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Determinants and disparities: A simulation approach to the case of child health care

Roy Lay-Yee*, Barry Milne, Peter Davis, Janet Pearson, Jessica McLay

Centre of Methods and Policy Application in the Social Sciences, Faculty of Arts, University of Auckland, New Zealand

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ABSTRACT

Though there is much agreement on the importance of the social determinants of health, debate continues on suitable empirically-based models to underpin efforts to tackle health and health care disparities. We demonstrate an approach that uses a dynamic micro-simulation model of the early life course, based on longitudinal data from a New Zealand cohort of children born in 1977, and counterfactual reasoning applied to a range of outcomes. The focus is on health service use with a comparison to outcomes in non-health domains, namely educational attainment and antisocial behaviour. We show an application of the model to test scenarios based on modifying key determinants and assessing the impact on putative outcomes. We found that appreciable improvement was only effected by modifying multiple determinants; structural determinants were relatively more important than intermediary ones as potential policy levers; there was a social gradient of effect; and interventions bestowed the greatest benefit to the most disadvantaged groups with a corresponding reduction in disparities between the worst-off and the best-off. Our findings provide evidence on how public policy initiatives might be more effective acting broadly across sectors and across social groups, and thus make a real difference to the most disadvantaged.

1. Introduction

Complex policy issues across a range of domains affecting children require thought and action based on the best evidence available and responsive to rapidly changing social conditions. We adopt a conceptual approach combining the social determinants of health framework with a life course perspective, and apply a methodological approach based on counterfactual modelling using a form of simulation. We construct a dynamic micro-simulation model of health service use and other outcomes in early childhood to assess the relative effects of altering social conditions at different levels of influence. Testing counterfactual scenarios in this way may illuminate the effectiveness of potential policy interventions.

1.1. Social determinants

There is much agreement on the importance of the social determinants of health (CSDH, 2008; The Marmot Review, 2010) and similar constructs such as 'circumstances' that give rise to 'inequality of opportunity in health' (Rosa Dias, 2009). However, debate continues on suitable empirically-based models to underpin efforts to tackle health and health care disparities (Batty, 2011; Harper and Strumpf, 2012).

Large-scale social experiments are not practicable or affordable but even so there is no guarantee that a particular policy intervention will be effective and make a difference. We propose and demonstrate an approach that uses a simulation model based on real data to test the differential impact of changing selected social determinants for disadvantaged groups on outcomes in a range of domains. The focus is on children's health service use with a comparison to outcomes in non-health domains – educational attainment and antisocial behaviour – as an indication of where policy initiatives might be the most effective.

Reducing inequity in health outcomes for children is a central concern of a fair society and raises a serious challenge to public policy (Asthana and Halliday, 2006; Hallam, 2008). Inequity refers to inequalities or disparities that are avoidable, amenable or unjust. Inequity in health arises because of differences among social groups such that they have different health status and associated need (Scambler, 2012). Inequity in health care may arise because

* Corresponding author. COMPASS Research Centre, Faculty of Arts, University of Auckland, Private Bag 92019, Auckland 1142, New Zealand.
E-mail address: r.layyee@auckland.ac.nz (R. Lay-Yee).

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children with the same need do not have access to the same care or those with more need do not receive more care (Starfield, 2011). Thus higher social class is associated with both better health and better access to health care (Starfield et al., 2002). These disparities then are rooted in social determinants that confer differential vulnerability to poor health or exposure to conditions that produce poor health (Frohlich and Potvin, 2008). To reduce disparities, public policy must find ways to address social determinants.

A key aim of the social determinants of health framework is 'to highlight the difference between levels of causation, distinguishing between the mechanisms by which social hierarchies are created, and the conditions of daily life which then result' (Solar and Irwin, 2010, p. 4). Thus the former 'structural' determinants (of health inequities) produce the latter 'intermediary' determinants, and together they comprise the social determinants of health. From a policy perspective, 'objectives are defined quite differently, depending on whether the aim is to address determinants of health or determinants of health inequities' (Solar and Irwin, 2010, p. 5).

There is debate as to the specific social determinants that play crucial roles in patterning health and health care, and to the relative importance, as effective policy levers, of those determinants upstream (distal) or downstream (proximal) to the outcome (Chokshi and Farley, 2012). We must put aside the structural determinants that are fixed or not modifiable at an individual level, such as family socio-economic position at the birth of the child. However there are proxy indicators, such as income source, that can be characterised as upstream and modifiable (Solar and Irwin, 2010). Downstream determinants are intermediary and may be modifiable at the individual level, such as family functioning and behaviour. In the social determinants of health framework, these intermediary ones are shaped by and are mediating the effects of underlying structural determinants. Furthermore, the social determinants that give rise to poor health in a particular group tend to cluster and accumulate over the life course (Larson et al., 2008; Stevens, 2006). Thus disadvantage is associated with the 'intersectionality' of multiple related determinants rather than independent single ones, tending to persist and become entrenched over time (Hankivsky, 2011).

In the rest of this paper we will use the term 'factor', meaning 'potential determinant', instead of 'determinant', to remove the connotation of social processes being completely deterministic.

1.2. The life course

The broad framework of the life course is especially relevant to the modelling of dynamic processes and their implications for public policy (Hunt, 2005; Policy Research Initiative, 2004). We draw conceptually on a range of relevant perspectives including human development (Keating and Hertzman, 1999), life course epidemiology (Ben-Shlomo and Kuh, 2002), and risk or resilience (Luthar, 2003). Using longitudinal data on a birth cohort, we focus on the influence of a range of key social determinants on health service use and other outcomes across the years of early childhood (Dearden et al., 2011; Holmes and Kiernan, 2013; Pearce et al., 2013). The temporal aspect is especially crucial to understanding the impact of potential policy interventions to promote health equity (Braveman, 2013). Here we focus on shorter term effects of social determinants within the early life course (to age 13) though there is extensive evidence that these effects accumulate and persist into adulthood (for example, see Conti et al. (2010)).

1.3. Counterfactual modelling

We adopt a counterfactual approach to causal inference (Davis, 2014; Glass et al., 2013). Using observational data to mimic an experiment, we compare what is actually observed with what might be observed in a counterfactual scenario. The focus is not to establish cause, though this may be indicative, but to evaluate the effects on social outcomes of different sets of circumstances (theoretical purpose) or competing intervention options (policy purpose).

Complex policy issues require methods that enable research synthesis and utilise systems thinking (Lobb and Colditz, 2013; Milne et al., 2014). Micro-simulation modelling has been used to represent systems and processes in health care and to test their functioning for policy purposes (Glied and Tilipman, 2010; Ringel et al., 2010; Rutter et al., 2011; Zucchelli and Rice, 2012). Micro-simulation sits within a continuum of social simulation methodologies with more aggregated approaches (for example, system dynamics) on the one hand and more behavioural ones (for example, agent-based modelling) on the other (Gilbert and Troitzsch, 2005).

The dynamic micro-simulation model, based on empirical individual-level data over time, can account for social complexity, heterogeneity, and change (Orcutt, 1957; Spielauer, 2011). This is the technical approach we adopt in this paper with an application focussing on health service use in early childhood, with comparison to two other non-health outcomes. It relies on data from the real world to create an artificial one that mimics the original but upon which virtual experiments can be performed (Gilbert and Troitzsch, 2005). It operates at the level of individual units, in our case children from a representative, real-world sample. Each child has a set of associated attributes as a starting point, for example age, gender, ethnicity and health state. A set of rules, here equations derived from statistical analysis of real longitudinal data, is then applied in a stochastic manner to this sample to simulate changes in state or behaviour over time. This model essentially generates a set of diverse synthetic health histories for our starting sample of children. Based on a form of counterfactual reasoning, modifications of influential factors can then be undertaken to test hypothetical 'what if' scenarios on a key outcome of policy interest such as health service use (Davis et al., 2010; Dubay and Kenney, 2003).

We used micro-simulation because it could integrate, and accommodate the manipulation of, the effects of variables across multiple model equations in one simulation run. Thus each otherwise separate equation is given its social context and influence among the other equations, representing a system of interdependent social processes.

2. Aims

The overall aim of this paper is to apply a computer-based model in a New Zealand setting designed to (1) represent health service use (and other comparative outcomes) in early childhood, and (2) enable experimentation on the impact of changing social determinants (Milne et al., 2014). Note that, in New Zealand, primary care is provided by private family physicians who receive a government subsidy per patient as well as patient co-payments. The family doctor has traditionally provided the majority of prevention and treatment services. For children, doctor visits are even more so the prime mode of contact with health services.

The construction of the model followed a framework (Fig. 1) based on the social determinants of health where structural factors related to social advantage or disadvantage fundamentally influence intermediary parental and family factors and final health outcomes (Solar and Irwin, 2010). Any specific factor may have a direct or an indirect effect, through a mediating factor, on the outcome.

We employed a dynamic micro-simulation model to reflect a life course perspective (Appendix, Fig. A1). In order to build an empirically realistic model, we used longitudinal data on children