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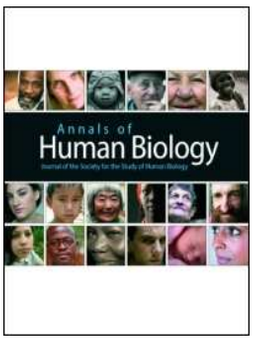

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Life expectancy and the Global Burden of Disease 1990-2016: little cause for complacency

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ABSTRACT

While the omission of behavioural and mechanistic factors from the BBC's "Life Expectancy Calculator" might undermine its utility as a health promotion tool, the centrality of these factors within the GBD 2016 Risk Factor Collaborators' analyses – which only detected "important changes" in behavioural (tobacco, alcohol and diet) and mechanistic (low birthweight, short gestation, BMI, blood pressure, fasting glucose) factors – undermines the "important" role that country-level variation in political, social and structural factors plays in the availability of those opportunities, circumstances, habits and behaviours necessary to deliver consistent, resilient and sustained mechanistic improvements in life expectancy.

KEYWORDS: Life expectancy; Global Burden of Disease; determinants of disease; causal inference; directed acyclic graph

Last year, the BBC News website published the "BBC Life Expectancy Calculator" (BBC 2018), based on the 2016 Global Burden of Disease Study (Wang et al., 2017) – an annual survey conducted by the US-based Institute of Health Metrics and Evaluation (see Rubin, 2017). The "Calculator" offers estimates of life expectancy across 198 countries disaggregated by: age; sex; and country – and is accompanied by a commentary examining "Nine facts about how long we live" (Calver and Stylianou, 2018). This commentary focused on: the general increase in life expectancy observed since 1990 (in all but 8 countries); the greater life expectancy of women as compared to men (in all but 3 countries); regional disparities in life expectancy (Western Europe dominating the top, Africa dominating the bottom); and the acute impact of environmental disasters and conflict on life expectancy (including the 1994-8 famine in North Korea, the 2010 earthquake in Haiti, the 1994 genocide in Rwanda and the ongoing Syrian civil war). Notwithstanding the latter, the overall thrust of the commentary was positive, concluding that "Since 1990, life expectancy has improved in 96% of countries. Back then, people born in 11 countries would not be expected to reach 50, yet this milestone was reached by every country in 2016."

However, such a modest "milestone" is little cause for complacency. Of greater concern to human biologists and public health practitioners is the extent to which the "Calculator" conceals far more than it reveals, and thereby offers false reassurance even for those of us who live in high income countries largely free from environmental disasters and/or conflict. To some extent this is simply an artefact of how 'life expectancy' is measured (and therefore what it means), since this simply constitutes an *estimate* of *future* age at death based on *past* measures of *average* age-specific mortality rates. All such estimates constitute predictions based on assumptions about the circumstances prevailing in the future – some assuming that

circumstances deteriorate or improve, others (as in this instance) assuming that current "rates of death and disability remain constant over the remainder of a person's life" (BBC, 2018). Indeed, the BBC "Calculator" concedes that this key assumption means that the estimates it provides "do not account for any expected scientific advances and improvements in medical treatments" – though it might have been more accurate to state that the estimates do not account for "any expected [*or unexpected*] advances [*or deteriorations*] in medical care [*or in the circumstances that enhance or damage health*]". Given the prevailing uncertainty surrounding globalisation, climate change, mass migration, political instability and economic realignment, assumptions based on the *status quo* are at best wishful thinking, and at worst reflect a degree of wilful complacency (not least given the dramatic, ongoing impact of environmental disasters and conflict cited in Calver and Styliano's accompanying commentary).

These issues aside, it is also unclear whether most users of the BBC's "Calculator" will necessarily grasp that the estimates provided relate to populations and not to individuals, and that *average* life expectancy can mask: an extraordinary degree of heterogeneity in the underlying, age-specific mortality rates on which these are based (von Roten and de Roten, 2013); and the established role that structural, socioeconomic and behavioural factors play in life expectancy. Hopefully, the disaggregation of estimates by age, sex and country (all of which are required when using the "Calculator") will, at the very least, illustrate to users the extent of prevailing demographic and contextual variability in life expectancy. Nonetheless, by limiting this disaggregation to just three criteria (and to three criteria over which individuals have little control), the "Calculator" glosses over the extent to which a whole host of interwoven, multi-layered factors contribute – both directly and indirectly – to mortality rates, and thereby to life expectancy. In particular, at the country-level, hierarchical societal structures and disparities in opportunity create the circumstances necessary to sustain inequalities in income, wealth and material wellbeing. Material inequalities underpin the sociocultural and class-related patterning of habits and behaviours. And these, in turn, become *embodied* through disease-specific mechanisms whose ultimate consequences manifest as variation in (premature) mortality.

This hierarchical, multi-layered perspective of the conditional, additive and/or multiplicative interplay of country-, provincial-, community-, household- and individual-level factors in the aetiology of morbidity and mortality is not new. It is central to established theories regarding the 'social determinants of health' which frame much of contemporary health policy at both global (Blas and Kurup, 2010) and national levels (e.g. US ODPHP, 2010 and UK PHE, 2017). It is also the framework within which a 'lifecourse' approach to physical anthropology and epidemiology has emerged – an approach which views *contexts* as critical determinants of both *external* (i.e. 'environmental') risks and *internalised* (i.e. individual-level) susceptibilities to ill-health (Halfon et al., 2018). Indeed, in their analysis of the potential contribution that "84 behavioural, environmental and occupational, and metabolic risks" might make to global variation in mortality, the GBD 2016 Risk Factors Collaborators (RFCs 2017) developed a four-tier hierarchy of risks. However, since many of the 11 "risk clusters" that formed the principal foci for their analyses are likely to operate across very different tiers, this weakens the interpretation of findings that appear to equate factors operating at structural, circumstantial, behavioural and mechanistic levels.

Recent advances in the use of causal path diagrams (and particularly 'directed acyclic graphs' or 'DAGs') can help disentangle *where* such factors operate, by operationalising these as a

contextually contingent temporal sequence of successive *causes* contributing to any given health outcome. Such diagrams draw on knowledge of temporality to determine: which variables represent events that *precede* others (and therefore *can* – and should ordinarily be assumed to – act as their potential causes); and which reflect events that occur *afterwards* (and should therefore be considered their consequences). These two rules (causality being determined by temporal positionality; and potential causality being assumed in the absence of definitive evidence to the contrary) not only facilitate the specification of such diagrams, but also simplify the identification of potential confounders (i.e. variables preceding, and thereby potentially causing, both the specified exposure and outcome) – variables that need to be adjusted for in any analysis of cause-and-effect. Figure 1 uses this approach to specify the plausible causal relationships between each of the 11 "risk clusters" examined by the GBD 2016 Risk factor Collaborators (RFCs 2017), together with the three criteria used to derive their "Socio-demographic Index" (fertility, education and income); and thereby helps emphasise the fundamental role that societal structure and disparities in opportunity play in determining access to material wellbeing, and the sociocultural patterning of habits and behaviours. Applying this at an ecological level – i.e. at the level of analysis undertaken here (RFCs 2017; Figure 1) – requires further layering of causal paths by the historical (sociocultural and geopolitical) factors that have led to country-level variation in societal structures; and which might also affect the direction and strength of subsequent causal paths common to *all* countries. Clearly, from this perspective, the legacy of history plays a fundamental role in determining *not only* the context (within which only a limited range of structures, opportunities and circumstances are possible/permissible), *but also* the impacts these have on individual habits, behaviours, mechanisms and consequences.

While the omission of behavioural and mechanistic factors from the BBC's "Life Expectancy Calculator" might undermine its utility as a health promotion tool, the centrality of these factors within the GBD 2016 Risk Factor Collaborators' analyses (RFCs 2017) – which only detected "important changes" in behavioural (tobacco, alcohol and diet) and mechanistic (low birthweight, short gestation, BMI, blood pressure, fasting glucose) factors – undermines the "important" role that country-level variation in political, social and structural factors plays in the availability of those opportunities, circumstances, habits *and* behaviours necessary to deliver consistent, resilient and sustained *mechanistic* improvements in life expectancy.

Disclosure statement

The author reports no conflicts of interest. The author alone is responsible for the content and writing of the paper.

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Figure 1. Directed acyclic graph (DAG) summarising the theoretical causal relationships between each of the 11 "risk clusters" and 3 "sociodemographic index" indicators examined by the 2016 GBD Risk Factor Collaborators (RFCs 2017); specified by assuming that (only) preceding events (can) operate as (potential) causes of subsequent consequences. The 7 levels included beneath the DAG (which do not form part of the DAG's formal structure) represent the hypothesised hierarchy of levels at which each of the risks/indicators operate; with each successive level influencing all of those that occur thereafter.