How well can poor child development be predicted from early life characteristics?
A whole-of-population data linkage study

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ABSTRACT

The Australian Early Development Census (AEDC) is a holistic measure of children's health and development. Local communities and service providers can use AEDC results to develop support for children and their families. A core concept in supporting child development is to provide services in a progressive universal framework. A challenge for progressive universal services is identifying, as early as possible, the children who are most at risk of later poor health and development. This study used de-identified, linked perinatal and AEDC data for 13,827 children to explore whether characteristics routinely collected in the perinatal period can predict which children will be vulnerable on two or more AEDC domains in their first year at school. A model containing 22 perinatal predictors demonstrated similar discrimination to a model of six predictors (maternal age, smoking during pregnancy, parity, marital status, and both parents' occupation, area under the receiver operating characteristic curve = 0.682 males, 0.724 females). If these six characteristics were used for targeting intensive support services, and the program targeted families with at least three of the six perinatal risk factors, approximately 10% of families in the population would be identified as needing an intensive intervention soon after birth. Sensitivity of the risk prediction model showed that such a targeted program would have the potential to prevent one-quarter of the cases of being vulnerable on two or more AEDC domains at age five. When assessing whether such prediction models could be turned into useful screening tools for determining eligibility for family support services, service providers need to consider the trade-off between sensitivity and the proportion of the population that would require services.

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1. Introduction

Early childhood is an important time for investing in child health and development. From an economic perspective, investments in interventions in this period are thought to provide the greatest rate of return (Heckman, 2006), and from a developmental perspective, this period is a unique time for preventive interventions (Shonkoff & Phillips, 2000). Accordingly, recommendations (Marmot et al., 2010), policies (Department of Health and Ageing, 2011), and interventions (Abbott-Shim, Lambert, & McCarty, 2003; Bierman et al., 2008; Olds, Kitzman et al., 2004; Sawyer, Frost, Bowering, & Lynch, 2013) have focused on this period of early child health and development.

Recent reviews into social and health inequalities have emphasized the need to give every child the opportunity for healthy development, particularly in the first five years, in order to overcome inequalities due to social and economic disadvantage (Commission on Social Determinants of Health, 2009; United Nations, 1989; United Nations General Assembly, 2010). Subsequent early child health and development policy recommendations apply the principles of progressive universalism, where support is provided to all families, but additional, more intensive services are provided for those in greater need.

A key challenge in applying progressive universalism to service provision is accurately identifying the children, and their families, who are most at risk of future poor health and development,

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and thus may have the most to gain from more intensive programs (Lynch, Law, Brinkman, Chittleborough, & Sawyer, 2010; Marmot et al., 2010). Data routinely collected at the time of birth may be useful for determining families' level of risk, their need for support, and their potential to gain from additional services (Brinkman, McDermott, & Lynch, 2010). The aim of this study is to explore whether risk factors routinely measured during the perinatal period can be used to identify children with poor development on the Australian Early Development Census (AEDC; Brinkman, Gregory, Goldfeld, Lynch, & Hardy, 2014). This perinatal information could then be used during universal home visits to screen families for who may benefit from intensive family support programs.

2. Child development at school entry

Children's health and development in the first year of school influences their social-emotional and academic outcomes throughout their schooling careers (Belsky & MacKinnon, 1994; Hair, Halle, Terry-Humen, Lavelle, & Calkins, 2006; Hamre & Pianta, 2001; Ladd & Dinella, 2009; Luster & McAdoo, 1996). Children's health and development is generally thought to include the broad dimensions of physical health, motor development, social and emotional wellbeing, learning approaches, language and communication, cognitive skills, and general knowledge (Kagan, Moore, & Bredekamp, 1995; Meisels, 1999). Accordingly, the AEDC, an adaptation of the Canadian Early Development Instrument (EDI; Goldfeld, Sayers, Brinkman, Silburn, & Oberklaid, 2009; Janus & Offord, 2007), is considered a holistic measure of children's development in their first year at school (Brinkman et al., 2014), assessing children's developmental competencies across physical health and wellbeing, social competence, emotional maturity, language and cognitive skills, and communication and general knowledge domains.

The AEDC national data collection is implemented by the federal government across Australia once every three years (www.aedc.gov.au). The AEDC was first implemented in 2009 and involved teachers completing questionnaires on the development of over 261,000 five-year-olds (Centre for Community Child Health and Telethon Institute for Child Health Research, 2009). Although the participating teachers rated the majority of children as on track, 23% of the children were classified as 'developmentally vulnerable' on the AEDC, on the basis of scoring in the lowest 10% on at least one of the five AEDC domains. Of particular concern is the subgroup of children (12% nationally) who were found to be vulnerable on two or more AEDC domains, indicating particularly high risk of poor development. Subsequent examination of school entry demographic characteristics indicated that this group of 'highly vulnerable' children comprised a higher proportion of boys, Aboriginal/Torres Strait Islander children, and children living in socioeconomically disadvantaged areas (Centre for Community Child Health and Telethon Institute for Child Health Research, 2009).

A main aim of the AEDC is to enable communities to understand areas for improvement to better support children and their families. Results could be used to shift the population curve of child development, by decreasing the proportion of children who are developmentally vulnerable, and increasing the proportion of children performing well (Centre for Community Child Health and Telethon Institute for Child Health Research, 2011). AEDC results may be able to inform programs that attempt to prevent problems from occurring, and not only programs that treat problems once they have emerged. Specifically, linking AEDC data with data collected in infancy will provide the opportunity to explore the impact of early life factors on later child development outcomes (Brinkman et al., 2014; Brinkman et al., 2010). The results of such linked data

sets could be used to identify the most vulnerable sub-populations who could subsequently be offered intensive targeted prevention programs, alongside the implementation of universal strategies for all children (Brinkman et al., 2012).

3. Identifying vulnerable families eligible for intensive support

Intensive services such as family home visiting programs are provided within a system of progressive universalism to vulnerable families who are in need of ongoing additional support. These services typically involve frequent home visits by a trained nurse over a two-year period and aim to improve the health, wellbeing and self-sufficiency of parents and their children (Barnes et al., 2008; Children Youth and Women's Health Service, 2005). In the US, there was a recommendation that family home visiting should be universal (Krugman, 1993), but in practice these programs are targeted because there are insufficient resources to provide these services to everyone. Programs such as the US Nurse Family Partnership, the UK Family Nurse Partnership, and Family Home Visiting in South Australia offer extended services beyond the immediate universal postnatal contact visit by nurses to vulnerable families. Classification of vulnerability varies across these programs, including characteristics such as young maternal age, first time motherhood, low income, social isolation, risk of poor attachment with infant, and Aboriginal or Torres Strait Islander status (Barnes et al., 2008; Children Youth and Women's Health Service, 2005; Olds, 2006).

Randomised trials of the US Nurse Family Partnership provide evidence to support the effectiveness of the program in improving child outcomes, including reduced child injuries, dangerous ingestions and behavior problems, and improved child language skills (Kitzman et al., 1997; Olds et al., 2014; Olds, Robinson et al., 2004). Evaluation of the UK Family Nurse Partnership indicated that the program was well supported and able to be delivered with fidelity (Barnes, 2010). A randomized trial of this UK program is ongoing (Owen-Jones et al., 2013). Initial evaluations have shown that for mothers in the South Australian Family Home Visiting program, perceptions of their relationships with their infants and their satisfaction with their role as mothers increased over time, relative to a comparison group of eligible mothers (Sawyer et al., 2013). Thus, intensive nurse-led family home visiting programs might be useful for reducing poor developmental outcomes among at-risk children. However, a challenge for all these programs is to define the eligibility criteria for offering intensive support. This process needs to balance the need to target population sub-groups due to resource restrictions, with the desire to reach those most in need, and those who may benefit most from multiple-visit intensive support by community-based child and family health nurses. As far as we know, this issue has received almost no research attention (Chittleborough, Lawlor, & Lynch, 2011, Chittleborough, Lawlor, & Lynch, 2012).

It is necessary to identify children with poor health and development as early as possible to be able to provide effective interventions that improve these outcomes by the time children reach school age. For early intervention policy and practice to be better informed by evidence, understanding of how various early life factors predict children's health and development needs to improve. To optimize intensive family support programs, it is important that families who can benefit most are offered the program so that improvements in child health and development by school entry can be seen at a population level (Brinkman et al., 2012; Lynch et al., 2010).

The use of predictive risk algorithms is well established in other fields, for example in cardiovascular disease (Lloyd-Jones, 2010) and predicting birth outcomes following in vitro fertilization