life annuitants for women are fairly low (as seen by the relatively wide confidence interval). Therefore, it was decided not to separate the adjustment factors by pension form for any group.

4.2.6 Variation by age band

The excess 2020 mortality calculations when looking at five-year age bands (separately for men and women, with annuitants and survivors combined) are shown below.





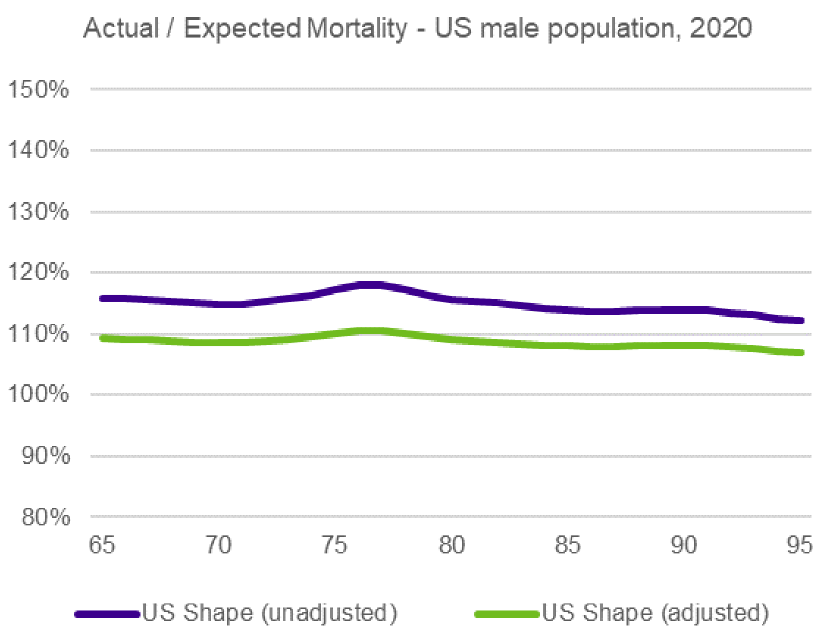
There is no clear pattern by age band for men or women, so no particular evidence to support adjustment factors varying by age. However we nonetheless felt it would be appropriate to add an age shape to the calculated adjustment factors. This was done with reference to the US national population age shape, as outlined in section 4.3.

4.3 Applying an age shape to the excess mortality

We started from the excess mortality in 2020 seen in the US population by age and sex, as published by the SoA[3], which showed some variation in excess mortality by age for both men and women. We used this age shape to derive an age shape to apply to the Club Vita excess mortality, by scaling to reflect the relative excess mortality rates seen in the two populations.

We followed a similar age standardisation approach to determine the overall measure of excess 2020 mortality seen in the US population, applying the same standard population to the SoA's published excess mortality rates – this gave an overall population excess measure of 15.5% for men and 13.8% for women.

We then obtain a scaling factor by comparing the excess 2020 mortality in the Club Vita data to that seen in the US national population. At an aggregate level, the Club Vita data saw excess mortality of 9% for men and 14% for women, which when compare to the 15.5% and 13.8% values above gave scaling factors of 58.1% for men and 101.4% for women. We illustrate the scaling impact for men in the chart below.



[3] See https://www.soa.org/resources/research-reports/2022/rpec-mortality-improvement/

Similar calculations are carried out to derive appropriate scaling factors for each set of adjustment factors. These scaling factors are then applied to the age based excess mortality rates for the US population (over the age range 65 to 95).

Finally checks are carried out to ensure that the resultant age shaped excess mortality rates are a better fit to the age based excess mortality than simply assuming an age invariant excess.

4.4 Converting excess mortality to adjustment factors

The process outlined above produces a total of 7 sets of distinct age-shaped excess mortality values – 3 for men and 4 for women. Each of these reflects the excess observed mortality experienced in 2020 for the appropriate subgroup of lives. The final stage was then to convert these excess mortality values into (age shaped) adjustment factors that could be used to adjust the business-as-usual VitaCurves (i.e. that could be multiplied by the v1 q_x rates to give the corresponding v2 q_x rates).

As discussed in 4.1.2, VitaCurves are essentially averaged over a three year period, and so 2020 itself can be assumed to only contribute 1/3 to the CV22 calibration, which is fitted over 2018 to 2020. If we assume for simplicity that this holds, and that the other two years experience 'normal' mortality, then we can effectively 'strip out' excess mortality in 2020 from CV22 using the following ratio::

$$\frac{3}{3 + \text{Excess mortality in 2020}}$$

The final adjustment factors by age, split into the 7 distinct groups, for age 65 to 95, are shown in Appendix 3.

These are then applied to the corresponding q_x rates from the BAU CV22 v1 calibration to obtain q_x rates for adjusted CV22 v2 over 65 to 95. The final step is to extend these adjusted curves to younger and older ages – this is done using the same principles as for BAU CV22 v1 Vita Curves. More details are set out in Appendix 2.

5 Reflecting a pension plan's profile

As noted above, we have now published both 'business as usual' CV22 VitaCurves, and an adjusted variant which strips out our view of the excess mortality arising from COVID-19 in 2020. Which set of VitaCurves is used will depend on the use case, as well as users' views on how best to reflect excess mortality.

For example, if applying to a pension plan whose membership is well distributed across the US, then the published adjustment factors may be viewed as being appropriate. Alternatively, if applying to a pension plan which is particularly geographically focused, given the known geographical component of COVID-19 infections and so impacts on mortality, the user may wish to apply different adjustment factors. For more details on appropriate regional adjustments, speak to your usual Club Vita contact.

6 Want to know more?

If you have any questions on this document or would like to know additional details regarding our data and methods for fitting our US VitaCurves, please get in contact with any of the team. We would be delighted to hear from you.

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February 2023

For and on behalf of Club Vita LLP

Reliances and Limitations

In this paper (the "Research"), Club Vita LLP has provided an overview of the methodology used to derive adjusted CV22 US VitaCurves by stripping out excess 2020 mortality from the business-as-usual edition of CV22. The Research is based upon Club Vita LLP's understanding of legislation and events as of February 2023 and therefore may be subject to change. Future actuarial measurements may differ significantly from the estimates presented in the Research due to experience differing from that anticipated by the demographic, economic or other assumptions. The Research should not be construed as advice and therefore not be considered a substitute for specific advice in relation to individual circumstances and should not be relied upon. Where the subject of the Research refers to legal; matters please note that Club Vita LLP is not qualified to give legal advice, therefore we recommend that you seek legal advice if you are wishing to address any legal matters discussed in this Research. Please be advised that Club Vita LLP (not its respective licensors) does not accept any duty, liability or responsibility regarding the use of the Research, except where we have agreed to do so in writing.

When read along with the "Zooming in on ZIP codes", "Data underpinning CV22 VitaCurves", and "Calibrating CV22 VitaCurves" papers, this paper complies with the relevant Actuarial Standards Board's Actuarial Standards of Practice (ASOP) and Financial Reporting Council's Technical Actuarial Standard (TAS) 100: Principles for Technical Actuarial Work.

Appendix 1 – Key assumptions

Any method which attempts to strip out excess mortality related to the COVID-19 pandemic mortality will require an element of subjectivity. We set out in this appendix some of the key assumptions in our methodology.

- All 'excess' mortality in 2020 is assumed to be entirely due to the impact of COVID-19. While this would appear to be appropriate in 2020, care will be required in future years, as and when the direct impact of COVID-19 reduces and there is greater risk of other emerging drivers of mortality influencing the overall level of mortality.
- The age shape of excess mortality in the Club Vita data is assumed to be equal to the (appropriately scaled) US population experience in 2020.
- Expected rates of mortality in 2020 have been determined based on applying the SOA MP-2021 improvement rates to roll forward mortality rates fitted over 2017-2019. These tables are both publicly available and regularly used by pension plans. However users may wish to consider whether they view the assumed rates of improvements for 2019 and 2020 to be appropriate. Had alternate improvements been assumed, this would impact on the expected 2020 mortality and so ultimately the adjustment factors used to derive the adjusted CV22 v2 VitaCurves. However we would not anticipate that the impact would be particularly material.

Appendix 2 – Extending to younger and older ages

In generating the adjustment factors we have focussed on ages 65 to 95, for consistence with the ages used to fit the BAU CV22 v1 curves. However we need to consider how best to extend the resultant adjusted curves across the full age range (i.e. 16 to 125). This could be done through either considering how to extend the calculated adjustment factors, or else by extending the adjusted curves themselves. We have chosen to follow the latter approach, as set out below.

Extending to older ages

We extend the adjusted curves in the same manner adopted for the BAU curves, consistent with the research carried out by the High Age Mortality Working Party ("HAMWP") of the Institute and Faculty of Actuaries. This uses the concept of 'parent curves' and 'child curves' with the 'child' blending into the 'parent' at oldest ages, with the general structure being as follows:

- The least granular curves (i.e. those that only use age as a rating factor) are set as the 'parent' of each more granular curve of the same gender and status.
- The age only curves for annuitants and surviving beneficiaries are extended with reference to the deaths and exposures of the US population.
- The disabled retiree curves, which are fitted to younger ages, converge in to a "parent" of the annuitant curve of the same gender to inherit the shape of pension plan mortality at older ages.

The only difference in the approach adopted for the adjusted curves, relative to that for the BAU curves, is that, while annuitant and surviving beneficiary age only BAU curves are extended based on US population experience over 2018 to 2020 (the same time period as used to fit the curves), given the adjusted curves are intended to have no COVID-19 impact, they are instead extended based on US population experience over 2017 to 2019.

Extending to younger ages

At younger ages, we adopt the same approach to that used to extend the BAU curves:

We identify a population-level mortality rate at a young age (i.e. prior to the "accident hump"). The VitaCurves are then generally set to decrease linearly in the logit scale from the rate at the youngest age fitted to, to the population-level mortality at that younger age. This is a pragmatic approach for younger ages which reflects the broad linearity of the mortality rates within the logit scale and the low financial materiality of the choice of method.

The main exception to this approach is for the disabled retiree curves, where the curve is held constant at younger ages, consistent with the data we see at the younger ages. For male disabled retirees, the curve is constant from age 55 downwards and for female disabled retirees, age 60 downwards.

Note that we could have followed a similar approach to the older age extension of basing the younger age extensions on 2017 to 2019 rather than 2018 to 2020. However, given that the impact of COVID-19 on the very young has been very small, and on the grounds of materiality, we instead followed the same approach as for the BAU curves, and reflected 2018 to 2020 US population when extending to the lowest ages.

Appendix 3 – Final CV22 adjustment factors

The following tables set out the final adjustment factors for each participant type and collar type (i.e. the factors that can be applied to the 'business as usual' CV22 v1 VitaCurves to obtain the adjusted CV22 c2 VitaCurves). Note that the v2 VitaCurves are then extended to younger and older ages using the same methods as the corresponding v1 VitaCurves (as set out in Appendix 2).

Male adjustments

Age	Male blue collar annuitants	Male white collar annuitants	Male annuitants with no collar, disabled retirees, surviving beneficiaries
65	96.56%	98.67%	97.01%
66	96.58%	98.68%	97.03%
67	96.61%	98.69%	97.05%
68	96.67%	98.71%	97.11%
69	96.75%	98.74%	97.18%
70	96.79%	98.76%	97.22%
71	96.77%	98.75%	97.20%
72	96.69%	98.72%	97.12%
73	96.58%	98.68%	97.03%
74	96.46%	98.63%	96.92%
75	96.27%	98.55%	96.76%
76	96.13%	98.50%	96.63%
77	96.13%	98.50%	96.63%
78	96.27%	98.55%	96.76%
79	96.48%	98.64%	96.94%
80	96.63%	98.69%	97.07%
81	96.67%	98.71%	97.11%
82	96.75%	98.74%	97.18%
83	96.84%	98.78%	97.25%
84	96.94%	98.82%	97.34%

Age	Male blue collar annuitants	Male white collar annuitants	Male annuitants with no collar, disabled retirees, surviving beneficiaries
85	97.00%	98.84%	97.40%
86	97.03%	98.85%	97.42%
87	97.03%	98.85%	97.42%
88	97.00%	98.84%	97.40%
89	97.00%	98.84%	97.40%
90	96.98%	98.83%	97.38%
91	97.00%	98.84%	97.40%
92	97.07%	98.87%	97.45%
93	97.15%	98.90%	97.53%
94	97.28%	98.95%	97.64%
95	97.36%	98.98%	97.71%

Female adjustments

Age	Female blue collar annuitants	Female white collar annuitants	Female annuitants with no collar, disabled retirees	Female surviving beneficiaries
65	94.87%	97.69%	96.45%	94.32%
66	94.83%	97.68%	96.43%	94.28%
67	94.83%	97.68%	96.43%	94.28%
68	94.87%	97.69%	96.45%	94.32%
69	94.90%	97.71%	96.48%	94.36%
70	94.83%	97.68%	96.43%	94.28%
71	94.73%	97.63%	96.35%	94.16%
72	94.69%	97.61%	96.33%	94.12%
73	94.76%	97.64%	96.38%	94.20%
74	94.87%	97.69%	96.45%	94.32%

Age	Female blue collar annuitants	Female white collar annuitants	Female annuitants with no collar, disabled retirees	Female surviving beneficiaries
75	94.76%	97.64%	96.38%	94.20%
76	94.62%	97.58%	96.28%	94.05%
77	94.62%	97.58%	96.28%	94.05%
78	94.83%	97.68%	96.43%	94.28%
79	95.11%	97.81%	96.63%	94.59%
80	95.22%	97.86%	96.70%	94.71%
81	95.19%	97.84%	96.68%	94.67%
82	95.15%	97.82%	96.65%	94.63%
83	95.08%	97.79%	96.60%	94.55%
84	95.01%	97.76%	96.55%	94.47%
85	94.94%	97.73%	96.50%	94.39%
86	94.87%	97.69%	96.45%	94.32%
87	94.76%	97.64%	96.38%	94.20%
88	94.69%	97.61%	96.33%	94.12%
89	94.66%	97.59%	96.31%	94.08%
90	94.66%	97.59%	96.31%	94.08%
91	94.69%	97.61%	96.33%	94.12%
92	94.76%	97.64%	96.38%	94.20%
93	94.90%	97.71%	96.48%	94.36%
94	95.11%	97.81%	96.63%	94.59%
95	95.22%	97.86%	96.70%	94.71%