



# WORKING PAPER SERIES

## INTERGENERATIONAL TRANSMISSION OF HUMAN CAPITAL ACROSS THREE GENERATIONS USING LATENT CLASS ASSOCIATIONS WITHIN FAMILIES

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No. 2021-03

February 2021



## NON-TECHNICAL SUMMARY

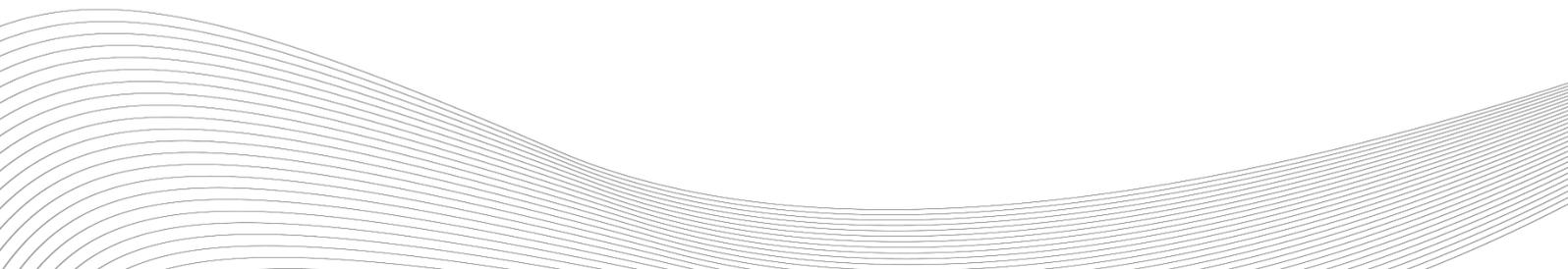
Associations between different forms of family disadvantage and different child development outcomes have long been documented in international research. Parent characteristics are a particularly important and well-researched influence on child development; the more social and economic opportunities, resources, or expectations parents have the more opportunities their children have for development across a range of outcomes. However, inequalities can also persist across more than just the parent and child generations. As children develop and expand their own sets of capabilities, resources, and expectations into adulthood, the next generation of children can then benefit from those resources.

To break cycles of intergenerational disadvantage it is necessary to understand the origins and pathways that shape this transmission across generations. Research has now expanded to include the contributions of the extended family, such as grandparents, on child development. However, current intergenerational research typically addresses family resources as independent factors, which ignores how risks can group together and accumulate over time.

In this study, using data from the Longitudinal Study of Australian Children, we identified different developmental circumstances for children based on the characteristics of their parents, and their maternal and paternal grandparents. We then examined how these different circumstances relate to children's educational outcomes.

We identified five distinct groups of grandparent characteristics: Low Grandparent Risk (40% of the sample), High Maternal Grandparent Disadvantage (20%), High Paternal Grandparent Disadvantage (17%), Low Grandparent Education Capital (14%), and High Blended Disadvantage (8%). Four distinct classes of parent characteristics were identified: Low Parent Risk (58% of the sample), Parent Health Risks (23%), Parent Financial Hardship (12%), and Multiple Parent Risks (6%). Of these classes, Low Grandparent Education Capital, Parent Financial Hardship, and Multiple Parent Risks latent classes were associated with lower grandchild literacy and numeracy scores in Year 3. Analysis of Year 5, 7, and 9 literacy and numeracy scores showed that while most associations between grandparent and parent disadvantage and grandchild achievement are evident in the early years of school, some grandchildren fall further behind their 'low risk' peers in subsequent years.

This study extends previous research by considering the transfer of multiple disadvantages across generations, and how these transfers relate to children's achievement outcomes. Results showed that the developmental circumstances of children can be defined using the characteristics of both parents and grandparents, and that the role of grandparents on children's development extends beyond the influence they have on parent outcomes. Importantly, considering clusters of risk factors, rather than isolated risk factors alone, this study highlights that addressing intergenerational transfers of disadvantage requires multiple, integrated, and coordinated policy approaches that go beyond addressing individual indicators of disadvantage.



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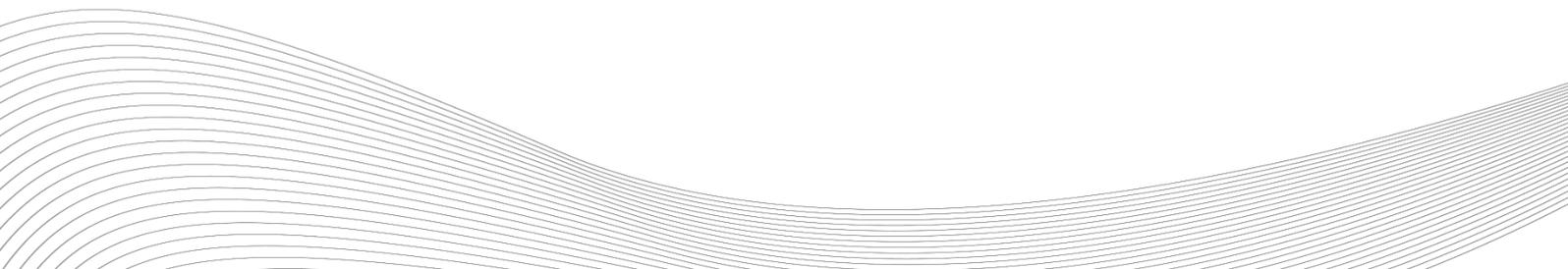
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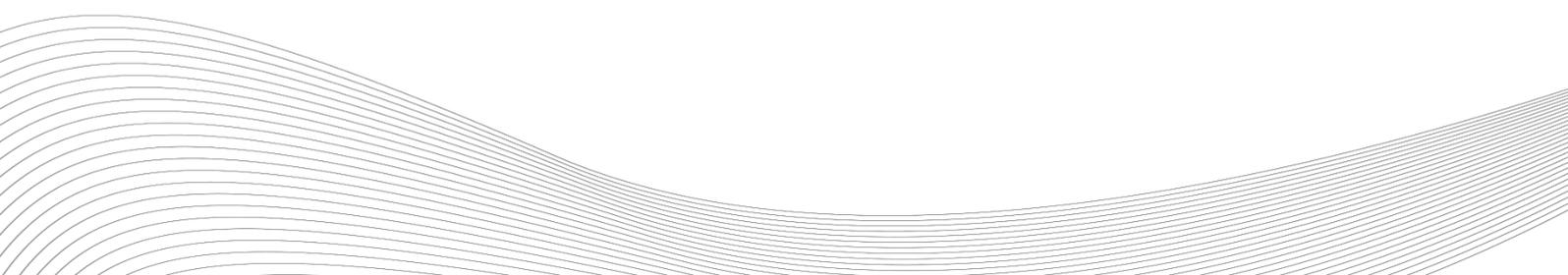


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## ACKNOWLEDGEMENTS

This research was supported by the Australian Research Council Centre of Excellence for Children and Families over the Life Course (project number CE140100027).

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## ABSTRACT

There is a large volume of research on the persistence of advantage and disadvantage across generations. Intergenerational studies typically address family resources as independent factors, which ignores how risks cluster together and accumulate over time. Using data from the Longitudinal Study of Australian Children and latent class methods, we used grandparent and parent characteristics to identify risk circumstances of grandchildren and then examined the association between risk circumstances and grandchild educational outcomes. Five qualitatively and quantitatively distinct latent classes of grandparent characteristics and four latent classes of parent characteristics were identified. Of these, Low Grandparent Education Capital, Parent Financial Hardship, and Multiple Parent Risks latent classes were associated with lower grandchild literacy and numeracy scores in Year 3. Disadvantages were concentrated within three-generation family units; grandparent latent classes were associated with parent latent classes, and grandparent and parent latent classes were associated with the grandchild's educational achievement.

**Keywords:** intergenerational disadvantage; educational achievement; latent class analysis

**Suggested citation:** Adams, E. K., Hancock, K. J. , Mitrou, F., Christensen, D., Taylor, C. L. & Zubrick, S. R. (2021). 'Intergenerational transmission of human capital across three generations using latent class associations within families', Life Course Centre Working Paper Series, 2021-03. Institute for Social Science Research, The University of Queensland.

## 1. Introduction

Associations between various forms of family disadvantage and child development outcomes are well-established in the international literature (OECD, 2018), and have long been documented in well-known socioecological models (Bronfenbrenner, 1986; Brooks-Gunn & Duncan, 1997). Parent characteristics are one such influence on child development, and there is a large volume of research on the persistence of advantage and disadvantage across two generations (OECD, 2018). Theories of cumulative advantage posit that disadvantages and advantages can compound over one's life and lead to an accumulation of risks, protections, and resources (Bask & Bask, 2015; DiPrete & Eirich, 2006). Cumulative advantage theories take a life course approach where different life trajectories arise from the varying advantages or disadvantages that children experience in early life (DiPrete & Eirich, 2006).

Extending cumulative advantage to an intergenerational perspective, inequalities can persist, and magnify, across generations (Mare, 2011). Broadly, the more social and economic opportunities or resources parents have the more opportunities their children have for development across a range of developmental indicators. These resources include attitudes and expectations towards child development outcomes that then influence the attainment of those outcomes. For example, parental expectations of child education may influence child educational achievement and attainment (Sommerfeld, 2016; Yamamoto & Holloway, 2010). In turn, as children develop and expand their own sets of capabilities, resources, and expectations into adulthood, the next generation of children can then benefit from those resources. In contrast, families with fewer resources to support child development may struggle to build the human capital needed to move beyond their level of disadvantage. This intergenerational dynamic maintains or widens the gap between people at the top and bottom of the socioeconomic ladder (OECD, 2018).

Intergenerational transmission of disadvantage is not inevitable; effective policies and programs can improve opportunities for social mobility (OECD, 2018). Yet, to break cycles of persistent disadvantage it is necessary to understand the origins and pathways that shape this transmission across generations. Given this need to understand intergenerational transmission of advantage, research now focusses on the contributions of the extended family, in particular contributions from grandparents. Exploring the potential impacts grandparents may have on grandchild outcomes is important because focusing solely on the parent to child relationship may underestimate the persistence of

disadvantage; i.e., a narrower focus can overestimate the extent of mobility experienced by grandchild generations (Anderson et al., 2018). In this paper, we refer to multiple generations by their relationship to the grandchild, i.e. as grandparent, parent, and grandchild.

Research on intergenerational advantage and disadvantage examines the influence of grandparent characteristics on the outcomes of their grandchildren through a combination of direct and indirect pathways. Broadly, there are two approaches to these intergenerational transfers: there are models which posit that intergenerational transfers are fully mediated by the parent generation, and there are models which also allow for direct transfers from grandparent to grandchild. The Markovian Model posits that grandparents' influence on their grandchildren is wholly mediated through the grandchild's parents (Mare, 2011), that is, grandparent effects are exclusively indirect.

In contrast, broader child development models posit that developmental and life course pathways can include multiple, intersecting spheres of influence, including both proximal (i.e. parents and siblings) and distal (e.g. grandparents and other extended family) family members, peers, school environments, broader community, and political and national contexts (Bronfenbrenner, 1986; Zubrick et al., 2009). These models suggest that grandparents can directly affect the outcomes of their grandchildren, over and above the indirect transfers that may occur via the parent generation. Grandparents can, and do, play a significant role in the lives of their grandchildren. Through face-to-face contact, grandparents have opportunities to pass on norms and values and model behaviour to their grandchildren (Bol & Kalmijn, 2016). In Australia, grandparents represent a substantial childcare resource for parents. Approximately 20% of grandchildren in Australia aged 0 to 11 years have received informal care from their grandparents (ABS, 2018). Informal care is just one form of contact grandparents can have with their grandchildren and does not include involvement with the grandchildren when the parents are also present, or co-residence. Even without direct contact or caregiving responsibilities, grandparents can potentially play a role in child development by financially scaffolding parents (Bol & Kalmijn, 2016; Mare, 2011), or by providing additional resources, opportunities, and expectations to grandchildren. Grandparents of limited means and resources may have fewer options to support their family.

The extant multigenerational research provides mixed evidence for the role of grandparents on child development. Several recent studies have found direct effects

between grandparent factors and grandchild outcomes in education, employment, health, and mental health after controlling for a range of parent characteristics (Acacio-Claro et al., 2018; Chan & Boliver, 2013; Doku et al., 2019; Ferguson & Ready, 2011; Fiel, 2019; Hällsten & Pfeffer, 2017; Hancock et al., 2018; Hancock et al., 2013; Lehti et al., 2019; Sheppard & Monden, 2018). Yet, other studies find no direct effects between grandparents and grandchildren (Bol & Kalmijn, 2016; Braun & Stuhler, 2016; Jæger, 2012). More recently, Engzell et al. (2020) found that grandparent effects are only identified when there are insufficient controls for parent factors.

There are several factors that likely contribute to these mixed findings. These include variability in the quality and richness of data sources, variability across studies concerning the lineages included in modelling (maternal, paternal, or both), and varying international contexts relating to childcare, life expectancy, and intergenerational mobility. A further reason is that previous studies often examine grandparent and parent characteristics as isolated characteristics. However, indicators for adversity do not usually occur as single risks but group together and accumulate as clusters of risk factors (Jobe-Shields et al., 2015). For instance, socioeconomic risks like low education and low occupational status can co-occur with poor housing, single parenthood, and poor health, which can combine to make upward mobility more difficult. Yet, low parental education may not be a barrier to children's upward mobility if parents have good health, good social support, and positive expectations for their children's education. As such, factors such as low parental education might not represent the same degree of risk for all families (Jobe-Shields et al., 2015). Considering risks as independent factors or as cumulative indices can miss the complexity of how risks cluster together to impact grandchildren's developmental pathways (Jobe-Shields et al., 2015). Therefore, considering a broader profile of characteristics may provide a more realistic account of the set of resources and characteristics that may be transferred across generations.

Understanding how social mobility may be affected by different combinations of risk factors can help identify modifiable leverage points to inform targeted programs and policies to improve social mobility and how individuals and families are selected for such programs (Goldfeld et al., 2018; OECD, 2018). Studies that use latent class approaches to describe child and parent characteristics highlight that more meaning can be gained about child development trajectories and outcomes when multiple risk factors are considered together, rather than the typical regression approach of assessing variables separately

(Christensen et al., 2020; Christensen et al., 2017; Taylor et al., 2020; Taylor et al., 2019).

In this study, we used latent class analysis (LCA) and grandparent and parent characteristics to identify risk circumstances of grandchildren and then examined the association between risk circumstance membership and grandchild educational outcomes. In doing so, we extend the previous research by adopting a grandchild-centred approach to identifying the variable mix of resources and characteristics over two generations that may be associated with grandchild development. By adopting a latent class approach, we can understand how the broader social and economic environments of maternal grandparents, paternal grandparents, and parents relate to grandchild educational achievement. This study therefore provides further understanding about the persistence of multiple disadvantages across generations, and the relative importance of enabling upward mobility for grandchildren growing up in relative disadvantage.

## 2. Methods

The Longitudinal Study of Australian Children (LSAC) is a nationally representative study of Australian children (Sanson et al., 2002; Soloff et al., 2005). Commencing in 2004, the LSAC collected data from two cohorts of study children, including 5,107 infants (B-cohort, aged 3-19 months) and 4,983 children (K-cohort, aged 4-5 years). The study children have been followed up every two years, with seven waves of data now available. This study uses data from both cohorts. The study child's primary carer (Parent 1) is the primary respondent at each wave, who completes a combination of in-home interviews and self-complete questionnaires at each wave. The second parent (where available) was provided with self-complete questionnaires. Primary caregivers were also asked for consent to link external administrative databases, including education records, to the survey data for each study child.

Study data relate to seven individual family members, including the study child (referred to in this paper as the grandchild, and the child's mother, father, maternal grandmother and grandfather, and paternal grandmother and grandfather. The analytic sample was restricted to grandchildren with two biological, adopted, or step-parents residing together in the same home, where at least one measure was available for each of the additional six family members under study. The analytic sample consists of 5,805 study children and

excludes children in sole-parent families at age 6-7 years. The LSAC has ethics approval from the Australian Institute of Family Studies Ethics Committee.

### *2.1 Measures*

The family structure was determined by the responding parents when the grandchild was aged 6-7 years (Wave 2 for K-cohort and Wave 4 for B-cohort), approximately two years before the first education achievement scores were collected.

Parent characteristics were taken from the wave when the study child was aged 6-7 years. Information on grandparent characteristics was provided by the parents at multiple waves and typically related to a point in time (e.g. grandparent educational attainment when the parent was age 14 years), or a general recollection from parents about their experiences growing up. All responses were dichotomised as outlined below to reflect the presence or absence of each risk factor. All grandparent characteristics were defined separately for maternal and paternal grandparents. For some measures, risk factors were defined individually for each grandparent or parent. For other measures, the data were combined into a single at-risk measure for the relevant couple; some variables were only available for the couple or family and not individual family members. The proportions of grandparents and parents experiencing each risk factor are provided in Table 1. In Table 1, each column presents the risk factors for the relevant couple, i.e. maternal grandparents, paternal grandparents, and parents. Unless otherwise indicated in the row label, the proportions represent the prevalence of that risk factor for the grandparent or parent couple, as outlined in the variable descriptions. For example, low education attainment for the maternal grandparents is the proportion of maternal grandparent couples where the grandmother and grandfather had attained Year 10 or lower education.

**Table 1. Proportion of grandparents and parents with each risk factor.**

Risk Factor	Maternal grandparents %	Paternal grandparents %	Parents %
Low educational attainment	32.8	32.9	12.8
Jobless household	11.0	6.5	3.1
Low financial comfort	35.7	41.4	19.9
Low general health*			
Grandmother/Mother	12.4	18.9	33.0
Grandfather/Father	11.5	21.0	36.3
Mental health problems*			
Grandmother/Mother	22.6	18.6	11.3
Grandfather/Father	14.1	11.7	10.3
Drinking or drug problem	18.9	16.7	
Low interest in parent education			
Grandmother	17.5	17.5	
Grandfather	28.6	33.7	
Separated	27.7	19.6	
Household conflict	19.4	13.8	
Low income			19.0
Financial hardship			13.6
Unable to raise \$2,000			13.4
Marital hostility			22.1
Low education expectations of child			14.4
Few home education activities			19.2
Few books in home			14.8

Table notes. Asterisked indicators have different coding between grandparents and parents.

### *2.1.2 Grandparent characteristics*

*Low education attainment.* Parents were asked about the highest educational qualification of the grandmother and grandfather when parents were aged 14 years. Responses ranged

from never attended school to university qualification. The grandparent couple was defined as having low educational attainment where neither the grandmother nor grandfather had progressed beyond Year 10—typically the last year of compulsory education for this cohort of grandparents.

*Jobless household.* Parents were asked about who the main breadwinner was while they were growing up (their mother, father, or someone else), and whether that breadwinner had ever been unemployed for a period of six months or more. The grandparent couple was coded as having been jobless if the main breadwinner had been unemployed for at least six months. Where both the grandmother and grandfather were identified as being breadwinners, grandparents were coded as being jobless if both grandparents had been unemployed for at least six months.

*Low financial comfort.* Parents were asked about their family's financial situation when they were growing up. Responses ranged from on a six-point scale from very poor to prosperous. Low financial comfort for the grandparent couple was defined where parents rated their financial comfort while growing up as 'very poor', 'poor', or 'just getting along'.

*Low general health.* Parents were asked about the general health of the grandmother and grandfather when the parents were growing up. Responses were on a five-point scale from excellent to poor. Low general health for each individual grandparent was defined where parents rated grandparent health as 'fair' or 'poor'.

*Mental health problems.* Parents reported whether the grandmother and grandfather had ever suffered from nervous or emotional trouble or depression while the parent was growing up. Responses were coded for each individual grandparent as yes or no.

*Drinking or drug problem.* Parents reported whether the grandmother and grandfather had ever trouble with drinking or drug use while the parent was growing up. Due to a low prevalence of drinking and drug use problems, responses on this item were combined across the grandparent couple. A drinking or drug problem reflects either the grandmother or grandfather (or both) having had trouble with drinking or drug use.

*Low interest in parent's education.* Parents were asked how much interest the grandmother and grandfather had shown in their education while they were growing up. Responses were on a four-point scale from 1 = a lot of interest to 4 = no interest, with an

additional option of didn't have a mother or father. Low interest in education for each individual grandparent was defined where grandparents had 'not much interest' or 'no interest' in the parent's education.

*Separated/divorced.* Parents were asked if the grandparents had permanently separated or divorced. Responses were yes, no, or never lived together and were recoded as no or yes/never together.

*Household conflict.* Parents were asked about the level of conflict that occurred in the household while they were growing up, with responses ranging from 1 = a lot to 3 = none. Grandparent household conflict included cases where parents responded 'a little' or 'a lot'.

### *2.1.3 Parent characteristics*

Parent characteristics were selected to provide an indication of the grandchild's home environment. While many indicators are available in the LSAC, we selected indicators that matched the constructs that were collected for grandparents. These included matching against the constructs measured by the grandparent variables (e.g. financial comfort, health, mental health, and education characteristics) but also to provide an indication of the broader home environment. All parent characteristics were measured when the grandchild was aged 6-7 years.

*Low education attainment.* Parents were asked about their highest year of school completion and highest educational qualification. Low education attainment for the parent couple was defined as such where neither parent had progressed at school beyond Year 10 or achieved a post-secondary qualification.

*Jobless household.* Jobless households were defined as those where neither parent had at least part-time employment.

*Low household income.* Equivalised household income was first calculated by dividing the household income by the number of people in the household. The lowest 20% of equivalised incomes were coded as at-risk.

*Low financial comfort.* Parent 1 was asked about how their family was getting on given their current needs and financial responsibilities. Responses ranged on a six-point scale

from very poor to prosperous. Low financial comfort for the parent couple was identified where comfort was rated as 'very poor', 'poor', or 'just getting along'.

*Financial hardship.* Financial hardship was assessed from a summary scale of six items asking Parent 1 about their ability to pay bills on time, pay the mortgage on time, if they had gone without meals, were unable to heat or cool home, had pawned or sold something, or had received assistance from welfare or a community organisation in the last 12 months. Parents responding yes to at least one item were defined as experiencing financial hardship.

*Unable to raise \$2,000.* Parent 1 was asked how difficult it would be for their family to raise \$2,000 in a week. Parents who responded that 'it would require a large sacrifice' or 'couldn't do this' were defined as being unable to raise \$2,000.

*Low general health.* Both parents were asked about their general health, with responses ranging from excellent to poor. Low general health was defined for each parent where health was rated as 'poor', 'fair' or 'good'. Different definitions for low health were used for parents and grandparents due to the different distributions of responses. Approximately two-thirds of parents rated their health as 'excellent' or 'very good'.

*Mental health problems.* Both parents completed the Kessler Psychological Distress Scale (K6) as a measure of non-specific psychological distress. Parents with scores of 8 or higher were coded as having psychological distress. This threshold has been used in previous research to identify elevated psychological distress (Christensen et al., 2017; Lawrence et al., 2011).

*Marital hostility.* Both parents were asked about their relationship with their partner. Items included the extent to which they disagreed about child-rearing, had stressful conversations, had arguments with their partner, or had hostility between them, with responses ranging from 1 = never to 5 = always. Responses from both parents were averaged to provide one overall scale from 1 to 5 of marital hostility. Parents in the highest quintile of responses were defined as experiencing marital hostility, which included scores above 2.5.

*Few home education activities.* Parent 1 was asked on how many days in the last week they did seven types of activities with the study child (grandchild read to, told a story to, drawn a picture with, played music with, played games with, involved in everyday

activities, played outside with). Responses ranged from 0 = none to 3 = every day (6 or 7 days). Responses were averaged across the scale and parents in the lowest quintile were defined as engaging in few home education activities, which included scores below 0.9.

*Few books in the home.* Parent 1 was asked about the number of books available in the home. Less than or equal to 30 books was defined as having few books in the home.

*Low education expectations of child.* Parent 1 was asked how far they expected the study child to go in their education. Parents that did not expect the child to engage in post-secondary education were defined as having low educational expectations. Responses were recoded into a binary variable, where at-risk was no post school education.

#### *2.1.4 Grandchild educational achievement*

Education is one of the most important factors that can facilitate or constrain mobility (Johnson et al., 2010; OECD, 2018), and for this reason education outcomes, in particular literacy and numeracy achievement, are the focus of the current study. We used the reading and numeracy test scores from the National Program of Literacy and Numeracy (NAPLAN) to assess grandchild achievement outcomes (ACARA, 2016). The NAPLAN is a suite of standardised tests of numeracy and literacy administered each year to all Australian students in Years 3, 5, 7 and 9. Tests have been administered since 2008, and scores are standardized and scaled by a central authority to compare the performance of grandchildren and schools over time. NAPLAN data are administered by the Australian Curriculum and Reporting Authority, with data linked to the NAPLAN dataset for families consenting to data linkage at Wave 3 and 4. As of Wave 7, test scores for Year 3, 5, 7, and 9 were available for most of the K-cohort, and in Year 3 and Year 5 for the B-cohort. All grandchildren who had at least one reading or one numeracy NAPLAN test score and the grandparent and parent variables were included in analyses (Year 3 reading n=4,508; Year 3 numeracy n=4,501).

#### *2.2 Statistical analysis*

A three-step approach was used for this analysis (Bakk et al., 2013), with the unit of analysis being the grandchild. First, we conducted two latent class analyses (LCA) to separately determine grandparent and parent latent classes. The number of optimal classes was determined using the BIC, AIC, entropy, group probabilities, group proportions, and subjective judgement for models with one to eight classes.

Second, for each LCA the grandchild was assigned to the most appropriate grandparent and parent latent classes, using proportional BCH adjustments to account for misclassification probabilities (Bakk et al., 2013; Bakk & Vermunt, 2015).

Third, the latent class assignments and grandchild educational achievement outcomes were used in multivariate regression analyses to determine (1) the association between grandparent and parent latent classes, and (2) grandchild achievement outcomes according to grandparent and parent latent classes. The final models with grandchild outcomes adjusted for grandchild gender (female vs. male), Aboriginal status (Aboriginal or Torres Strait Islander vs. non-Indigenous), and cohort (B vs. K). Interactions between parent and grandparent latent classes were tested in the models. As these interactions were not statistically significant, they were excluded from the findings presented here.

Latent class analysis was undertaken in SAS 9.4, using PROC LCA v. 1.3.2 (Lanza et al., 2015). The latent class posterior probabilities were imported into Latent GOLD 5.1 for determining class assignment and estimating class effects on grandchild achievement outcomes (Bakk et al., 2013; Vermunt & Magisdon, 2013; Zhu et al., 2017). All analyses were adjusted for the complex sampling strategy by adjusting for sampling weight and cluster in latent class analysis, and weight, cluster, and strata in regression analysis. Latent GOLD syntax is available in Supplement S1.

The LCA for grandparent characteristics models risks across both the maternal and paternal grandparents in a single analysis. Separate LCA were also conducted for maternal and paternal grandparent characteristics separately to identify if different latent classes emerged for maternal and paternal grandparents. As similar latent classes emerged for maternal and paternal grandparents, we chose to model all grandparent characteristics within a single LCA. This decision was made so that the family history of the grandchild could be described more completely than could be achieved if maternal and paternal grandparent characteristics were described separately.

### *2.3 Sensitivity analysis*

The analysis was necessarily limited to families where data on all six family members (both paternal grandparents, both maternal grandparents, and both parents) were available (n=5,805). This approach therefore excludes sole-parent families who did not provide data for a secondary parent, or where either parent did not provide data for a particular grandparent (e.g. if a parent indicated they did not have a mother). This

approach also excludes two-parent families where the secondary carer did not return the self-complete questionnaire. While data from a parent living elsewhere was available from Wave 3, these data were not included due to the complexities this would introduce due to varying contact and caring responsibilities.

To determine how results may have varied had all families been included in analysis, we repeated the models on a broader sample of LSAC families by including information relating to mothers (or the household) and the maternal grandparents (n=7,756) so that the majority of children in sole-parent families could also be included. A variable for whether the mother had ever (vs. never) been a single mother was included. All other parent variables were the same as for the main analysis, but excluded father health and father mental health. The aim of this analysis was to provide context around the generalizability of the analysis that excluded children in sole-parent families.

### 3. Results

#### *3.1 Grandparent latent classes*

Table 2 provides the fit statistics for grandparent latent class models with one to eight classes. Based on the fit criteria and assessment of the latent class membership, a five-class solution was selected as the best model. All five latent classes had mean posterior probabilities greater than 0.7, indicating reasonable model fit (Table 3). Figure 1 presents the probabilities of risk exposure by grandparent latent class.

The latent classes were named according to their risk exposures and relationships to the grandchild. The first latent class, named Low Grandparent Risk (40% of the sample), was defined by low probabilities of all risk factors compared with the other classes (see Figure 1). On average, grandchildren in this class had 2.1 of 24 possible grandparent risks (Table 3). Latent classes 2-5 were characterised by grandchildren having relatively higher probabilities of all risk factors across maternal grandparents only, paternal grandparents only, or both maternal and paternal grandparents. Grandchildren in the second latent class, High Maternal Grandparent Disadvantage (20%), had higher probabilities of maternal grandparent risk factors, including low financial comfort, household conflict, separation, and the maternal grandfather having a low interest in the mother's education, but low probabilities of any paternal grandparent risks. On average, grandchildren in this class had

4.7 grandparent risk factors. In contrast, the High Paternal Grandparent Disadvantage latent class (17%) had higher probabilities of all risk factors among the paternal grandparents, and low probability of any maternal grandparent risks. The average number of risks for grandchildren in this class was 5.8. The fourth latent class was named Low Grandparent Education Capital (14%) for the high probabilities of risk in both maternal and paternal grandparents for education, financial comfort, and interest in parent education risk factors, but low probabilities of items relating to conflict or health issues. The average number of grandparent risk factors for grandchildren in this class was 5.8 grandparent risks. Finally, the High Blended Disadvantage latent class (8%) was characterised by high probabilities of risks across most of the maternal and paternal risk factors. Grandchildren in this class had 9.5 grandparent risks on average. These latent classes demonstrate that while the largest class had very few of the grandparent risk factors (Low Grandparent Risk), more than half the grandchildren (60%) had either maternal or paternal grandparents (or both) experiencing several risk factors that could relate to the development of the grandchildren.

**Table 2. Fit statistics for grandparent LCA with 1 to 8 classes**

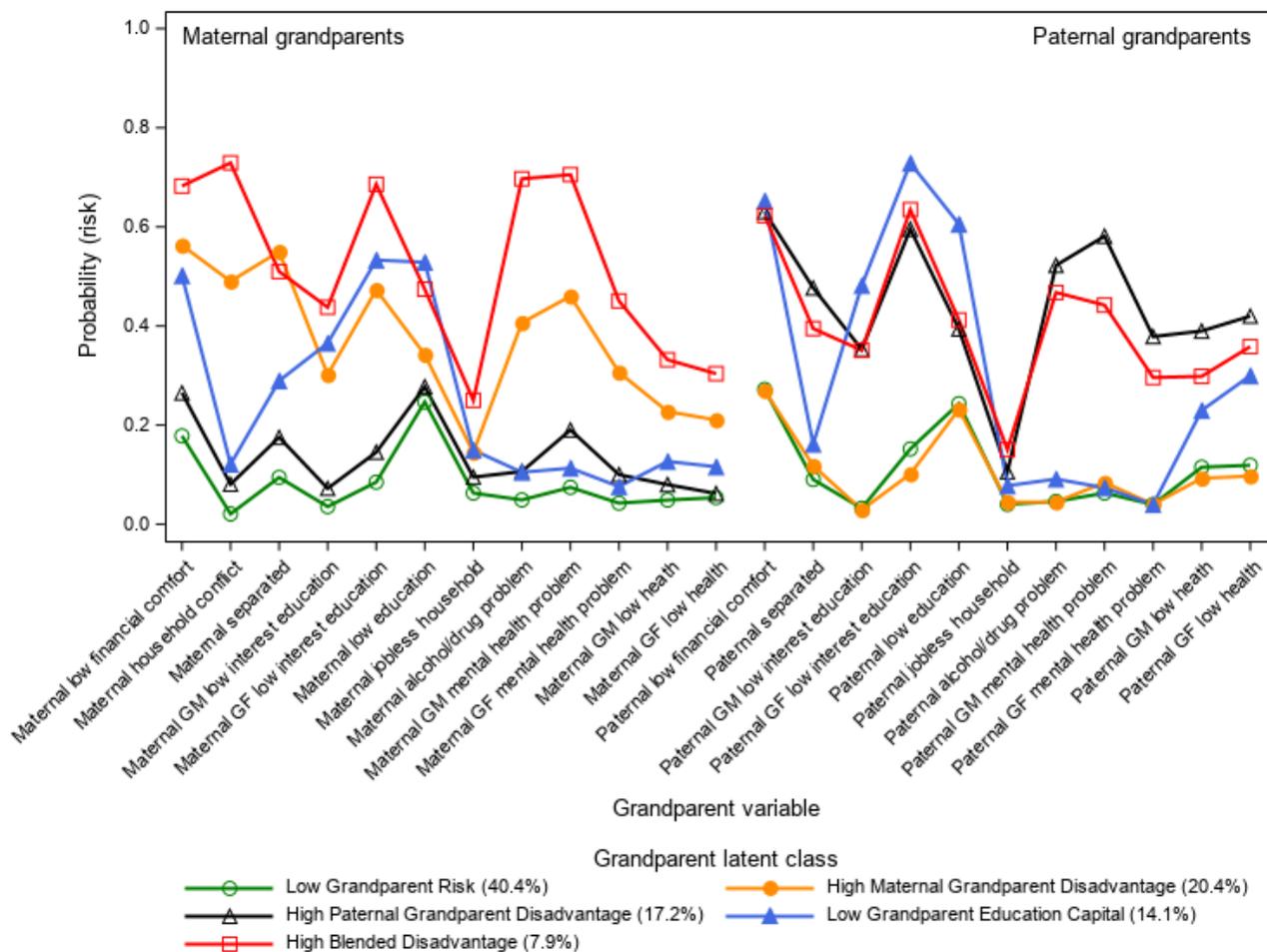
Number of classes	AIC	BIC	Entropy	Change in AIC (relative to K-1)	Change in BIC (relative to K-1)
1	30369	30529	1.00		
2	26344	26671	0.64	-4025	-3858
3	24181	24674	0.70	-2163	-1997
4	23610	24270	0.69	-571	-400
5	23110	23936	0.67	-500	-334
6	22786	23779	0.68	-324	-157
7	22504	23663	0.65	-282	-116
8	22370	23697	0.66	-134	34

**Table 3. Class probability and mean posterior probabilities for grandparent five-class latent class model.**

Latent Class	Class members hip probability	Best class members hip %	N Risks, Total	N Risks, Maternal	N Risks, Paternal	Mean Posterior Probabilities				
						1	2	3	4	5
1. Low Grandparent Risk	0.404	44.2	2.1	1.4	1.6	<b>0.826</b>	0.072	0.042	0.059	0.001
2. High Maternal Grandparent Disadvantage	0.204	20.1	4.7	3.9	1.5	0.094	<b>0.764</b>	0.019	0.067	0.057
3. High Paternal Grandparent Disadvantage	0.172	16.6	5.8	1.8	4.5	0.074	0.016	<b>0.818</b>	0.059	0.034
4. Low Grandparent Education Capital	0.141	12.0	5.8	3.0	3.3	0.085	0.086	0.080	<b>0.708</b>	0.042
5. High Blended Disadvantage	0.079	7.1	9.5	5.5	4.0	0.001	0.090	0.072	0.052	<b>0.786</b>

Maximum number of risks = 24.

Fig 1. Probability of risk exposure by grandparent latent class.



The terms GM and GF refer to the grandmother and grandfather respectively.

### 3.2 Parent latent class

The latent class model with four latent classes was determined to be the best fit for parent characteristics. The fit statistics are provided in Table 4, the mean latent class posterior probabilities in Table 5, and the probabilities of risk exposure by parent class in Figure 2.

**Table 4. Fit statistics for parent LCA with 1 to 8 classes.**

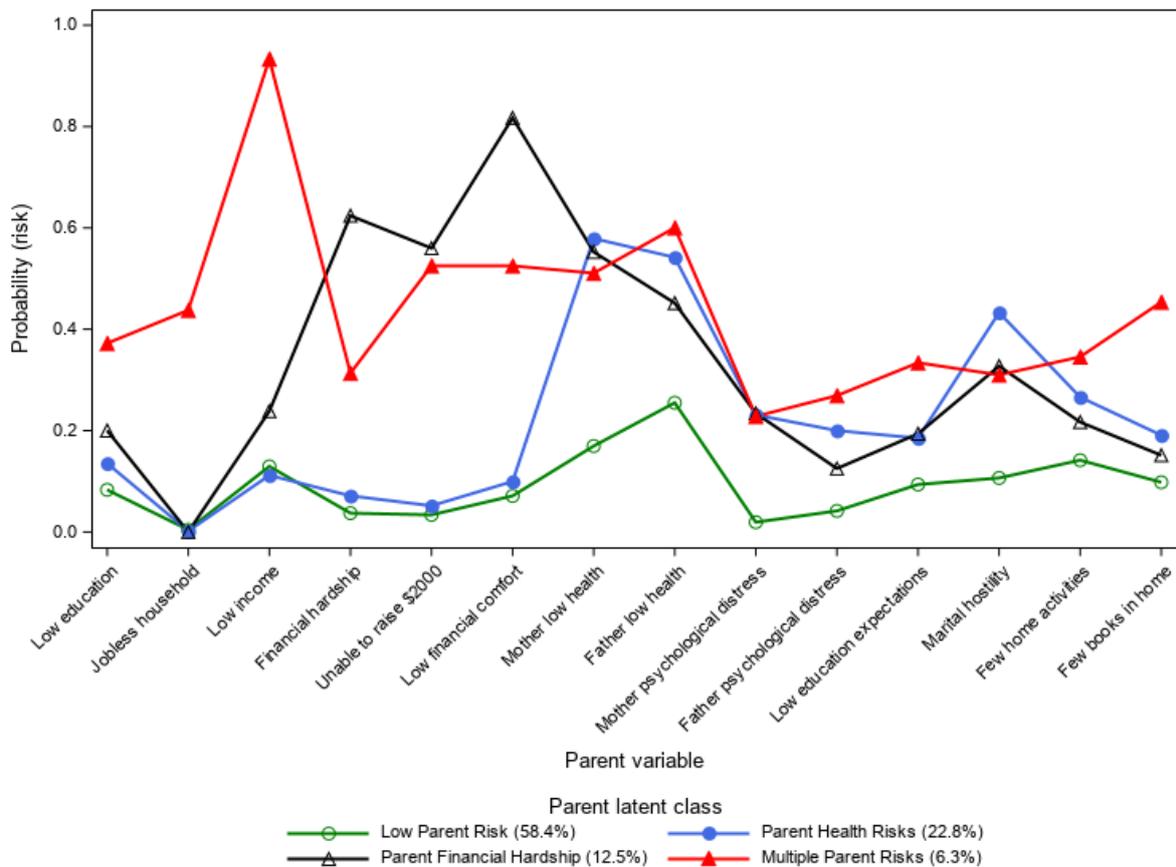
Number of classes	AIC	BIC	Entropy	Change in AIC (relative to K-1)	Change in BIC (relative to K-1)
1	7849	7942	1.00		
2	4974	5167	0.75	-2875	-2775
3	4668	4961	0.56	-306	-206
4	4325	4719	0.65	-343	-242
5	4214	4707	0.68	-111	-12
6	4175	4768	0.69	-39	61
7	4109	4802	0.69	-66	34
8	4053	4847	0.70	-56	45

**Table 5. Class probability and posterior probabilities for parent four-class latent class model.**

Latent Class	Class membership probability	Best class membership %	N Risks	Mean Posterior Probabilities			
				1	2	3	4
1. Low Parent Risk	0.584	65.2	1.6	<b>0.833</b>	0.142	0.018	0.007
2. Parent Health Risks	0.228	17.8	3.4	0.216	<b>0.693</b>	0.071	0.019
3. Parent Financial Hardship	0.125	11.1	4.6	0.055	0.052	<b>0.832</b>	0.062
4. Multiple Parent Risks	0.063	5.8	5.9	0.046	0.053	0.103	<b>0.798</b>

Maximum number of risks = 14.

Fig 2. Probability of risk exposure by parent latent class.



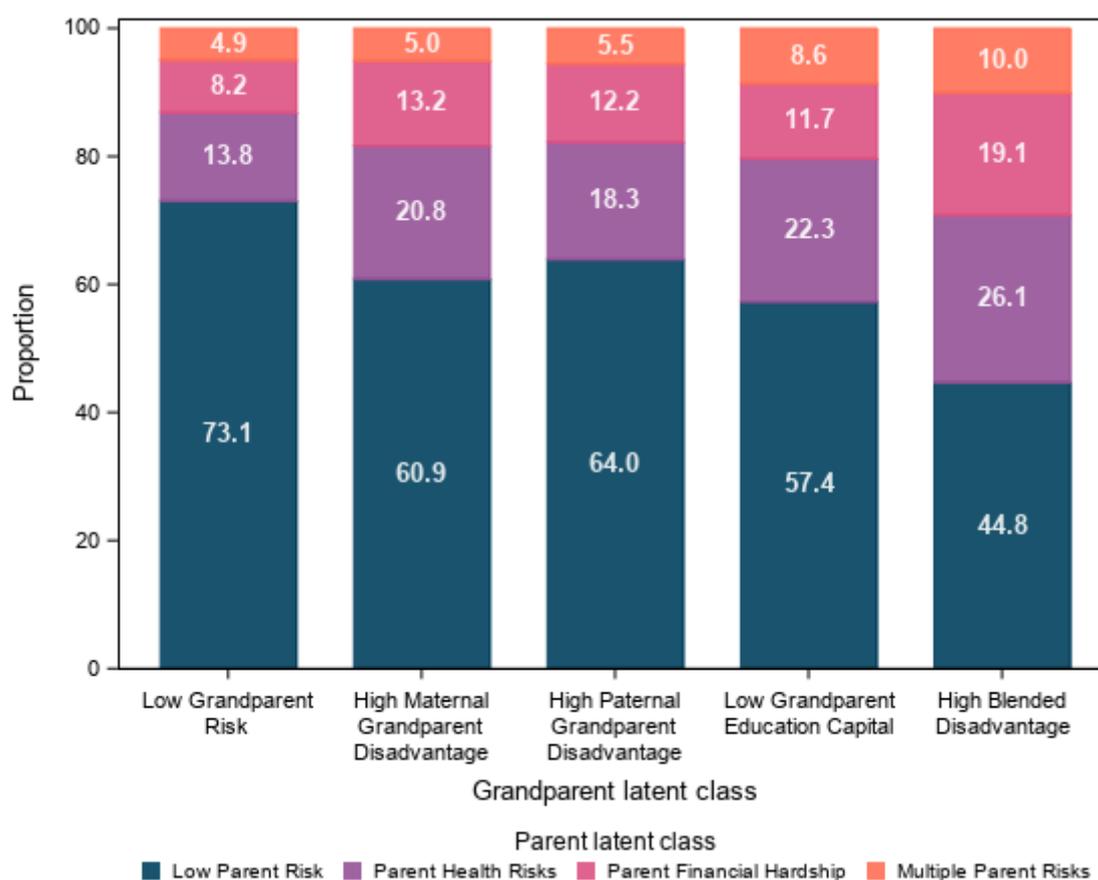
The first latent class, named Low Parent Risk (58% of the sample), was characterised by low probabilities of exposure to all risk factors compared with the other classes. On average, grandchildren in this class were exposed to 1.6 of 14 possible parent risks. The second latent class, Parent Health Risks (23%), was characterized by higher probabilities of exposure to low health and marital hostility, but low probabilities for the remaining risk factors. On average, grandchildren in this class were exposed to 3.4 parent risks. The third latent class, Parent Financial Hardship (12%) was characterised by a higher probability of financial hardship, being unable to raise \$2000, and low financial comfort. In this class there were also relatively high probabilities of exposure to health and marital hostility risk factors. Grandchildren in this class were exposed to 4.6 parent risk factors on average. The final latent class was the Multiple Parent Risks class (6%). This class had relatively high probability of most risk factors, and distinctly high-risk probabilities for low parental education, being in a jobless household, being low income, few home education activities, and few books in the home. On average, grandchildren in this class were exposed to 5.9

parent risks. Overall, using the best class membership, 32% of grandchildren were classified as being low risk for both the grandparent and parent latent classes.

### *3.3 Intergenerational effects*

Figure 3 highlights the association between the grandparent and parent latent classes, using the best class membership, and shows that parent latent class membership varied across grandparent latent class. Nearly three-quarters (73%) of grandchildren in the Low Grandparent Risk class were also classed as Low Parent Risk, compared to just 45% of grandchildren in the High Blended Disadvantage class. Compared with the low risk grandparent and parent latent classes, the likelihood of being in any of the at-risk parent latent classes was greater when the grandchild was in an at-risk grandparent latent class (Supplement S2). This figure indicates that while there is some persistence of disadvantage from grandparents to parents, there are also many cases of apparent upward mobility (e.g. the 45% of families in the High Blended Disadvantage group being classed in the Low Parent Risk group) and downward mobility (e.g. the 27% of families in the Low Grandparent Risk group who were *not* classed as Low Parent Risk).

Fig 3. Transition of grandparent to parent latent class, using best class membership.



### 3.4 Reading achievement

Mean reading scores for each latent class were highest for the Low Grandparent Risk and Low Parent Risk classes and were lowest for the Low Grandparent Education Capital and Multiple Parent Risks classes (Supplement S3). Grandchild reading achievement gaps were larger when comparing across different parent latent classes than when comparing across grandparent latent classes.

Table 6 presents the adjusted regression coefficients for grandchild reading achievement scores against grandparent and parent latent class membership; unadjusted coefficients are available in Supplement S4. The adjusted analyses controlled for child sex, Aboriginality, cohort, and, after Year 3, prior achievement. Grandchildren in the Low Grandparent Education Capital, Parent Health Risks, Parent Financial Hardship, and/or Multiple Parent Risks latent classes had significantly lower Year 3 reading scores than

grandchildren in the low risk groups (Model 1). Being female and being non-Aboriginal were both associated with higher Year 3 reading scores. The effects of membership in Parent Financial Hardship were much smaller on Year 5 (Model 2) reading than Year 3 but remained significant after adjusting for prior achievement. Parent Health Risks and Parent Multiple Risks were no longer associated with Year 5 reading achievement in the adjusted models. Membership in the Low Grandparent Education Capital class was significantly associated with lower Year 5 reading scores, again with a smaller effect size than for Year 3. These results suggest that grandchildren in the Low Grandparent Education Capital and Parent Financial Hardship latent classes have lower achievement scores by Year 3 that persist to Year 5. For Year 7 reading scores (Model 3), grandchildren in the High Maternal Grandparent Disadvantage and High Paternal Grandparent Disadvantage latent classes had lower reading scores than grandchildren in the Low Grandparent Risk latent class. Grandchildren in the Parent Financial Hardship and Multiple Parent Risk classes also had lower reading scores than grandchildren in the Low Parent Risk latent class. In Year 9 (Model 4), reading achievement was not associated with parent latent class membership. Low Grandparent Education Capital was negatively associated with reading scores.

### *3.5 Numeracy achievement*

Mean numeracy scores for each latent class were highest for the Low Grandparent Risk and Low Parent Risk classes and were lowest for the Low Grandparent Education Capital and Multiple Parent Risks classes (Supplement S3). As with reading, grandchild numeracy achievement gaps were larger when comparing across different parent latent classes than when comparing across grandparent latent classes.

Table 7 presents the adjusted regression coefficients for grandchild numeracy achievement scores against grandparent and parent latent class memberships; unadjusted coefficients are provided in Supplement S4. Grandchildren in High Paternal Grandparent Disadvantage, Low Grandparent Education Capital, Parent Financial Hardship, and/or Multiple Parent Risks had significantly lower Year 3 numeracy scores (Model 1). Being male, non-Aboriginal, or in the K-Cohort was associated with higher Year 3 numeracy scores. In Year 5 (Model 2), there were no associations between membership in parent and grandparent latent classes and numeracy scores. In Year 7 (Model 3) and Year 9 (Model 4), there were no significant associations between membership in grandparent latent classes and numeracy scores. In Year 7, grandchildren in the Parent Financial Hardship or Multiple Parent Risks latent classes had significantly lower numeracy scores, and in Year 9

grandchildren in the Parent Financial Hardship latent class had significantly lower numeracy scores

**Table 6. Regression coefficients of Year 3 to Year 9 reading scores for each grandparent and parent latent class relative to low risk latent classes.**

	Year 3 (N=4,508) Model 1	Year 5 (N=4,150) Model 2	Year 7 (N=2,365) Model 3	Year 9 (N=2,090) Model 4
<b>Grandparent latent classes</b>				
Low Grandparent Risk	REF	REF	REF	REF
High Maternal Grandparent Disadvantage	2.646	0.870	7.752*	-5.624
High Paternal Grandparent Disadvantage	2.416	0.179	7.470*	0.315
Low Grandparent Education Capital	-16.620**	-9.947*	0.742	-11.510*
High Blended Disadvantage	-5.995	-0.933	0.750	-1.854
<b>Parent latent classes</b>				
Low Parent Risk	REF	REF	REF	REF
Parent Health Risks	-13.875*	1.215	-8.900	-3.532
Parent Financial Hardship	-33.445***	-9.662**	-17.926***	0.947
Multiple Parent Risks	-55.397***	-9.938	-19.374**	-9.080
Female	14.677***	2.398	2.408	7.840***
Aboriginal	-37.055**	-4.794	-12.156	-22.617**
B-Cohort	5.191	1.642	-	-
Year 3 score	-	0.662***	-	-
Year 5 score	-	-	0.648***	-
Year 7 score	-	-	-	0.774***

Table notes. Model 3 and Model 4 only include K-cohort. \* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

**Table 7. Regression coefficients of Year 3 to Year 9 numeracy scores for each grandparent and parent latent class relative to low risk latent classes.**

	Year 3 (N=4,501) Model 1	Year 5 (N=4,117) Model 2	Year 7 (N=2,340) Model 3	Year 9 (N=2,075) Model 4
<b>Grandparent latent classes</b>				
Low Grandparent Risk	REF	REF	REF	REF
High Maternal Grandparent Disadvantage	-2.571	-1.537	-0.686	0.001
High Paternal Grandparent Disadvantage	-8.917*	-3.503	-1.378	-0.949
Low Grandparent Education Capital	-17.231**	-4.252	-7.776	5.193
High Blended Disadvantage	-10.779	-2.664	-3.985	-0.529
<b>Parent latent classes</b>				
Low Parent Risk	REF	REF	REF	REF
Parent Health Risks	-6.833	2.355	3.429	-5.968
Parent Financial Hardship	-23.839***	-2.625	-9.610*	-10.547**
Multiple Parent Risks	-43.094***	-4.043	-14.213*	-8.478
Female	-6.235*	-7.022***	-2.325	-0.426
Aboriginal	-29.465*	-2.811	-5.362	-0.920
B-Cohort	-13.745***	1.621	-	-
Year 3 score	-	0.704***	-	-
Year 5 score	-	-	0.821***	-
Year 7 score	-	-	-	0.864***

Table notes. Model 3 and Model 4 only include K-cohort. \* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

Sensitivity analysis findings were similar to those for the main results (Supplement S5), though grandchild membership in any parent latent classes remained significantly associated with reading and numeracy scores beyond Year 3.

## 4. Discussion

This study used a child-centred approach to identify latent classes of child risk circumstances based on characteristics of the extended family and estimated the association between these latent classes and onward academic achievement outcomes in the children of these families. While previous multigenerational studies have focussed on transmission of single risk factors across generations (e.g. educational attainment, personal income, mental health), this study extends previous research by considering the transfer of multiple disadvantages across generations, and how these transfers relate to children's achievement outcomes. Importantly, using a latent class approach means we considered the collective set of risks that the child experiences. This study offers a new approach for assessing transmission of disadvantage across three generations of Australian families.

Analysis of parent and grandparent characteristics identified latent classes that have been observed in previous studies using LCA: overall high risk, overall low risk, and nuanced categories of risk circumstances (Christensen et al., 2020; Christensen et al., 2017; Jobe-Shields et al., 2015; Taylor et al., 2020; Taylor et al., 2019). This study identified five latent classes of grandparent risks: Low Grandparent Risk (40% of the sample), High Maternal Grandparent Disadvantage (20%), High Paternal Grandparent Disadvantage (17%), Low Grandparent Education Capital (14%), and High Blended Disadvantage (8%). The High Maternal and High Paternal Grandparent Disadvantage classes were characterised by higher probabilities of risk exposure within only one grandparent lineage, whereas the Low Grandparent Education Capital and High Blended Disadvantage classes had higher probabilities of risks among both sets of grandparents. Analysis of parent characteristics identified four latent classes of parent risks: Low Parent Risk (58% of the sample), Parent Health Risks (23%), Parent Financial Hardship (12%), and Multiple Parent Risks (6%). Overall, only 32% of grandchildren had membership in both the Low Grandparent Risk and the Low Parent Risk classes.

Latent class approaches have been used in several studies assessing child development outcomes such as vocabulary growth and academic achievement (Christensen et al., 2020; Christensen et al., 2017; Taylor et al., 2020; Taylor et al., 2019). Our findings that children with a mix of different parent risk characteristics tend to have lower achievement outcomes is consistent with this previous research. The association between parent latent class and child achievement also supports other research that has shown

income inequality in parent generations is negatively associated with child achievement (Brooks-Gunn & Duncan, 1997; OECD, 2018). In this study, the Parent Financial Hardship and Multiple Parent Risks classes, both of which were characterised by higher probabilities of financial risk factors, were associated with significantly lower reading and numeracy scores in the grandchildren in Year 3.

Furthermore, this study extends previous research by demonstrating that the risk circumstances of children extends beyond the characteristics of their immediate family. Latent classes of grandparents were associated with the achievement outcomes of grandchildren in Year 3, even when accounting for the latent class of their parents. Notably, of all the grandparent latent classes, grandchildren in the Low Grandparent Education Capital class had lower Year 3 reading and numeracy scores than grandchildren in the Low Grandparent Risk class. Grandchildren in the Low Grandparent Education Capital class had higher probabilities of risks for the education risk factors, particularly for the paternal grandparents, compared with the other grandparent classes, which highlights the intergenerational nature of transfers of education attainment. However, there are two caveats to these grandparent associations. Firstly, the risk exposure arising from the grandparent generations seemed to have a greater effect on grandchild numeracy achievement than on literacy achievement. Secondly, grandparent latent class associations with grandchild achievement were smaller in magnitude than the parent associations.

Examining later achievement outcomes in Years 5, 7, and 9 that controlled for the grandchildren's prior achievement indicated the grandparent latent classes were typically not associated with increasing gaps in literacy or numeracy achievement. The latent classes were inconsistently associated with increasing gaps in literacy and numeracy achievement; some of this inconsistency is likely due to the changing analytic sample with different year levels. Where additional effects of latent class membership were found after Year 3, notably for reading scores and Low Grandparent Education Capital and Parent Financial Hardship, the latent classes were associated with increasing achievement gaps over time. This finding suggests that while most associations between grandparent and parent disadvantage and grandchild achievement are evident in the early years of school, some grandchildren fall further behind their 'low risk' peers in subsequent years.

Patterns of association between the grandparent and parent latent classes were aligned with the intergenerational disadvantage literature, though the use of LCA offers new

insights to these patterns. Grandchildren in any of the at-risk grandparent latent classes were more likely to also have parents in similar latent classes, demonstrating the persistence of disadvantage from the grandparent to parent generation. As well, disadvantages were concentrated within three-generation family units, such that grandparent latent classes were associated with parent latent classes, and grandparent and parent latent classes were associated with the grandchild's educational achievement. These associations are suggestive of both direct and indirect grandparent effects, supporting broader child development models rather than Markovian models of intergenerational transfer. This concentration of advantages across multiple generations could contribute to limiting social mobility and widening education gaps between children at the top and bottom of the socioeconomic ladder. Furthermore, these gaps may not just relate to education outcomes; education has also been shown to interact with early life advantages or disadvantages to influence later health, wealth, income, and occupation (Melo et al., 2019), outcomes that have also shown patterns of association across multiple generations (Chan & Boliver, 2013; Doku et al., 2019; Hancock et al., 2013; OECD, 2018). The effects of the collective grandchild risk circumstances on other development outcomes and more distal socioeconomic outcomes should be assessed.

Understanding transmission pathways between generations, as undertaken here, is an important part of being able to improve positive social mobility for children; policies need to focus on measures to equalise children's opportunities, regardless of the achievements and successes of their immediate or extended family. Identifying risk circumstances early in a child's life, including both grandparent and parent sociodemographic factors, is important for addressing issues when they may be more malleable (Jobe-Shields et al., 2015). These results show that addressing intergenerational transfers of disadvantage needs to encompass multiple, integrated, and coordinated approaches that go beyond addressing isolated indicators of disadvantage. Though income-related approaches are necessary (OECD, 2018; Vera-Toscano & Wilkins, 2020), policies also need to address access to health and mental health services, achievement gaps in the early years of school, and access to other social services (OECD, 2018). For example, recent Australian research has explored the ways families use child and family service hubs, information which can be used for system-wide service planning to reduce inequalities (Taylor et al., 2020; Taylor et al., 2017). Internationally, there are examples of family resource centers and early childhood centers that provide multiple health, education, and social services to families to improve child development outcomes (Child Welfare Information Gateway, 2020; McMillan Early Childhood Centre, 2020). Policies addressing disadvantage should

intervene early in the child's life before their achievement patterns become entrenched due to the inertia of extant family factors.

#### *4.1 Limitations*

The LCA allows for missing data on any of the variables included in the models, but the analytic sample specifications required at least one piece of data to be available for each grandparent and parent. This approach meant that sole-parent families and those who did not respond to survey questions were necessarily excluded from analyses, and we did not find it appropriate to use multiple imputation without some degree of person-relevant factors (i.e. we were reluctant to impute information about grandparents based on the characteristics of mothers or fathers). Therefore, the generalisability of these findings may be limited. However, sensitivity analyses that examined grandchild achievement outcomes as a function of latent class membership based on the characteristics of mothers and the maternal grandparents—extending the Year 3 analytic sample from ~4,500 to ~6,000—found similar results to the main results. The at-risk mother latent classes were associated with reading and numeracy achievement, and some maternal grandparent latent classes were associated with grandchild achievement after parent classes were accounted for.

A limitation of the LSAC data in this context is that the grandparent characteristics related to the parent's childhood. As such, the measures do not necessarily reflect grandparent circumstances as the grandchild is growing up, the time at which grandparents would have any 'direct' influence on the child. For instance, financial comfort and health status can vary considerably across the life course and different latent classes and grandchild outcomes may have been observed if measures related to grandparents' current circumstances. However, we were unable to test how within-grandparent variation in risk factors influences the results presented here. This limitation is common to studies of intergenerational disadvantage, where retrospective or historical data is used to assess grandparent characteristics rather than more recent circumstances.

The limitations of the available grandparent items in the LSAC support a case for collecting a wider range of more detailed information on grandparents to examine possible grandparent effects on grandchild outcomes. In addition to attitudes and beliefs or other aspects of social capital, other additional questions could capture the strength of the relationship between parents and grandparents and between grandchildren and grandparents, the proximity of grandparents to grandchildren, detail on the involvement

of grandparents with grandchildren, and measures related to grandparents' current circumstances. Measurement error might be reduced in families where the grandparent has a closer relationship with the parents, and associations between grandparent characteristics and grandchild outcomes may vary when grandparents have more involvement with their grandchildren (Anderson et al., 2018). Further research considering how variations in the amount of contact between generations might influence grandparent effects on grandchild achievement is recommended.

## 5. Conclusions

This study offers a new perspective of how family factors across two generations relate to achievement outcomes of grandchildren. Five latent classes of grandparent characteristics and four latent classes of parent characteristics were identified. Disadvantages were concentrated within three-generation family units; grandparent latent classes were associated with parent classes, and grandparent and parent latent classes were associated with the grandchild's educational achievement. The Low Grandparent Education Capital, Parent Financial Hardship, and Multiple Parent Risks latent classes were associated with lower grandchild literacy and numeracy scores in Year 3; parent latent classes associations were greater than grandparent latent classes associations. Analysis of Year 5, 7, and 9 literacy and numeracy scores suggest that while most associations between grandparent and parent disadvantage and grandchild achievement are evident in the early years of school, some grandchildren fall further behind their 'low risk' peers in subsequent years. If reducing school achievement gaps is a critical pathway for improving children's social mobility, then policies that focus on targeted educational interventions for children with multigenerational disadvantaged are required.

## 6. References

- ABS. (2018). *Childhood Education and Care, Australia, June 2017*.  
<https://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/4402.0June%202017?OpenDocument>
- Acacio-Claro, P. J., Doku, D. T., Koivusilta, L. K., & Rimpelä, A. H. (2018, 2018/07/03). How socioeconomic circumstances, school achievement and reserve capacity in adolescence predict adult education level: a three-generation study in Finland. *International Journal of Adolescence and Youth*, 23(3), 382-397.  
<https://doi.org/10.1080/02673843.2017.1389759>
- ACARA. (2016). *NAPLAN*. Australian Curriculum, Assessment and Reporting Authority. Retrieved October 7 from <https://www.acara.edu.au/assessment/naplan>
- Anderson, L. R., Sheppard, P., & Monden, C. W. S. (2018). Grandparent Effects on Educational Outcomes: A Systematic Review. *Sociological Science*, 5(6), 114-142.  
<https://doi.org/10.15195/v5.a6>
- Bakk, Z., Tekle, F. B., & Vermunt, J. K. (2013, 2013/08/01). Estimating the Association between Latent Class Membership and External Variables Using Bias-adjusted Three-step Approaches. *Sociological Methodology*, 43(1), 272-311.  
<https://doi.org/10.1177/0081175012470644>
- Bakk, Z., & Vermunt, J. K. (2015). Robustness of Stepwise Latent Class Modeling With Continuous Distal Outcomes. *Structural equation modeling*, 23(1), 20-31.  
<https://doi.org/10.1080/10705511.2014.955104>
- Bask, M., & Bask, M. (2015). Cumulative (Dis)Advantage and the Matthew Effect in Life-Course Analysis. *PloS one*, 10(11), e0142447.  
<https://doi.org/10.1371/journal.pone.0142447>
- Bol, T., & Kalmijn, M. (2016). Grandparents' resources and grandchildren's schooling: Does grandparental involvement moderate the grandparent effect? *Social Science Research*, 55, 155-170.

- Braun, S. T., & Stuhler, J. (2016). The transmission of inequality across multiple generations: Testing recent theories with evidence from Germany. *The Economic Journal*, 128(609), 36-128:609<136. <https://doi.org/10.1111/eoj.12453>
- Bronfenbrenner, U. (1986). Ecology of the family as a context for human development: Research perspectives. *Developmental Psychology*, 22(6), 723-742.
- Brooks-Gunn, J., & Duncan, G. J. (1997). The Effects of Poverty on Children. *Future of Children*, 7(2), 55-71. <https://doi.org/10.2307/1602387>
- Chan, T. W., & Boliver, V. (2013). The grandparents effect in social mobility: Evidence from British Birth Cohort studies. *American Sociological Review*, 78(4), 662-678. <https://doi.org/10.1177/0003122413489130>
- Child Welfare Information Gateway. (2020). *Family Resource Centers*. Children's Buereau, U.S. Department of Health and Human Services. Retrieved November 10 from <https://www.childwelfare.gov/topics/preventing/prevention-programs/familyresource/>
- Christensen, D., Taylor, C. L., Hancock, K. J., & Zubrick, S. R. (2020). School readiness is more than the child: a latent class analysis of child, family, school and community aspects of school readiness. *Australian Journal of Social Issues*, 0(0), 1-19. <https://doi.org/10.1002/ajs4.138>
- Christensen, D., Taylor, C. L., & Zubrick, S. R. (2017). Patterns of Multiple Risk Exposures for Low Receptive Vocabulary Growth 4-8 Years in the Longitudinal Study of Australian Children. *PloS one*, 12(1). <https://doi.org/10.1371/journal.pone.0168804>
- DiPrete, T. A., & Eirich, G. M. (2006). Cumulative Advantage as a Mechanism for Inequality: A Review of Theoretical and Empirical Developments. *Annual review of sociology*, 32(1), 271-297. <https://doi.org/10.1146/annurev.soc.32.061604.123127>
- Doku, D. T., Acacio-Claro, P. J., Koivusilta, L., & Rimpela, A. (2019). Health and socioeconomic circumstances over three generations as predictors of youth unemployment trajectories. *The European journal of public health.*, 29(3), 517-523. <https://doi.org/10.1093/eurpub/cky242>

- Engzell, P., Mood, C., & Jonsson, J. O. (2020). It's All about the Parents: Inequality Transmission across Three Generations in Sweden. *Sociological Science*, 7, 242-267. <https://doi.org/10.15195/v7.a10>
- Ferguson, J. L., & Ready, D. D. (2011). Expanding notions of social reproduction: Grandparents' educational attainment and grandchildren's cognitive skills. *Early Childhood Research Quarterly*, 26, 216-226. [https://doi.org/10.1016/\\*j.ecresq.2010.10.001](https://doi.org/10.1016/*j.ecresq.2010.10.001)
- Fiel, J. E. (2019). The transmission of multigenerational educational inequality. *Social Forces*, 97(4), 1455-1486. <https://doi.org/10.1093/sf/soy090>
- Goldfeld, S., O'Connor, M., Cloney, D., Gray, S., Redmond, G., Badland, H., Williams, K., Mensah, F., Woolfenden, S., Kvalsvig, A., & Kochanoff, A. T. (2018). Understanding child disadvantage from a social determinants perspective. *Journal of Epidemiology and Community Health*, 72(3), 223-229. <https://doi.org/10.1136/jech-2017-209036>
- Hällsten, M., & Pfeffer, F. T. (2017). Grand Advantage: Family Wealth and Grandchildren's Educational Achievement in Sweden. *American Sociological Review*, 82(2), 328-360. <https://doi.org/10.1177/0003122417695791>
- Hancock, K. J., Mitrou, F., Povey, J., Campbell, A., & Zubrick, S. R. (2018). Educational inequality across three generations in Australia. *Australian Journal of Social Issues*, 53(1), 34-55. <https://doi.org/10.1002/ajs4.33>
- Hancock, K. J., Mitrou, F., Shipley, M., Lawrence, D., & Zubrick, S. R. (2013). A three generation study of the mental health relationships between grandparents, parents and children. *BMC Psychiatry*, 13, 299.
- Jæger, M. M. (2012). The extended family and children's educational success. *American Sociological Review*, 77(6), 903-922. <https://doi.org/10.1177/0003122412464040>
- Jobe-Shields, L., Andrews, A. R., Parra, G. R., & Williams, N. A. (2015). Person-Centered Approaches to Understanding Early Family Risk. *Journal of Family Theory & Review*, 7(4), 432-451. <https://doi.org/10.1111/jftr.12118>

- Johnson, W., Brett, C. E., & Deary, I. J. (2010). The pivotal role of education in the association between ability and social class attainment: A look across three generations. *Intelligence*, 38(1), 55-65.  
<https://doi.org/10.1016/j.intell.2009.11.008>
- Lanza, S. T., Dziak, J. J., Huang, L., Wagner, A. t., & Collins, L. M. (2015). *PROC LCA & PROC LTA Users' Guide Version 1.3.2*. methodology.psu.edu
- Lawrence, D., Mitrou, F., & Zubrick, S. R. (2011). Non-specific psychological distress, smoking status and smoking cessation: United States National Health Interview Survey 2005. *BMC public health*, 11(1), 256-256. <https://doi.org/10.1186/1471-2458-11-256>
- Lehti, H., Erola, J., & Tanskanen, A. O. (2019). Tying the Extended Family Knot—Grandparents' Influence on Educational Achievement. *European sociological review.*, 35(1), 29-48. <https://doi.org/10.1093/esr/jcy044>
- Mare, R. D. (2011). A multigenerational view of inequality. *Demography*, 48, 1-23.  
<https://doi.org/10.1007/s13524-011-0014-7>
- McMillan Early Childhood Centre. (2020). *McMillan Early Childhood Centre*. Retrieved November 10 from <https://www.mcmillanearlychildhoodcentre.co.uk/>
- Melo, S., Guedes, J., & Mendes, S. (2019). Theory of Cumulative Disadvantage/Advantage. In D. Gu & M. E. Dupre (Eds.), *Encyclopedia of Gerontology and Population Aging* (pp. 1-8). Springer International Publishing. [https://doi.org/10.1007/978-3-319-69892-2\\_751-1](https://doi.org/10.1007/978-3-319-69892-2_751-1)
- OECD. (2018). *A Broken Social Elevator? How to Promote Social Mobility*.  
[https://read.oecd-ilibrary.org/social-issues-migration-health/broken-elevator-how-to-promote-social-mobility\\_9789264301085-en#page3](https://read.oecd-ilibrary.org/social-issues-migration-health/broken-elevator-how-to-promote-social-mobility_9789264301085-en#page3)
- Sanson, A., Nicholson, J., Ungerer, J., Zubrick, S., Wilson, K., Ainley, J., Berthelsen, D., Bittman, M., Broom, D., Harrison, L., Rodgers, B., Sawyer, M., Silburn, S., Strazdins, L., Vimpani, G., & Wake, M. (2002). *Introducing the Longitudinal Study of Australian Children*.

- Sheppard, P., & Monden, C. (2018). The Additive Advantage of Having Educated Grandfathers for Children's Education: Evidence from a Cross-National Sample in Europe. *European Sociological Review*, 34(4), 365-380.  
<https://doi.org/10.1093/esr/jcy026>
- Soloff, C., Lawrence, D., & Johnstone, R. (2005). *Sample design: LSAC technical paper No. 1*. Australian Institute of Family Studies.
- Sommerfeld, A. (2016, 06//). Education as a collective accomplishment: how personal, peer, and parent expectations interact to promote degree attainment [Article]. *Social Psychology of Education*, 19(2), 345-365. <https://doi.org/10.1007/s11218-015-9325-7>
- Taylor, C. L., Christensen, D., Stafford, J., Venn, A., Preen, D., & Zubrick, S. R. (2020). Associations between clusters of early life risk factors and developmental vulnerability at age 5: a retrospective cohort study using population-wide linkage of administrative data in Tasmania, Australia. *BMJ Open*, 10.  
<https://doi.org/10.1136/bmjopen-2019-033795>
- Taylor, C. L., Jose, K., van de Lageweg, W. I., & Christensen, D. (2017, 2017/10/03). Tasmania's child and family centres: a place-based early childhood services model for families and children from pregnancy to age five. *Early Child Development and Care*, 187(10), 1496-1510. <https://doi.org/10.1080/03004430.2017.1297300>
- Taylor, C. L., Zubrick, S. R., & Christensen, D. (2019). Multiple risk exposures for reading achievement in childhood and adolescence. *J Epidemiol Community Health*, 0, 1-8.  
<https://doi.org/10.1136/jech-2018-211323>
- Vera-Toscano, E., & Wilkins, R. (2020). *Does poverty in childhood beget poverty in adulthood in Australia?*  
[https://melbourneinstitute.unimelb.edu.au/\\_\\_data/assets/pdf\\_file/0008/3522482/Breaking-Down-Barriers-Report-1-October-2020.pdf](https://melbourneinstitute.unimelb.edu.au/__data/assets/pdf_file/0008/3522482/Breaking-Down-Barriers-Report-1-October-2020.pdf)
- Vermunt, J. K., & Magisdon, J. (2013). *LG-Syntax User's Guide: Manual for Latent GOLD 5.0 Syntax Module*.

Yamamoto, Y., & Holloway, S. D. (2010, 2010/09/01). Parental Expectations and Children's Academic Performance in Sociocultural Context. *Educational Psychology Review*, 22(3), 189-214. <https://doi.org/10.1007/s10648-010-9121-z>

Zhu, Y., Steele, F., & Moustaki, I. (2017). A General 3-Step Maximum Likelihood Approach to Estimate the Effects of Multiple Latent Categorical Variables on a Distal Outcome. *Structural equation modeling*, 24(5), 643-656. <https://doi.org/10.1080/10705511.2017.1324310>

Zubrick, S. R., Taylor, C. L., Lawrence, D., Mitrou, F., Christensen, D., & Dalby, R. (2009). The Development of Human Capability across the Lifecourse: Perspectives from Childhood. *Australasian Epidemiologist*, 16(3), 6-10.

## Supporting Information

### S1 Latent GOLD Syntax

#### options

```
step3 proportional bch;  
output  
parameters standarderrors profile estimatedvalues;
```

#### variables

```
stratumid stratum;  
psuid pcodes;  
samplingweight weight rescale;
```

#### dependent

```
score continuous;
```

#### latent

```
ClusterGP nominal coding=1 posterior=(postlc1_gp postlc2_gp postlc3_gp postlc4_gp postlc5_gp),  
ClusterP nominal coding=1 posterior=(postlc1_par postlc2_par postlc3_par postlc4_par);
```

#### independent

```
sex nominal coding = 1, aboriginal nominal coding = 1, cohortb nominal coding = 1;
```

#### equations

```
clusterGP<->clusterP;  
score <- 1 + ClusterGP + ClusterP + sex + aboriginal + cohortb;
```

*S2 Grandparent to parent multinomial regression*

**Table S1. Transition matrix and odds of membership in the parent latent class for each grandparent latent class relative to the low risk latent classes.**

	Low Parent Risk		Parent Health Risks		Parent Financial Hardship		Multiple Parent Risks		Total
	%	OR	%	OR	%	OR	%	OR	%
Grandparent latent class									
Low Grandparent Risk	73.1	REF	13.8	REF	8.2	REF	4.9	REF	100.0
High Maternal Grandparent Disadvantage	60.9	REF	20.8	4.178***	13.2	3.050***	5.0	1.369	100.0
High Paternal Grandparent Disadvantage	64.0	REF	18.3	3.124***	12.2	2.312***	5.5	1.129	100.0
Low Grandparent Education Capital	57.4	REF	22.3	6.334***	11.7	3.707***	8.6	5.293***	100.0
High Blended Disadvantage	44.8	REF	26.1	11.933***	19.1	13.915***	10.0	7.235***	100.0

\* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

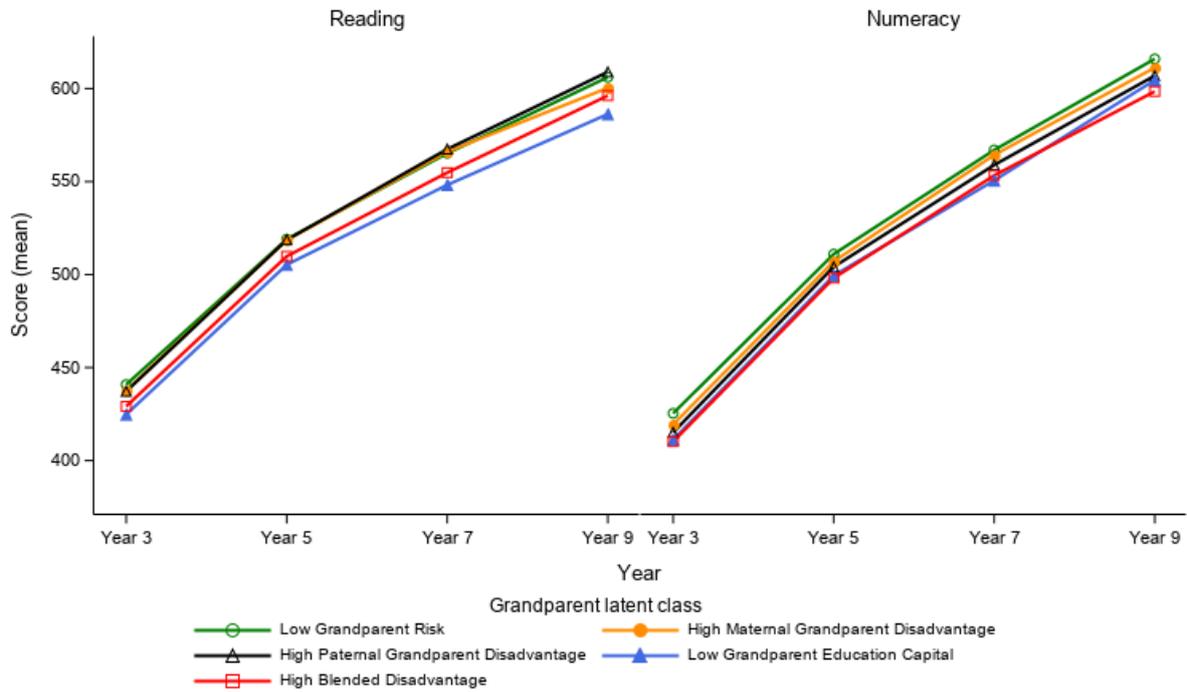
*S3 Mean reading and numeracy scores for each grandparent and parent latent class*

**Table S2. Unadjusted mean reading and numeracy scores for each grandparent and parent latent class.**

Reading	Year 3	Year 5	Year 7	Year 9
<b>Grandparent latent class</b>				
Low Grandparent Risk	440.9	519.0	565.2	606.1
High Maternal Grandparent Disadvantage	437.7	518.6	566.1	600.4
High Paternal Grandparent Disadvantage	437.2	518.6	567.4	608.9
Low Grandparent Education Capital	424.8	505.3	548.2	586.3
High Blended Disadvantage	429.2	509.8	554.8	596.2
<b>Parent latent class</b>				
Low Parent Risk	443.5	522.7	570.2	608.4
Parent Health Risks	434.7	513.5	558.9	594.8
Parent Financial Hardship	416.0	501.7	544.5	591.3
Multiple Parent Risks	400.3	478.7	522.6	566.9
Numeracy	Year 3	Year 5	Year 7	Year 9
<b>Grandparent latent class</b>				
Low Grandparent Risk	425.4	511.0	567.0	615.9
High Maternal Grandparent Disadvantage	419.4	507.1	564.3	611.2
High Paternal Grandparent Disadvantage	415.1	504.1	558.9	606.9
Low Grandparent Education Capital	411.3	499.4	550.6	604.5
High Blended Disadvantage	410.2	498.1	553.3	598.5
<b>Parent latent class</b>				
Low Parent Risk	424.8	511.0	567.9	616.6
Parent Health Risks	419.9	507.3	562.8	610.8
Parent Financial Hardship	402.1	492.4	539.7	588.1
Multiple Parent Risks	388.3	479.7	533.4	580.3

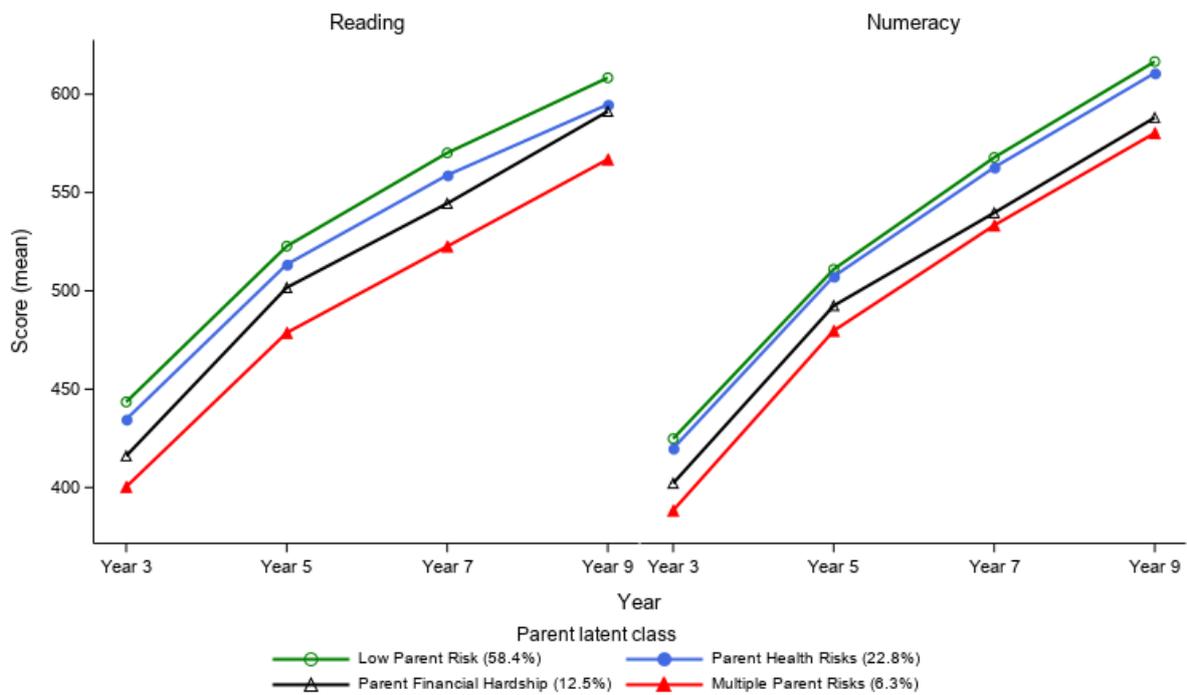
Year 7 and Year 9 only include K-cohort.

Fig S1. Mean reading and numeracy scores for each grandparent latent class.



Year 7 and Year 9 only include K-cohort.

Fig S2. Mean reading and numeracy scores for each parent latent class.



Year 7 and Year 9 only include K-cohort.

*S4 Unadjusted regression coefficients for Year 3*

**Table S3. Unadjusted regression coefficients of Year 3 reading scores for each grandparent and parent latent class relative to low risk latent classes.**

	Year 3 (N=4,508)	Year 3 (N=4,508)	Year 3 (N=4,508)
	Model 1	Model 2	Model 3
<b>Grandparent latent class</b>			
Low Grandparent Risk	REF	-	REF
High Maternal Grandparent Disadvantage	-2.543	-	2.686
High Paternal Grandparent Disadvantage	-2.822	-	1.346
Low Grandparent Education Capital	-26.979***	-	-16.811**
High Blended Disadvantage	-20.403**	-	-5.987
<b>Parent latent class</b>			
Low Parent Risk	-	REF	REF
Parent Health Risks	-	-17.171**	-14.960*
Parent Financial Hardship	-	-35.931***	-34.327***
Multiple Parent Risks	-	-62.073***	-57.834***

\* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

**Table S4. Unadjusted regression coefficients of Year 3 numeracy scores for each grandparent and parent latent class relative to low risk latent classes.**

	Year 3 (N=4,501)	Year 3 (N=4,501)	Year 3 (N=4,501)
	Model 1	Model 2	Model 3
<b>Grandparent latent class</b>			
Low Grandparent Risk	REF	-	REF
High Maternal Grandparent Disadvantage	-4.613	-	-1.796
High Paternal Grandparent Disadvantage	-11.293**	-	-8.742*
Low Grandparent Education Capital	-21.680***	-	-15.162**
High Blended Disadvantage	-20.241**	-	-10.613
<b>Parent latent class</b>			
Low Parent Risk	-	REF	REF
Parent Health Risks	-	-9.290	-6.393
Parent Financial Hardship	-	-27.828***	-25.038***
Multiple Parent Risks	-	-48.762***	-44.967***

\* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

### *S5 Sensitivity analysis*

For maternal grandparent characteristics, based on the fit criteria and assessment of the latent class membership, a five-class solution was selected as the best model. (Table S5, Table S6, Fig S3). For mothers, the four-class model was selected as the best fit (Table S5, Table S7, Fig S4). Multinomial regression showed most grandparent latent classes were significantly associated with the mother's latent class (Table S8). Mean reading and numeracy scores for each latent class were highest for grandchildren in the Low Maternal Grandparent Risk and Low Mother Risk latent classes and were lowest for grandchildren in the High Maternal Grandparent Disadvantage and Single Mother, Multiple Risks latent classes (Table S9). Multivariate regression findings were similar to the main results, though membership in parent latent classes remained significant beyond Year 3 for both reading and numeracy (Table S10 and Table S11).

**Table S5. Fit statistics for maternal grandparent and mother LCA with 1 to 6 classes.**

Number of classes	AIC	BIC	Entropy	Change in AIC (relative to K-1)	Change in BIC (relative to K-1)
<b>Maternal grandparent</b>					
1	8336	8419	1.00		
2	4004	4178	0.65	-4332	-4241
3	3327	3592	0.67	-677	-586
4	3041	3396	0.58	-286	-196
5	2848	3294	0.65	-193	-102
6	2810	3346	0.61	-38	52
7	2636	3262	0.64	-174	-84
8	2602	3319	0.65	-34	57
<b>Mother</b>					
1	13409	13499	1.00		
2	6100	6288	0.81	-7309	-7211
3	5268	5553	0.81	-832	-735
4	4910	5292	0.74	-358	-261
5	4638	5118	0.71	-272	-174
6	4516	5093	0.74	-122	-25
7	4433	5108	0.70	-83	15
8	4418	5190	0.70	-15	82

**Table S6. Class probability and mean posterior probabilities for maternal grandparent five-class latent class model.**

Latent Class	Class	Best class	N Risks	Group Probabilities				
	membership	membership		1	2	3	4	5
	probability	%						
1. Low Maternal Grandparent Risk	0.463	51.1	1.4	<b>0.827</b>	0.113	0.047	0.002	0.011
2. Maternal Grandparent Separation	0.240	21.2	2.8	0.124	<b>0.711</b>	0.075	0.079	0.011
3. Low Maternal Grandparent Education	0.146	13.0	3.2	0.089	0.126	<b>0.708</b>	0.061	0.016
Capital								
4. High Maternal Grandparent Disadvantage	0.100	9.2	6.0	0.001	0.125	0.075	<b>0.743</b>	0.056
5. Maternal Grandparent Health Risks	0.058	5.6	3.8	0.091	0.005	0.051	0.091	<b>0.761</b>

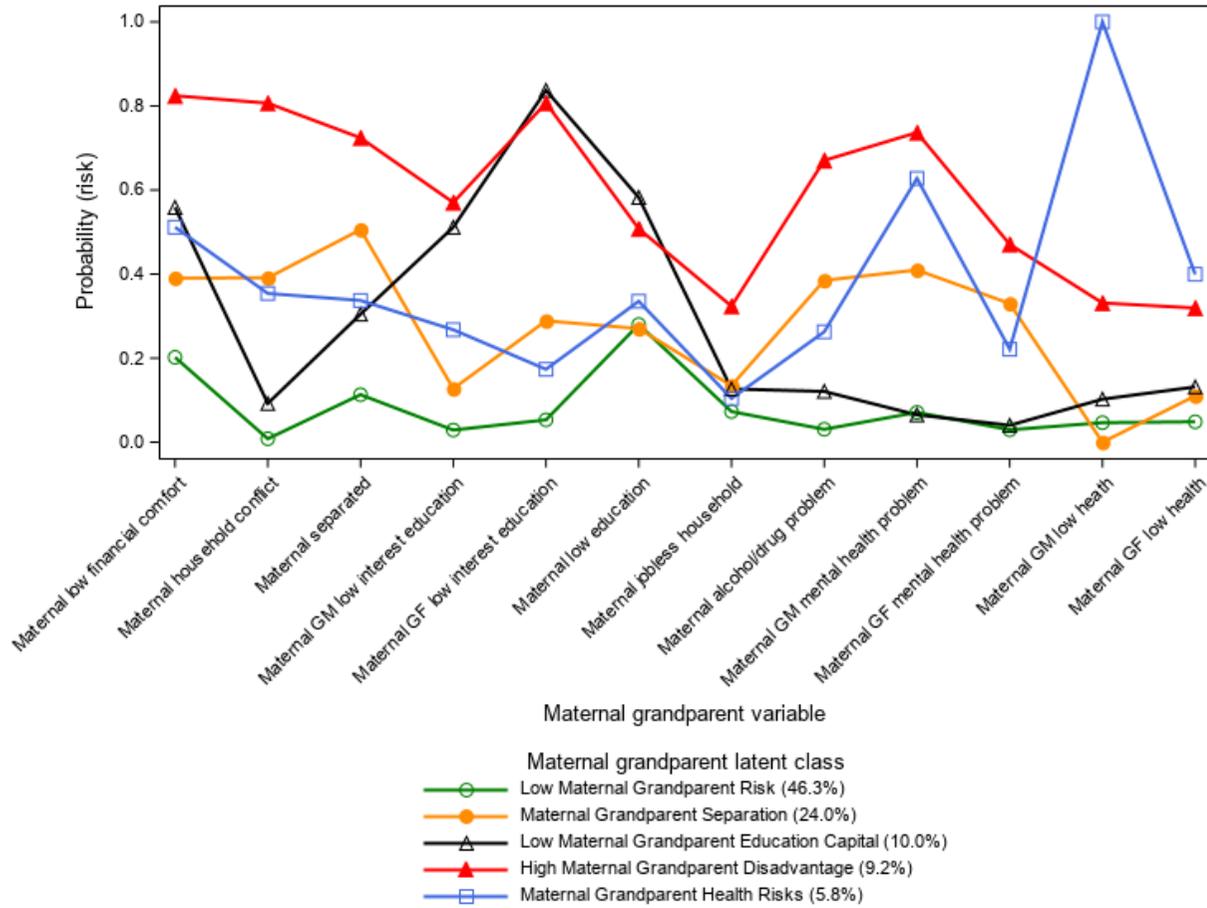
Maximum number of risks = 12.

Table S7. Class probability and posterior probabilities for mother four-class latent class model.

Latent Class	Class	Best class	N Risks	Group Probabilities			
	membership	membership %		1	2	3	4
	probability						
1. Low Mother Risk	0.610	65.9	1.7	<b>0.895</b>	0.035	0.070	0.000
2. Mother Financial Hardship	0.173	16.8	4.6	0.073	<b>0.817</b>	0.064	0.046
3. Mother Low Resource	0.132	9.5	3.9	0.164	0.096	<b>0.679</b>	0.061
4. Single Mother, Multiple Risks	0.085	7.8	7.0	0.000	0.035	0.057	<b>0.908</b>

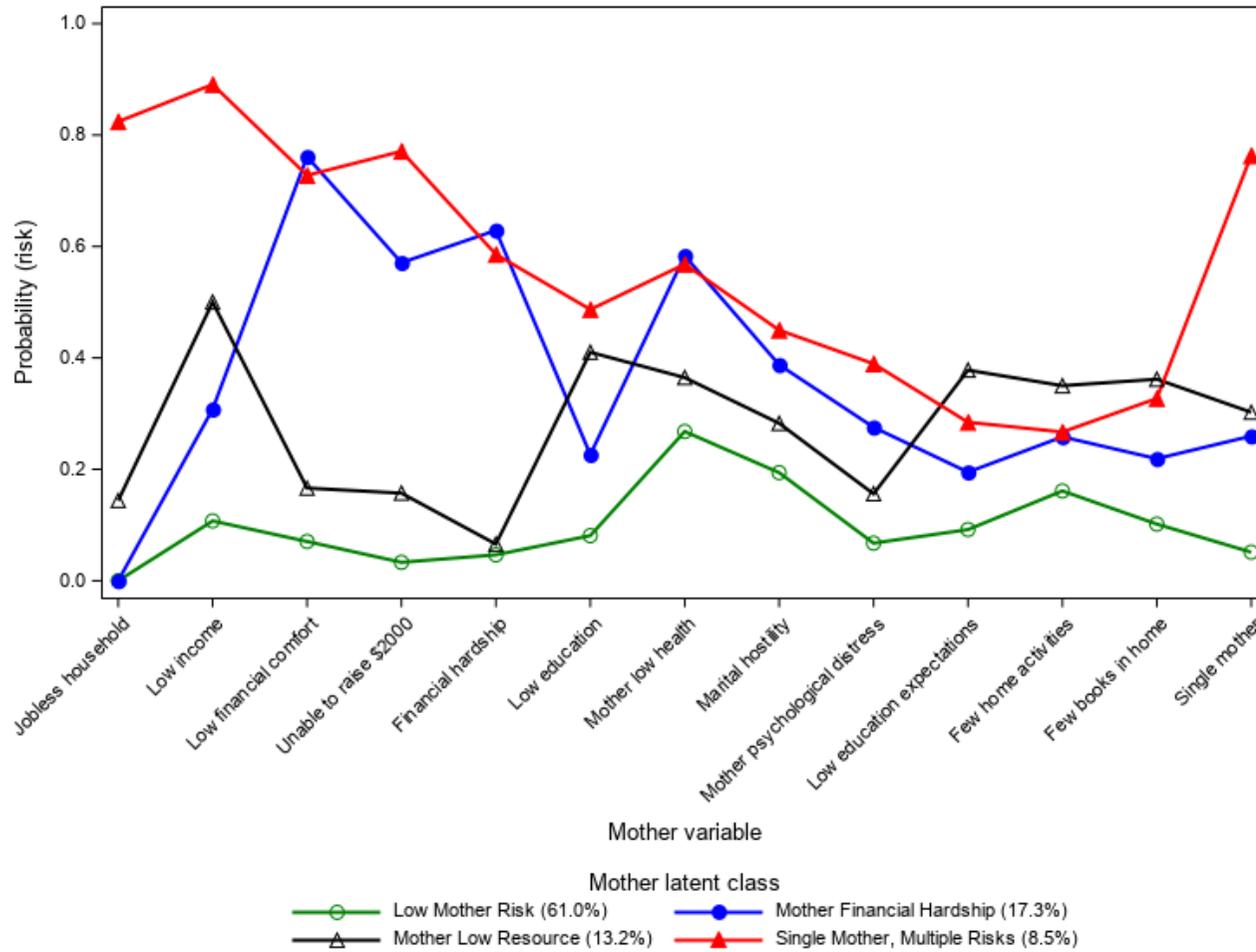
Maximum number of risks = 13.

Fig S3. Probability of risk exposure by maternal grandparent latent class.



The terms GM and GF refer to the grandmother and grandfather respectively.

Fig S4. Probability of risk exposure by mother latent class.



**Table S8. Transition matrix and odds of membership in the mother latent class for each maternal grandparent latent class relative to the low risk latent classes.**

	Low Mother Risk		Mother Financial Hardship		Mother Low Resource		Single Mother, Multiple Risks		Total
	%	OR	%	OR	%	OR	%	OR	%
Maternal grandparent latent class									
Low Maternal Grandparent Risk	72.1	REF	13.5	REF	8.9	REF	5.5	REF	100.0
Maternal Grandparent Separation	63.2	REF	18.8	2.249***	9.1	1.180	8.9	2.098**	100.0
Low Maternal Grandparent Education	61.5	REF	17.8	2.391***	11.3	3.122***	9.5	3.712***	100.0
Capital									
High Maternal Grandparent	49.6	REF	25.2	5.338***	10.5	2.758**	14.6	8.245***	100.0
Disadvantage									
Maternal Grandparent Health Risks	56.3	REF	23.2	4.503***	10.5	2.179*	10.0	3.179***	100.0

\* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

**Table S9. Unadjusted mean reading and numeracy scores for each maternal grandparent and mother latent class**

Reading	Year 3	Year 5	Year 7	Year 9
<b>Maternal grandparent latent class</b>				
Low Maternal Grandparent Risk	433.6	513.5	559.2	600.1
Maternal Grandparent Separation	425.6	511.2	563.9	599.2
Low Maternal Grandparent Education Capital	412.7	495.1	541.5	580.4
High Maternal Grandparent Disadvantage	414.5	497.4	552.6	596.4
Maternal Grandparent Health Risks	436.9	515.1	558.1	595.4
<b>Mother latent classes</b>				
Low Mother Risk	440.5	520.0	568.8	606.9
Mother Financial Hardship	409.7	492.4	540.3	581.3
Mother Low Resource	394.8	482.9	530.3	568.2
Single Mother, Multiple Risks	387.3	476.3	514.1	555.9
Numeracy	Year 3	Year 5	Year 7	Year 9
<b>Maternal grandparent latent class</b>				
Low Maternal Grandparent Risk	416.8	504.4	556.8	605.3
Maternal Grandparent Separation	411.2	498.3	559.1	606.9
Low Maternal Grandparent Education Capital	397.0	487.3	547.4	596.2
High Maternal Grandparent Disadvantage	399.9	490.2	548.4	594.1
Maternal Grandparent Health Risks	411.5	503.1	552.2	605.0
<b>Mother latent classes</b>				
Low Mother Risk	421.8	509.2	566.1	614.2
Mother Financial Hardship	395.5	484.5	537.7	584.1
Mother Low Resource	385.7	478.0	530.1	573.9
Single Mother, Multiple Risks	377.2	466.4	516.3	568.3

**Table S10. Regression coefficients of Year 3 to Year 9 reading scores for each maternal grandparent and mother latent class relative to low risk latent classes.**

	Year 3 (N=5,959)	Year 3 (N=5,959)	Year 3 (N=5,959)	Year 3 (N=5,959)	Year 5 (N=5,422)	Year 7 (N=3,093)	Year 9 (N=2,674)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<hr/>							
Maternal							
grandparent							
latent class							
Low	REF	-	REF	REF	REF	REF	REF
Maternal							
Grandparent							
Risk							
Maternal	-6.377	-	1.229	2.553	7.971**	7.105*	1.001
Grandparent							
Separation							
Low	-	-	-17.171**	-16.806**	-2.963	-2.552	-4.136
Maternal	33.022***						
Grandparent							
Education							
Capital							
High	-	-	-9.233	-8.989	-2.027	4.619	2.197
Maternal	25.878***						
Grandparent							
Disadvantage							
Maternal	7.157	-	18.418**	18.206**	8.958*	2.398	0.625
Grandparent							
Health Risks							
<hr/>							
Mother latent							
class							

Low Mother Risk	-	REF	REF	REF	REF	REF	REF
Mother Financial Hardship	-	-	-	-	-	-	-5.788
Mother Low Resource	-	-	-	-	-11.622**	-	-10.788*
Single Mother, Multiple Risks	-	-	-	-	-12.608**	-	-15.957*
		40.281***	39.973***	38.743***	13.329***	15.649***	
		59.887***	56.735***	52.225***		25.195***	
Female	-	-	-	16.114***	2.314	3.645*	7.867***
Aboriginal	-	-	-	-	-5.719	-9.825	-16.546**
B-Cohort	-	-	-	3.959	0.643	-	-
Year 3 score	-	-	-	-	0.657***	-	-
Year 5 score	-	-	-	-	-	0.626***	-
Year 7 score	-	-	-	-	-	-	0.774***

Model 6 and Model 7 only include K-cohort. \* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.

**Table S11. Regression coefficients of Year 3 to Year 9 numeracy scores for each maternal grandparent and mother latent class relative to low risk latent class.**

	Year 3 (N=5,951)	Year 3 (N=5,951)	Year 3 (N=5,951)	Year 3 (N=5,951)	Year 5 (N=5,385)	Year 7 (N=3,064)	Year 9 (N=2,657)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
<hr/>							
Maternal grandparent latent class							
Low	REF	-	REF	REF	REF	REF	REF
Maternal Grandparent Risk							
Maternal	-5.845	-	0.241	0.265	-3.060	3.282	4.166
Grandparent Separation							
Low	-	-	-15.466**	-	-0.709	4.357	4.652
Maternal	27.566***			17.523***			
Grandparent Education Capital							
High	-	-	-5.328	-5.925	-0.338	1.231	-2.146
Maternal	19.148***						
Grandparent Disadvantage							
Maternal	-4.043	-	5.583	3.785	12.276**	6.126	3.872
Grandparent Health Risks							
<hr/>							
Mother latent class	-						

Low Mother Risk	-	REF	REF	REF	REF	REF	REF
Mother Financial Hardship	-	-	-	-	-6.582*	-	-
Mother Low Resource	-	-	-	-	-9.968*	-	-15.225**
Single Mother, Multiple Risks	-	-	-	-	-	-	-9.410*
Female	-	-	-	-5.986**	-6.840***	-3.089	-0.486
Aboriginal	-	-	-	-	-9.062	-2.184	-6.211
B-Cohort	-	-	-	-	2.160	-	-
Year 3 score	-	-	-	-	0.711***	-	-
Year 5 score	-	-	-	-	-	0.790***	-
Year 7 score	-	-	-	-	-	-	0.841***

Model 6 and Model 7 only include K-cohort. \* p-value <0.05, \*\* p-value <0.01, \*\*\* p-value <0.001.