Chronic Conditions and Child Health: Does Income Mediate?

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Abstract

Discussions of the income-child health gradient have often focused on the question of whether the association between household income and child health is attributable to children from low-income households experiencing more health shocks, responding less well to the health shocks they experience, or both. This question was originally posed by Currie and Stabile (2003), who produced evidence that children from lower-income households in Canada experienced more health shocks. However, few authors have been able to address these questions empirically, as suitable (panel) data have, until recently, been scarce. The current paper contributes to this small literature by producing new empirical evidence for Australia, using the Longitudinal Study of Australian (LSAC) to examine the question of how the income-child health gradient may be explained. The central results are that we find no evidence that children from low-income households are subject to more frequent health shocks (as measured by chronic conditions), and nor do we find that children from low-income households register any worse recovery from a health shock once it has occurred. Our findings are in contrast to those for the United States, as reported by Murasko (2008) and Condliffe and Link (2008). We speculate that the extensive and universal public healthcare system in Australia may offset some of the important health-related disadvantages that are associated with low incomes in other countries.

Key words: Child health, Income gradient, Chronic condition, Panel data, Australia

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1 Introduction

The nature of the relationship between household income and child health has generated considerable attention from researchers and policy-makers alike. Several questions have preoccupied researchers since the seminal work of Case, Lubotsky, and Paxson (2002) on this topic was published. One of the central questions of interest is whether or not any disparities in the health of children from low- and high-income households narrows or widens with as children age. If there is an inverse correlation of income and child health, and if that relationship also becomes stronger with age, this begs further questions about the genesis of such an income-child health gradient. Specifically, one may hypothesise that children from low-income households are subject to more health shocks or that – additionally, or alternatively – children from lower-income households do not have the resources to respond as effectively to health capital shocks. Currie and Stabile (2003), who discovered an income-child health gradient for their Canadian sample, found evidence that lower-income children were subject to more health shocks. A related question is whether or not the source of an income-child health gradient, where it exists, is attributable to contemporaneous or cumulative effects of household income on health.

The results from this empirical literature are germane to policy-makers for several reasons. First, if children from lower-income households tend to have poorer health, and that health state is carried into adulthood, it may constitute the source of a poverty cycle, wherein low income begets poor health and poor health begets lower incomes. Second, whether the causal path is due to more frequent health shocks, poorer responses to health shocks, or both, may influence policy choices over prevention and treatment programs, for example.

Empirical evidence on the income-child health gradient has now been produced for the United States (Case, Lubotsky, and Paxson, 2002;Condliffe and Link, 2008 and Murasko, 2008), Canada (Currie and Stabile, 2003), the United Kingdom (Currie, Shields, and Price, 2007; Propper, Rigg, and Burgess, 2007) and Australia (Khanam, Nghiem, and Connelly, 2009). Several of these studies, for example, Case et al (2002), Currie and Stabile (2003, subsequently C&S), Condliffe and Link (2008) and Murasko (2008)have found that this relationship is more pronounced for older children. Khanam, Nghiem, and Connelly (2009) found a similar result for Australian children (from early- to mid-childhood) when similar variables and specifications were used.

Case et al. (2002) explored the possible mechanisms of the positive relationship between income-child health and the increasing gradient in their cross-sectional American sample[1] and found no precise mechanism that could explain this relationship and the increasing income gradient. Currie and Stabile (2003)'s study was the first that provided some explanation of the increasing income-child health gradient. One possible mechanism of this increasing trend found by Currie and Stabile was that low-SES Canadian children were subject to frequent health shocks. Using a regional UK birth cohort data Propper, Rigg, and Burgess (2007) revealed that maternal health, particularly maternal mental health, could explain the relationship between child health and family income in the UK. They found no direct effect of income if parental health and parental child health related behaviour are controlled for. Khanam et al. (2009) also found that parental health, in particular, mother's health was influential in their sample of Australian children. These two studies from the UK and Australia used samples of children of similar ages (0-7 years) and found that the relationship between income and child health disappears when controls for parental health are used. Khanam et al. (2009), however, did not look at the two other possible mechanisms of increasing income gradient proposed

[1] Case et al. (2002) used the National Health Interview Survey(NHIS) of America.

by Currie and Stabile (2003).

These hypotheses are that "low-SES children are less able to respond to a given health shock, so that the negative effects of health shocks persist and accumulate over time" (Currie and Stabile 2003, p.1813). The second hypothesis is that "low-SES children respond to health shocks in a way that is similar to high-SES children, but are subject to more health shocks". Currie and Stabile (2003) found that the increasing gradient in child health in Canada was not because of these children lack resources to respond to a health shock. They found that low-SES children responded to a particular health shock to a similar rate as high SES children as they age, but they were subject to more health shocks. However, a recent study by Condliffe and Link (2008, subsequently, C&L) presents evidence that, in the United States, low-SES children also appear to respond differently to past health shocks compared with children from high-income households. C&L found some evidence that low-SES children were subject to more health shocks as they age, however, this effect was not as strong as the effect that Currie and Stabile (2003) found for Canadian children. Wei (2007)'s study, using the 1996-2004 Medical Expenditure Panel Survey (MEPS), also confirmed that children from high-income USA households recovered better from a past health shocks compared to children from low-income household. However, she found that children from low-income family were not subject to higher incidence of health shocks. Rather, low-income households were less able to manage health shocks, which in turn, left children from those households in poor health.

Recently,Murasko (2008) focussed on a different dimension of the increasing gradient. He argued that health status observed in the baseline wave of a panel survey of children could be used to model the 'cumulative effect of income', with income *per se* being used to separate the contemporaneous effect of income. He found that the 'cumulative effect of income' explained the increasing income-child gradient, at least until children in the MEPS reached adolescence.

In this paper, we explain the steepening gradient in child health in Australia using panel data from the LSAC, focusing mainly on the two hypotheses proposed by Currie and Stabile. We also test the 'cumulative effect' and 'contemporaneous effect' of income hypotheses that were advanced by Murasko (2008).

2 Literature Review

As we discussed in the previous section, Currie and Stabile (2003) found that the increasing income gradient in child health in Canada was not because low-SES children were more affected by a health shock than their wealthier peers. Rather, children from lower-SES households experienced more health shocks compared to high-SES children. A recent study by Condliffe and Link (2008), however, revealed that low-SES children were hit harder by a health shock than children from higher-SES households.. Moreover, these authors found that low-SES children were also more likely to experience incident chronic conditions as they aged. The latter may explain why the income-health gradient was stronger for older children in this US sample. Interestingly, the income gradient that was uncovered by Condliffe and Link (2008), using the 1996-2002 Medical Expenditure Panel Survey (MEPS), was flatter than the gradient that Case et al. (2002) discovered. Additionally, the gradient that emerges from their empirical estimates in the US is smaller than the estimated income-child-health gradient in Canada (Currie and Stabile, 2003). This is perhaps surprising because Canada has a long-standing universal health insurance scheme which could be expected to afford protection to low-income children who experience a health shock.

Wei (2007) has also examined the role of chronic conditions using the MEPS for the years 1996-2004.

She found that child health was affected by both current and past health shocks, but that children from low-income households were not subject to more health shocks than other children. Rather, children from lower-income households were more susceptible to remain in poor health following a given health shock. Her results also suggest that the resilience that higher incomes may produce for child health is conditional on the severity of the chronic conditions that are experienced. Specifically, she found that although children with severe and financially-intensive chronic conditions from high-income households had better recovery prognoses than their low-income counterparts, family income was not protective in reducing the morbidity of children who had either a mild or a time-intensive chronic condition. The latter is an interesting result inasmuch as it may suggest the point at which market inputs (as proxied by income) and parental time inputs become perfectly substitutable in the child health production process, for some conditions. Wei pointed to this aspect of the work but also noted that parental disease management abilities may also be related to income, and that this could explain the stronger relationship between income and health in children with chronic conditions.

Murasko (2008) has also used the MEPS data (1996-2005) to examine the income-child health gradient. The purpose of his study was to find a way to diaggregate the cumulative and contemporaneous effects of income which, as he points out, are indiscernible in cross-sectional data (e.g., in Case, Lubotsky, and Paxson 2002). Murasko constructs an argument that the child's health at the baseline observation (the health state of the child at the first survey wave) may be taken as an indicator of the cumulative effect of income on the health stock. Using this conception of the production of the baseline health stock, he estimated regressions wherein the coefficient of income is taken represent that contemporaneous effect of income on health, while the coefficient on the baseline health measure was taken to be a measure of the cumulative effect of income. This approach produced an increasing income-child health gradient but the association was weaker in the MEPS than that which was estimated by Case et al. (2002) using the 1995 NHIS . Murasko found that if baseline health was included in the model, the child health-income gradient flattened , however poor health was still more prevalent in older children from lower-income households. Thus, he concluded that it was the cumulative effect of income on health that explains much of the observed gradient of child health and income – particularly prior to adolescence – however, a strong contemporaneous association remained for the adolescent age group.

In this paper, we consider the effect of chronic conditions on child health, and also consider the cumulative and contemporaneous roles of income, using Murasko's (2008) approach, on a large Australian panel dataset.

3 Data and Descriptive Statistics

This study utilises the data from the first two waves of the nationally representative Longitudinal Study of Australian Children (LSAC) (Australian Institute of Family Studies, 2007). The LSAC has so far involved two waves of data collection for more than ten thousand children. The LSAC involves biennial follow-up of the enrolled households and will continue until at least 2018. The LSAC was conducted using both face-to-face interviews and survey instruments that were sent and retrieved via mail. The main topics covered include demographics, health status, education, the relationship history of parents, parenting practices, financial factors, lifestyle, housing and neighbourhood attributes.[2] The data were collected using a two-stage clustered sampling design with postcodes were used as

[2]For a more comprehensive account of the LSAC sampling frame of the LSAC see Soloff, Lawrence, and Johnstone (2005).

the primary sampling unit (PSU). To ensure proportional geographic representation, postcodes were selected as a stratified sample by state of residence, and urban and rural geographical status. The sampling frame for the second stage consisted of all children born in the selected PSUs between March 2003 and February 2004 (B-Cohort, infants aged 0-1 years in 2004), and between March 1999 and February 2000 (K-Cohort, children aged 4-5 years in 2004) who were enrolled on the Health Insurance Commission's Medicare database. The Australian Medicare scheme is universal and compulsory; thus the sample constructed for the LSAC is generally representative of Australian children in these age cohorts, although children living in remote areas were not sampled.

The LSAC approach results in a sample frame that contains approximately 5000 children in each cohort, with an average of 20 children per cohort per postcode. The final respondent samples consist of 5107 and 4983 children in cohorts B and K, respectively, in Wave 1 (conducted in 2004). The numbers of children surveyed in Wave 2 (conducted in 2006) of the respective cohorts is slightly lower, primarily as a result of attrition, with 4606 and 4464 children retained in cohorts B (aged 2-3 years in 2006) and K (aged 6-7 years in 2006), respectively. The attrition rates are therefore 9.8 and 10.4 per cent for B and K cohorts, respectively. The logistic regressions conducted by Mission and Sipthorp (2007, Tables 1-2) reveal that attrition occurred mostly at random in the LSAC. However, attrition was slightly more likely if Parent 1 (primary caregiver) is a young male, the household was living in a rented home, or in an areas with a lower socio-economic status index. For the B-cohort, attrition was also more likely to occur among households in areas where fewer people in the postcode speak only English in the home.

In order to take the advantage of the survey's design characteristics , all analyses presented in this paper apply the sampling weights of the LSAC. These are computed as the inverse of the probability of a child being selected for inclusion in the LSAC sample. For example, if the probability of a child is being sampled is 0.20, the weight given to that child's response is 5.0. In addition, cluster information are used to produce correct variances of the estimates as there is less variations among variables within a cluster (i.e., postcode). This approach also corrects for the fact that the variance is reduced in a finite population with non-replacement sampling (i.e., in non-replacement samples, the population being sampled is reduced as the sampling progresses; and the variance is thereby reduced). The descriptive statistics of the variables are reported in Table 1.

3.1 Child Health

As with the foregoing literature on income and child health (see for example, Case et al., 2002; J. Currie and Stabile, 2003; A. Currie et al., 2007), our measure of child health is constructed from the following question that was asked to the child's primary care-giver (Parent 1)[3]: "*In general, how would you say child's current health is?*" The responses were recorded on a five-point Likert scale upon which 1 is "Excellent" 2 is "Very good"; 3 is "Good"; 4 is "Fair" and 5 is "Poor". Other researchers have found that there are typically very few respondents in the "Poor" health category: in the LSAC approximately 0.30 per cent of the children sampled fall into this category. Some authors (e.g., A. Currie et al., 2007) have chosen to merge the lowest and second-lowest health state categories as a response to the (relatively) small number of observations in the "Poor" health category. Since there are no shortage of degrees of freedom in our study, we do not compress the "Fair" and "Poor" categories of child health. Thus, our dependent variable for parent-reported overall child health contains the five

[3]In principle, Parent 1 is the person in the family who knows the most about the study child. In most cases this is the child's biological mother but, alternatively may be the biological father, a step-parent, an adoptive parent, a guardian, or someone else who has a parental/guardian relationship with the child.

Table 1: Descriptive statistics

Description	Obs	Means	Linearised Std. Err.	Min	Max
Log of income	18929	10.99	0.02	3.26	13.24
Child's age (months)	18929	82.09	0.05	3.00	94.00
Gender of the child (male=1)	18929	0.51	0.01	0.00	1.00
Log of household size	18929	1.49	0.00	0.69	2.64
Both biological parents present	18929	0.80	0.01	0.00	1.00
Mother age at birth (years)	18833	29.67	0.11	13.00	63.00
Mother completed year 12	18929	0.49	0.01	0.00	1.00
Mother had a graduate degree	18929	0.19	0.01	0.00	1.00
Mother had a postgraduate degree	18929	0.05	0.00	0.00	1.00
Primary caregiver is not mother	18929	0.10	0.01	0.00	1.00
Low income household*	18929	0.11	0.01	0.00	1.00
General health status in Wave 1	9009	1.59	0.01	1.00	5.00
Poor health of the child**	18929	0.13	0.01	0.00	1.00
Number of chronic conditions	18929	0.36	0.01	0.00	7.00
Number of conditions in Wave 1	18929	0.28	0.00	0.00	7.00
Number of new chronic conditions***	18929	0.18	0.01	0.00	5.00
Having new health shock	18929	0.16	0.01	0.00	1.00
Chronic condition in Wave 1	9010	0.34	0.01	0.00	1.00
Asthma in Wave 1	4420	0.21	0.01	0.00	1.00
Injury in Wave 1	9010	0.17	0.01	0.00	1.00

*Note: * Determined using the poverty line of Australia (Melboure Institute, 2008); **health status good, fair and poor, ***Number of chronic conditions appear in Wave 2 but not in Wave1; Means and standard errors are estimaed using the Taylor linearisation method (Kish, 1995; Chambers and Skinner, 2003)*

Source: Computed from the Longitudinal Study of Australian Children (Australian Institute of Family Studies, 2007).

original categories.[4]

3.2 Chronic Conditions

The prevalence of chronic conditions and the likelihood of their diagnosis is a function of child age: because the children in our sample are young by comparison to those included in the studies cited above, the prevalence of chronic conditions thus also expected to be lower in our sample, *ceteris paribus*. In the LSAC, Parent 1 was asked whether or not the child had a long-term medical condition, the nature of the condition and whether the child had experienced any developmental delays that were attributable to the problem, compared to children of a similar age. If the answer was yes, the respondent was asked to check up to fourteen chronic conditions. Approximately 30 per cent of survey children in the LSAC were reported to have at least one such condition, and seven per cent have more than one such condition.[5] Furthermore, the LSAC contains information on whether the child has asthma or bronchiolitis, *as diagnosed by a health professional.*[6] The survey revealed that 19.32 and 13.32 per cent of children, respectively, were reported to have been diagnosed with asthma and bronchiolitis (see Table 2). Approximately nine per cent of children who did had no chronic condition in Wave 1 were diagnosed with a new chronic condition by Wave 2. The LSAC revealed that 12.58%, 30.48% and 20.82% children respectively were reported as having good, fair or poor

[4]Nevertheless, we also conducted analysis with the last two categories recoded and the results show little differences. These estimates are available from the authors upon request.

[5]Chronic conditions include hearing problems, vision problems,eczema, diarrhea/collitis, ear infections, other infections, food or digestive allergies, other illness, other physical disabilities, recurrent abdominal pain, development delay, anaemia, attention deficit disorder and frequent headaches.

[6]The survey questions for this variable is "Has a doctor ever told you that you child has: asthma?, bronchiolitis?"

Table 2: Children with chronic conditions and injury by SES and Wave

Waves	SES	Any chronic condition	Asthma	Injury
Wave 1	Low	31.24%	22.09%	12.29%
	High	30.20%	20.39%	11.34%
	All	30.48%	20.82%	11.63%
Wave 2	Low	28.40%	20.49%	17.75%
	High	29.89%	17.05%	16.51%
	All	29.41%	18.51%	17.66%
Both	Low	30.02%	21.13%	14.64%
	High	30.05%	18.26%	13.87%
	All	29.97%	19.32%	14.50%

Note: The definition of low SES and high SES was applied according to Condlife and Link (2008). Low SES includes those whose income is below the mean income by one standard deviation while high SES include those whose income is above the mean level by one standard deviation.

Source: Computed from the Longitudinal Study of Australian Children (Australian Institute of Family Studies, 2007).

health . For comparative purposes, we follow the literature to date, by combining these three health status categories to construct for our binary measure of child health. Specifically, as the other studies in this field have done, we treat the foregoing three categories as indicative of "poor" health child health (i.e., "poor health"=1), while children who are in very good or excellent health are treated as being in "good" health (i.e., "poor health"=0).

We are interested in examining how the parents manage a previous health shock that affects current health status of a child. We also investigate factors determining whether or not a child had an injury in the wave 1.[7] We assume that injury is a health shock that could affect health. The LSAC reported that 11.63% children had at least one injury in Wave 1 whilst the figure of Wave 2 is 17.66%.

4 Method

Following Grossman(1972; 2000) we argue that a child is born with a initial stock of health that depreciates over time. The arrival and severity of different health shocks, and insufficient investment into health capital could accelerate the rate of depreciation of the health stock. However, health stock should be retained to a level that is above to a critical minimum level for survival. This conceptual framework could explain the increasing gradient by child age. Suppose, if the depreciation rate of health stock of older children is higher than the younger children, then that will result in an increasing gradient over the age-group. As a child grows older, he is susceptible to more health shocks, in the form of chronic condition, injury from an accident, which could depreciate the health stock. If proper investment is not made to recover from those health shock then health disparities will increase. The depreciation rate might be higher for children from low-SES, and children with chronic condition. Because, children from low-SES households are more likely to have a health shock (because of differences in lifestyle, poor housing quality, inadequate nutrition) and recover slowly from a health shock because of lack of information or resource constraint of the parents. Low-SES parents are less able to manage a health shock as effectively as high-SES parents, which leaves their children in poor health. These propositions could explain the increasing income-child health gradient. Therefore, family income could affect child health through the incidence of chronic condition and

[7]The primary care-giver was asked: "what types of injury or accident did child have that needed medical attention? Ten types of injuries were reported: broken or fractured bones, burn or scald, dislocation, sprain or strain, cut or scrape, concussion or internal head injury, internal injury (not head), dental injury, accidental poisoning and other.

different recovery rate because of differential investment to the health stock.

Previous research has identified two possible channels by which income gradient may increase by child age. First, children of low-SES parents may respond to health shock differently than the high-SES parents. That is low-socio-economic status children may recover slowly from a particular health shock than the high-SES children, so negative effects of health shock accumulate over time , and may contribute to the increasing gradient. Second, Low-SES children may experience more incidence of health shock (chronic conditions, diseases requiring medical attention, different forms of injuries). Therefore, the depreciation rate of health stock of low SES children could be higher than the high SES children as a results of these two channels. The recent literature (Condliffe and Link, 2008) has established that differential response to past health shocks by SES can contribute to the increasing gradient. Children of low-SES parent are also more likely to have more health shock than the high-socioeconomic status.

The following empirical approach is adopted to explore these issues in a multivariate context. We first proceed by exploring the income gradient in child health. In an attempt to do this, we pool data from the first two waves from the LSAC to replicate the results of Currie and Stabile (2003) and Condliffe and Link (2008). We estimate the following equation:

$$health_{it} = \alpha_0 + \alpha_1 ln(inc)_{it} + \alpha_2 age_{it} + \alpha_3 X_{it} + \varepsilon_{it} \quad (1)$$

where, $health_{it}$ is a child's health status (in time t) measured on 1-5 point Likert scale with 1 indicating excellent and 5 indicating poor health. The term, $ln(inc)_{it}$ is log of permanent family income of a household which is believed to have stronger effect on health than transitory variations in income. We take the average annual income of each family in Wave 1 and Wave 2. The income estimates were then adjusted using the Australian national Consumer Price Index (CPI) for the study period, using the CPI at Wave 1 as the base (Australian Bureau of Statistics, 2008). The term age_{it} is a set of age dummies, and X_{it} is a set of exogenous variables that include a set of dummies for mother education, wave dummies, cohort dummies, log of family size, a dummy variable for the sex of the child, a dummy variable for having a primary care giver *(person responding to the survey questions)* that is not the biological mother, a dummy variable for having a female care giver, a dummy variable for having two biological parents in the household, and the mother's age at birth. As the children in our sample are for ages 0-8 years, so we estimate equation (1) for the age groups: 0-3years and 4-8 years. The equation 1 is a basic equation used in the previous literature (for example, Case, Lubotsky, and Paxson, 2002; Currie and Stabile, 2003; Condliffe and Link, 2008; Murasko, 2008) to examine the relationship between child health and household income. Given the ordered nature of $health_{it}$, eqation 1 is estimated by a ordered probit model. We expect a negative sign for α_1 and the absolute value of $\alpha_1$will increase over the age groups suggesting an increasing income-child health gradient.

Murasko (2008) argued that it is not possible in cross section (for example, eq.1) whether any increasing income-child gradient is due to a cumulative, a contemporaneous effect, or a combination of both. The cumulative effect of income is consistent with the idea that prevalence of poor health in low-SES children in their early years of life might be carried out into their adulthood, which in turn increases health disparities among low and high SES. This could be one reason why income gradient increases by age. The contemporaneous effect suggests that the health disadvantages faced by the low-SES households do not become obvious until the children grow older. He proposed to add baseline health in eq (1) to evaluate these potential effects.

Therefore, to test the 'cumulative' and 'contemporaneous' effect of income, we propose the following model for child health:

$$health_{it} = \beta_0 + \beta_1 ln(inc)_{it} + \beta_2 age_{it} + \beta_3 health_{it-1} + \beta_4 X_{it} + \varepsilon_{it} \quad (2)$$

where $health_{it-1}$ is child's general health state measured in time $t-1$, which is wave 1 in the LSAC; the remaining variables are defined as above.

Now we proceed to test the two hypothesis proposed by Currie and Stabile (2003) and evidenced by Condliffe and Link (2008) by exploiting panel data of LSAC. We estimate the following equation that is basically based on Currie and Stabile (2003) and Condliffe and Link (2008):

$$health_{it} = \gamma_0 + \gamma_1 In(inc)_{it} + \gamma_2 age_{it} + \gamma_3 shock_{i(t-1)} + \gamma_4 In(inc)_{it} * shock_{it-1} + \gamma_5 X_{it} + \varepsilon_{it} \quad (3)$$

where, $health_{it}$ is a measure of child health in wave 2; $shock_{i(t-1)}$ is a health shock in wave 1; and rest of the variables are defined as above. The variable $health_{it}$ is a dichotomous variable equals to one if health status is poor, fair, or good; $shock_{i(t-1)}$ is also a dichotomous variable which equals 1 if the child has any chronic condition, asthma or an injury in wave 1. The equation 3 is measured by binary probit model. A statically significant and negative coefficient for γ_4 would indicate that low-SES children will be severely affected by a health shock.

The second hypothesis is tested by the following equation:

$$Newshock_{it} = \delta_0 + \delta_1 In(inc)_{it} + \delta_2 age_{it} + \delta_3 In(inc)_{it} * age_{it} + \delta_4 shock_{t-1} + \delta_5 X_{it} + \varepsilon_{it} \quad (4)$$

where, $Newshock_{it}$ refers to number of new conditions in wave 2 and other variables are defined as above. The dependent variable, $Newshock_{it}$, equals 1 if a child develops a new condition between two periods. The equation 4 is estimated by a binary probit model. We will estimate the several forms of the above equation to test the hypothesis: children from low-SES experience more incidence of health shock.

5 Results

5.1 The Gradient:Cross-Sectional Estimates

The equation 1 is estimated for the children aged 0-3 years and aged 4-8 years, with and without mother education to compare with C&S and C&L. Our results from the LSAC and C&S and C&L results are reported in Table 2. It is noteworthy that C&S's and C&L's analysis were for the children aged 0-15 year and aged 0-17 year respectively. As LSAC provides data for the children 0-8 years, so we will replicate the results for these age groups from C&S and C&L. In line with the previous literature, the results from the LSAC reveal an increasing income and child health gradient in Australia for 0-8 year-olds. However, the association between family income and child health is weaker in the LSAC data than the results reported for Canada and the USA.[8] The inclusion of maternal education has no

[8] It is important to acknowledge that the income data from these three studies have not been homogenised (e.g., expressed on the same scale, using a purchasing power parity measure), so that the coefficients on income are not strictly comparable. Nevertheless, the coefficient sizes are of sufficiently different magnitude that rescaling is unlikely to affect this conclusion.

Table 3: The increasing income gradient in child health (ordered probit models)

Variables	0-3 years old			4-8 years olds		
	Canada (C&S, 2003)	**USA** (C&L, 2008)	**Australia** This paper	**Canada** (C&S, 2003)	**USA** (C&L, 2008)	**Australia** This paper
Without mother's education	***-0.151 (0.026)	***-0.136 (0.018)	***-0.078 (0.027)	***-0.216 (0.019)	***-0.204 (0.014)	***-0.148 (0.023)
With mother's education	***-0.132 (0.027)	***-0.093 (0.018)	***-0.083 (0.027)	***-0.182 (0.020)	***-0.156 (0.014)	***-0.144 (0.025)

*Notes: (i) The dependent variable is an ordered categorisation of the child's general health status (e.g., 1= excellent, 2 = very good, 3 = good, 4= fair and 5= poor) as reported by a parent/guardian. (ii) As the LSAC data are only available for children aged 0-8, we report the results for same age groups from previous studies, though those studies also included children older than 8 years. (iii) Robust standard errors are in parentheses. (iv)***Significant at the one per cent level.*

Sources: J.Currie and Stabile (2003), Condlifee and Link (2008)). Australian estimates were computed from the Longitudinal Study of Australian Children (Australian Institute of Family Studies, 2007).

effect on the magnitude of the coefficients on income in Australia, although the inclusion of maternal education reduced the magnitude of the income coefficients, and the income gradient, in both Canada and the USA.

5.2 Causes of the Gradient:Panel Estimates

In this section we explore the underlying mechanisms of the increasing gradient exploiting the panel data of LSAC. Since it is not possible to determine whether a steepening income-child-health gradient is attributable to a cumulative effect of income on health or a stronger contemporaneous effect of income on health for older children (Murasko 2008), we exploit our LSAC panel to investigate this issue. First, we focus on Murasko(2008)'s 'cumulative effect and contemporaneous effect of income', then we test the hypotheses of C&S.

5.2.1 Cumulative Effect Versus Contemporaneous Effect

We estimate eq (2) to examine whether the cumulative effect and contemporaneous effect of income can explain the increasing gradient in the LSAC data. Our other covariates are similar to C&S to keep consistency with rest of the paper. However, we also estimate eq(1) and eq (2) using similar variables as Murasko. The results of these specifications(not reported in the paper) show similar trends. When we control for baseline health status of a child, the income coefficient becomes insignificant for the 0-3 age group. Murasko's also found insignificant coefficient on income for this age group in the USA. Murasko (2008) revealed that controlling for the baseline health status flattens the income gradient in the USA, our results also show similar trends over the age groups: 0-3 years and 4-8 years.

Murasko argued that if cumulative effect is dominant, then the coefficient on income (α_1) would be relatively flatter. If contemporaneous effect is dominant in the steepening income gradient, then the coefficient on income (α_1) would be stronger over the age group.. In line with Murasko, if we explain previous health states as a 'cumulative effect' of income, we find that controlling for baseline health (cumulative effect) makes the income-child health gradient flatter. This findings from the LSAC suggest that 'cumulative effect' can explain some of the increasing gradient in income and child health. The incidence of poor health increases over the age groups, which is also consistent with Murasko's finding. The high prevalence of poor health among the 4-8 years may partly explain why the relationship between income and child health becomes stronger for the older children.

Table 4: The effects of based line health on current health status.

Variables	0-3 years United States Murasko (2008)	 Australia This Paper	4-8 years United States Murasko(2008)	 Australia This Paper
Ordered probit estimates				
Log of income	-0.025	-0.066	***-0.059	***-0.123
	(0.021)	(0.051)	(0.021)	(0.034)
Health_{i-1}=1	***0.523	-0.276	***0.585	***-2.140
(excellent)	(0.040)	(0.406)	(0.036)	(0.501)
Health_{i-1}=2	***0.851	0.182	***0.962	***-1.490
(very good)	(0.043)	(0.404)	(0.048)	(0.502)
Health_{i-1}=3	***1.335	0.500	***1.368	**-1.076
(good)	(0.095)	(0.410)	(0.087)	(0.504)
Health_{i-1}=4		0.644		-0.758
(fair)		(0.424)		(0.530)
N	7596	3323	10352	4520
Probit estimates				
Log of income	-0.010	0.023	**-0.012	***-0.151
(lninc)	(0.007)	(0.068)	(0.006)	(0.048)
Health_{i-1}=3,4 or 5	***0.229	***0.727	***0.279	***0.989
(good, fair or poor)	(0.016)	(0.068)	(0.017)	(0.060)
N	7596	3315	10352	4520

*Note: (i)Robust standard errors are in parentheses. (ii) Significant levels are ***=1%, **=5%, and *=10%*

Sources: Condlifee and Link (2008)). Australian estimates were computed from the Longitudinal Study of Australian Children (Australian Institute of Family Studies, 2007).

5.2.2 The Role of Chronic Condition

In this section, we follow Currie and Stabile (2003) and Condliffe and Link (2008) to test the hypotheses originally proposed by Currie and Stabile.

Is There any Differential Response by Different SES to Past Health Shocks?

In this section we examine whether low-SES children are hit harder by a health shock. Following C&S and C&L we estimate different versions of Equation 3 by binary probit models. We report the results of Currie and Stabile (2003), Condliffe and Link (2008) and this paper in Table 5.

Our results show that earlier health shock increases the probability of having poor health in current period. For example, the presence of chronic conditions in Wave 1 (2004) increases the probability of being in poor health in wave 2 (2006) by 7 percentage points (estimated from relevent marginal effects); the estimated coefficient is statistically significant at the 1 percent level. The positive and statistically significant (at the 1 percent level) coefficient on asthma show that having asthma in Wave 1 (in 2004) increases the likelihood of being reported in poor health in Wave 2 (in 2006) by 10 percentage points(estimated from corresponding marginal effects). However, the coefficients of earlier shocks become statistically insignificant when an interaction term between health shock and family income is used in the regression. It is noteworthy that having an injury in Wave 1 does not increases the probability of poor health in Wave 2.

The coefficients on income are always negative and statistically significant at the 1 % level in these specifications indicating a protective effect of income on child health. However, the interaction term between family income and a lagged health condition is not significant and in some cases the sign is positive. This results is not surprising because children in our sample are younger (0-7 years)

Table 5: The effects of earlier health conditions on poor health today

Canadian evidence *(J.Currie and Stabile, 2003)*

Variables	(1)	(2)	(3)	(4)
Chronic Condition in 1994	**0.108	*0.257		
	(0.008)	(0.138)		
Asthma in 1994			**0.136	*0.357
			(0.012)	(0.209)
Log of average income	**-0.055	**-0.052	**-0.055	**-0.053
	(0.007)	(0.007)	(0.007)	(0.007)
Interactions of the logs average income with				
Chronic Condition in 1994		-0.014		
		(0.013)		
Asthma in 1994				-0.021
				(0.019)

American evidence *(Condliffe and Link, 2008)*

Variables	(1)	(2)	(3)	(4)
Chronic Condition in 1997	**0.0567	**0.631		
	(0.024)	(0.303)		
Asthma in 1997			**0.086	0.549
			(0.036)	(0.418)
ln (family income)	**-0.055	**-0.040	**-0.054	**-0.048
	(0.019)	(0.020)	(0.019)	(0.012)
Interactions of the logs average income with:				
Chronic Condition in 1997		**-0.054		
		(0.028)		
Asthma in 1997				-0.044
				(0.039)

Australian evidence *(This Paper)*

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log of income	***-0.143	***-0.140	***-0.245	***-0.225	***-0.141	***-0.148
	(0.030)	(0.036)	(0.043)	(0.047)	(0.03)	(0.031)
Chronic Condition in Wave 1 (2004)	***0.307	0.414				
	(0.035)	(0.623)				
Asthma in Wave 1 (2004)			***0.431	1.319		
			(0.060)	(0.938)		
Injury in Wave 1 (2004)					0.028	-0.651
					(0.053)	(0.845)
Interactions of the logs of average income with:						
Chronic Condition in Wave 1		-0.010				
		(0.056)				
Asthma in Wave 1				-0.081		
				(0.085)		
Injury in Wave 1						0.062
						(0.076)
N	8957	8957	4381	4381	8957	8957

*Notes: (i) Robust standard errors are in parentheses. (ii) Significant levels are **= 1%, **=5%, and *=10% (iii)For details of the Specifications for the J.Currie and Stabile (2003) see their Table 3 and for the Condliffe and Link, (2008) see their Table 8. (iv) Australian estimates are computed from the Longitudinal Study of Australian Children (Australian Institute of Family Studies, 2007).*

Table 6: The effects of income and past health shocks on new health shocks

Variables	(1)	(2)	(3)	(4)
Log of family income	0.022	0.032	0.029	0.299
	(0.025)	(0.054)	(0.054)	(1.006)
Interaction of age and income		-0.0001	-0.0001	-0.004
		(0.001)	(0.001)	(0.012)
Chronic condition in previous period			***0.124	
			(0.031)	
Asthma in the previous period				***0.180
				(0.050)
N	8957	8957	8957	4381

*Notes: (i) Robust standard errors are in parentheses. (ii) Significant levels are ***=1%, **=5%, and *=10%*

than those of J.Currie and Stabile and Condliffe and Link. These children are perhaps too young to capture any income related disparity. However, the negative and statistically insignificant sign for the interaction terms indicate that the low-SES household do not respond to a health shock differently compared to high-SES household. This finding is in line with J. Currie and Stabile (2003) but in contrast to Condliffe and Link(2008). Therefore, our results do not provide any evidence that low-SES households respond to a past health shock differently than the high-SES households or they are less able to manage a health shock than the high-SES household.

New Health Shock

We estimate different forms of Equation (4) by probit models to see whether a child from low-SES background is more likely to experience a new health shock. First we include income with the standard control variables, then we include an interaction term of income and age. Finally, we include an indicator for past health shock that equals 1 if the child had any chronic condition or asthma in wave 1. Our results indicate that SES plays no role on the probability of having a new shock. Our results are in line with Wei (2007)'s who also found that children from low income household are not subject to new health shock. Although C&S established that low-SES Canadian children were subject to more health shocks, subsequent studies from the USA do not find any conclusive evidence in support of this. For example, C&L used two dataset from the USA, in one data set (PSID) they found no evidence that low-SES children are more likely to experience new health shock.

Our results reveal that children who experienced past healths are more likely to experience new health shocks. For example, children who had a health shock in wave 1 (in 2004) are 4 percentage points more likely to have a new health shock in wave 2 (in 2006). The children who had asthma in wave 1 (in 2004) are 5 percentage points more likely to diagnose with a new health condition in wave 2 (in 2006).[9]

Affects of Health Expenditure

One may argue that health-related expenditure should be controlled for when examining the child health-income gradient. In this study, we select the sum of payment from Medical Benefit Scheme (MBS) and Pharmaceutical Benefit Scheme (PBS) as a proxy for medical expenditure of households. However, there is a high possibility that health status is simultaneously determined with health expenditure. We employ the generalised Hausman test, which is essentially the adjusted Wald test, checking

[9]These figures - not reported in Table 5 - are obtained from the corresponding marginal effects .

Table 7: Income gradient with control for health expenditure

Variables	Health status		Health expenditure	
	coef.	std. err.	coef.	std. err
Log of income	***-0.108	0.011	-0.020	0.020
Gender of the child	***0.112	0.020	***0.148	0.023
Log of hh size	**0.085	0.036	***-0.44	0.047
Both biological parent presence	-0.039	0.033	*0.076	0.040
Mothe age at birth	***-0.006	0.002	**0.005	0.002
Mother's education> year 12	-0.003	0.038	0.009	0.025
First caregiver is not mother	***-0.129	0.016	***0.685	0.024

*Note: Wald test for independent of equations, $Chi^2(1)$=963.15, p-value=0.00. Significant levels are ***=1%, **=5%, and *=10%*

for the systematically differents of coefficients from two models with and without the medical expenditure. The test rejects the null hypothesis of no endogeneity issue (F(8,262)=57.17, p-value=0.00). To overcome the endogeneity issue, a bivariate ordrered probit model[10] is applied to estimate the base model of income and child health relationship. While the behaviour of most health determinants (e.g., income, age and gender of the child, household size and family characteristics) are almost unchanged compared with the single equation model, the bivariate estimates reveal an imporant finding that income plays an insignificant role in determining health expenditure. This finding is support by the fact that Australia has a universal health care system (Medicare) which provides people most medical needs regardless of their income level.

6 Conclusions

Our results show that none of the hypotheses proposed by C&S can explain the increasing income-child health gradient in Australia. Our results revealed that low-SES Australian children are not severely affected by a health shock, and they are not subject to more health shock as they age. Our results find support for Murasko(2008)'s cumulative effects of income hypothesis. Our results show that the incidence of poor health increases by child age, which indicates that cumulative effects of baseline health contribute to poor health of the older children. However, it has some role to reduce the increasing gradient, but it does not make the income coefficient insignificant. It is noteworthy that our analysis is for the children aged 0-7 years, while the literature in this field is for the children aged 0-15/17 years. Therefore, our analysis might not be easily comparable to the whole range of findings from the existing literature. However, it is still comparable to the same age group and provides some important insights that could be interesting for policy purpose. So far, from the existing literature, we do not see any uniform mechanism that can be applied universally. So, policies to address this issue should be country specific.

[10]In this model we convert the natural log of medical expenditure to categorical measure where the first, second, third and last quartiles were coded as 1, 2, 3 and 4 respectively. Then a bivariate ordered probit model is estimated where the self-reported health and medical expenditure (categorical form) are estimated simultaneously.

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