Erengul Dodd, Jonathan J Forster and Jason Hilton's contribution to the Discussion of 'Some statistical aspects of the Covid-19 response' by Wood et al.

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In Section 2.4 the authors consider the computation of excess deaths, defined as *the excess of actual deaths over what might reasonably be expected given the situation in previous years*. Equivalently we might characterise this as excess of actual deaths over what might reasonably have been forecast given mortality experience up to the start of the pandemic. We argue that it is natural, therefore, to use mortality forecasting methodology for this computation. This approach has the advantage both of allowing for predictable variation in exposures to risk at different ages over time, as the authors do, but also of incorporating predictable patterns of mortality change, which the authors do not. Mortality forecasting in the UK context generally assumes that mortality will improve, in line with experience over recent decades and this mortality improvement is embedded into forecasting methodology. Different models for weekly Covid excess mortality have been proposed by, for example, Aburto et al (2021), the EuroMOMO group (e.g. Nielsen et al, 2021), Ellison et al (2021) and OHID (2021), but all incorporate some combination of seasonal effects, holiday effects and, critically, a log-linear mortality improvement trend based on historical data. One key difference is over what period that historical trend is estimated. Our approach (Ellison et at, 2021) is to assume that the long-term (60-year) trend applies, but the model also incorporates a sporadic, unpredictable (age-independent) mortality improvement component, in common with the classic mortality forecasting models of Lee and Carter (1992) and Cairns, Blake and Dowd (Cairns et al, 2011). This latter component contributes

considerably to the uncertainty associated with any forecast and hence any estimate of Covid excess mortality. Our estimates, an updated version of the original estimates in Ellison et al (2021), are displayed in Figure 1. The estimated excess mortality is somewhat larger than the authors' estimates, due to the allowance for mortality improvement in the forecast model, but are similar to the ONS estimates. The ONS approach also ignores mortality trends, and additionally fails to account for ageing population, as pointed out by the authors. It seems that these two limitations, working in opposing directions, almost exactly cancel each other out, the two approaches in Figure 1 yielding similar results despite their somewhat differing assumptions.

The significant uncertainty resulting from the sporadic component in the forecasting model is noteworthy and suggests that precise inference about this aspect of the pandemic may be elusive.

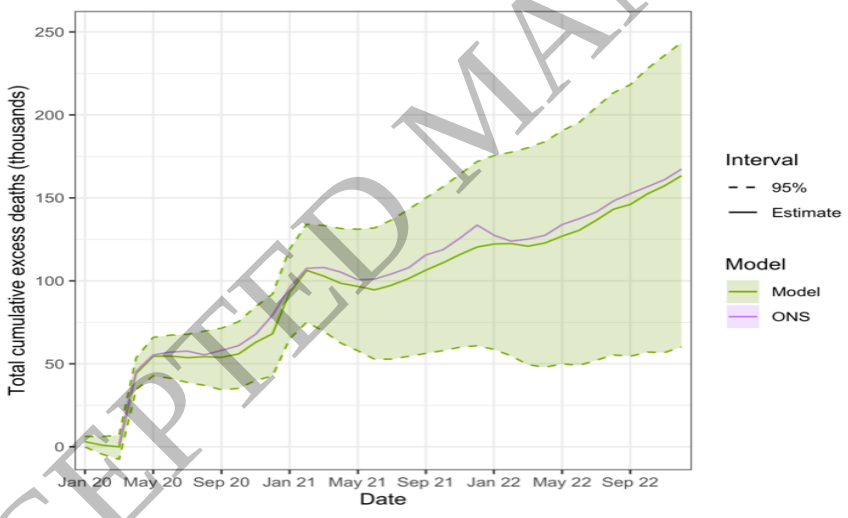

Figure 1: Covid excess mortality estimates and uncertainty, compared with ONS

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OHID (2022). *Excess mortality in England: methodology*. https://fingertips.phe.org.uk/documents/EMMethodology.pdf