



Research article

Costs for physical and mental health hospitalizations in the first 13 years of life among children engaged with Child Protection Services

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ABSTRACT

Background: Longitudinal data on health costs associated with physical and mental conditions are not available for children reported to child protection services.

Objective: To estimate the costs of hospitalization for physical and mental health conditions by child protection status, including out-of-home-care (OOHC) placement, from birth until 13-years, and to assess the excess costs associated with child protection contact over this period.

Participants and setting: Australian population cohort of 79,285 children in a multi-agency linkage study.

Methods: Costs of hospitalization were estimated from birth (if available) using Round 17, National Hospital Cost Data Collection (2012-13; deflated to 2015-16 AUD). Records of the state child protection authority determined contact status. Data were reported separately for children in OOHC. Hospital separations were classified as mental disorder-related if the primary diagnosis was recorded in ICD-10 Chapter V (F00-F99).

Results: Hospital separations were more common in children with child protection contact. Physical health care costs per child decreased with age for all children, but were significantly higher for children with contact. Mental health costs per child were always significantly higher for children with contact, with marked increases at $3 \leq 4$ years and $8 \leq 9$ years. Point estimates of annual costs per child were always highest for children with an OOHC placement. The net present value of the excess costs was \$3,224 per child until 13- years, discounted at 5 %.

Conclusions: Children in contact with child protection services show higher rates and costs for physical and mental health hospitalizations in each of their first 13 years of life.

1. Introduction

Child maltreatment is a significant public health problem with extensive impacts for the child who is maltreated, their current and future families, and broader society (Gilbert et al., 2009). Internationally, an increasing number of studies have sought to estimate the economic burden of those impacts, for both multiple (Fang, Brown, Florence, & Mercy, 2012; Fang, Fry, Brown et al., 2015; Fang, Fry,

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Ji et al., 2015; Gelles & Perlman, 2012; Habetha, Bleich, Weidenhammer, & Fegert, 2012; McCarthy et al., 2016; Wada & Igarashi, 2014) and single types of abuse (Fang et al., 2017; Letourneau, Brown, Fang, Hassan, & Mercy, 2018). For example, in Australia, McCarthy and colleagues (McCarthy et al., 2016) estimated the total lifetime financial costs for incident cases of child maltreatment in 2012–13 at \$9.3 billion (\$176,437 per maltreated child), increasing to \$26.7 billion (\$505,194 per maltreated child) with the inclusion of non-financial costs (e.g., with a value placed on quality of life losses). As reflected in these estimates, a primary objective of economic burden or cost-of-illness analyses is to bring much needed attention to the high costs of child maltreatment over the life course (Corso & Fertig, 2010).

From the outset of work on the economics of child maltreatment, a common goal has been to inform the prevention or minimization of the consequences of maltreatment (Butchart, Phinney Harvey, Kahane, Mian, T, & F., 2006; Courtney, 1999; Krug, 2006; Lanier, Jonson-Reid, Stahlschmidt, Drake, & Constantino, 2010; O'Donnell et al., 2016). This goal requires information on the specific health effects associated with maltreatment prior to adulthood (Lanier et al., 2010), and the reasons for (and outcomes associated with) differences in health care costs for children with a history of maltreatment (Campbell, Telford, Cook, Waitzman, & Keenan, 2016). These questions cannot be addressed through modelled economic burden studies, but only through individual level analysis.

Historically, the health costs incurred during childhood because of maltreatment have been assessed according to the costs of an individual episode of health care, usually a single inpatient hospital admission, with maltreatment status determined through an ICD-9 diagnosis of abuse or neglect within the health records (Brown, Fang, & Florence, 2011). Eight short-term studies of this kind were identified in the systematic review by Brown and colleagues, of which only Rovi, Chen, and Johnson (2004) included hospital admissions beyond injury. Several studies focused on specific injuries, such as head trauma and/or traumatic brain injury (Dominguez, Chalom, & Costarino, 2001; Ettaro, Berger, & Songer, 2004; Libby, Sills, Thurston, & Orton, 2003), and burn injury (Evasovich, Klein, Muakkassa, & Weekley, 1998). All studies consistently reported longer lengths of stay (except for Forjuoh, 2000) and higher average charges and/or costs per episode of care for children who had been maltreated, except for two non-representative studies (Dominguez et al., 2001; Forjuoh, 2000). The importance of severity of illness (Evasovich et al., 1998; Irazuzta, McJunkin, Danadian, Arnold, & Zhang, 1997) and diagnosis (Dominguez et al., 2001) were also identified. On the basis of this literature, the need to capture the ongoing health effects of child maltreatment and the assessment of costs by age from early childhood, as afforded by larger longitudinal studies, were identified as important to furthering research in the field (Brown et al., 2011).

Use of linked administrative data, with its capacity to track an individual's service use and, where available, costs/charges associated with this service use over time, has been acknowledged as one of the potentially most effective approaches to improve our knowledge of the health costs associated with child maltreatment (Courtney, 1999). In the US, several linked data analyses have assessed health expenditure in maltreated children enrolled in Medicaid (Campbell et al., 2016; Clark, Yampolskaya, & Robst, 2011; Florence, Brown, Fang, & Thompson, 2013; Raghavan, Brown, Allaire, Garfield, & Ross, 2014; Raghavan, Brown, Allaire, Garfield, Ross, Snowden et al., 2014). Most studies have been published since the systematic review of Brown et al. (2011), including the first systematic assessment of the costs of maltreatment by Florence et al. (2013). Florence et al. (2013) reported on children with both substantiated and unsubstantiated child protection reports in 14 States, of whom 98 % were less than 15 years of age, and assessed differences in health expenditures compared with a propensity-score matched comparison group over a four-year period (2000–2003). Higher expenditures were found for 'maltreated' children, predominantly due to higher inpatient and non-inpatient psychiatric care, underpinned by both higher rates of care and higher expenditures per case. In this same observation period, Raghavan, Brown, Allaire, Garfield, Ross et al. (2014) reported higher mean annual expenditures on psychotropic medications for children in contact with child protection services, relative to those who were not. Increased mental health-related expenditures were also identified by Campbell et al. (2016) in a four-year case-control study of children aged 0–14 years, whose first child protection report did not result in an out-of-home-care placement; in that study, the highest health costs were for children with a first report between the ages of 11–14 years. Several other studies have also identified that health expenditures increase with age (Clark et al., 2011; Raghavan, Brown, Allaire, Garfield, Ross, Snowden et al., 2014).

In the present study, we undertook a longitudinal assessment of the short-term costs of severe health impacts among children known and not known to child protection services using multi-agency linked data for a population cohort of more than 70,000 children in New South Wales, Australia's most populous State. First, we determined the rates of separations per 10,000 population, the mean annual costs per child (population mean costs), and the mean annual costs per admitted child – by age-band and by child protection status – for all hospital admissions for physical health and mental health conditions separately, up to the age of 13 years. Second, we assessed the excess costs associated with contact with child protection services as the difference in cost trajectories by child protection status.

2. Methods

2.1. Source population and data sources

The data were drawn from the Wave 2 linkage (Green et al., 2018) of the New South Wales Child Development Study (NSW-CDS) (Carr et al., 2016). The NSW-CDS is a population-based cohort of children identified through repeated waves of record linkage based on aspects of school engagement. The first wave of linkage (Wave 1 - 1994–2009) identified children during their first year of formal schooling (kindergarten) in 2009, when the majority of children were aged 5–6 years. The Wave 2 linkage (spanning records available from 1994 to 2016), expanded the inclusion criteria to include children who undertook the Middle Childhood Survey of mental health and wellbeing in 2015, when the majority were aged 11–12 years. In Wave 1, 87,037 children were identified, and through Wave 2, an additional 4598 children were included owing to their movement into the state of NSW between the first and

final year of primary (elementary) school. Children included in the Wave 2 cohort were born between 2002 and 2006; with only 92 children born outside of 2003–2004. The majority of the children were thus aged between 13–14 years at the time of the Wave 2 data extraction in 2016.

For the present analyses, we used child data from the NSW Registry of Births, Deaths and Marriages (RBDM-Births: years 2002–2006 and RBDM-Deaths: 2000–2016), the NSW Ministry of Health's Admitted Patient Data Collection (APDC: 2001–16) and Perinatal Data Collection (PDC: 2002–2006), and the NSW Family and Community Services' (FACS) Child Protection Case Management System – Key Information Directory System (CMS-KiDS: 2000–2016). Probabilistic linkage of government-owned records was undertaken by an independent agency, the NSW Centre for Health Record Linkage (CHeReL; <http://www.cherel.org.au>), according to nationally legislated privacy protocols, with an estimated false positive linkage rate of < 0.5 %. Ethical approval for the study was obtained from the NSW Population and Health Services Research Ethics Committee (HREC/15/CIPHS/21).

2.1.1. Admitted patient data collection (APDC)

The APDC records all inpatient separations (discharges, transfers, and deaths) for public and private hospital admissions in NSW, including fields for dates of admission and separation (restricted to day/month only), principal and additional diagnostic codes (coded according to Tenth Revision of the International Classification of Disease Australian Modification (ICD-10-AM)), public or private hospital designation, length of stay (in days), and Australian Refined-Diagnosis Related Group (AR-DRG) codes. For public hospitals, discharges can include a “statistical discharge” associated with a change in “type of care”, including newborn care, acute care, and mental health care (NSW Ministry of Health, 2017). An individual could therefore have multiple separations in the one hospital admission or episode of care. The AR-DRG codes comprise a large suite of approximately 700 inpatient categories, each intended to encompass clinically meaningful groups of care of similar levels of complexity and resource use, assigned on the basis of individual episode diagnoses, interventions provided, and other routinely collected data (e.g., age and sex).

2.2. Study sample and characteristics

The sample selection procedure is summarised in Fig. 1. Children were included for the costing analysis if they had at least one APDC record (including birth admission) within the NSW-CDS (79,301 children, 86.5 %), which was associated with an AR-DRG code (79,294 children, 203,677 separations) across the age-range of available data (≤ 13 years). Data cleaning identified one child with a record dated pre-birth, and eight children with admissions only in the cost year 2015–16 (age $13 \leq 14$ years); these nine children were excluded from further analyses. The final sample thus comprised 79,285 children for whom 203,445 separations were costed across the period 2001–02 to 2014–15 (nominally, from birth to the child's thirteenth birthday, based on month and year of birth). Of these 79,285 children, 208 gave rise to 253 separations (0.12 %) that had no AR-DRG code, so could not be costed. Of the separations to be costed, 162,409 (79.8 %) related to public hospital admissions, and 41,036 (20.2 %) were for private hospital admissions.

2.2.1. Child protection status

Of the sample of 79,285 children, there were 19,729 children (24.9 %) with at least one child protection report in the FACS CMS-KiDS before December 2016 (Table 1). This included 16,717 (84.5 %) with at least one report that met thresholds for Risk of Significant Harm (ROSH), including some who were placed in out-of-home care (OOHC), 2948 (14.9 %) children with non-ROSH reports (i.e., reports that did not meet criteria for risk of harm, requiring no further follow-up), and 1957 children with at least one placement in OOHC (9.9 % of children known to child protection services). There were 59,556 (75.1 %) children without any history of child protection contact (i.e., unknown to child protection services). Children with at least one OOHC placement were investigated as a separate sub-group who may have experienced more severe maltreatment or been exposed to additional adverse social circumstances compared to children with child protection contact that did not result in OOHC (Green, Kariuki et al., 2019).

2.2.2. Socioeconomic disadvantage

The *Socioeconomic Index for Areas (SEIFA)* was estimated as a function of the average income and employment status for the child's residential postcode (Pink, 2013) at the time of birth, drawn from the PDC; all SEIFA quintiles were determined according to the most recent Australian data (Australian Bureau of Statistics, 2011).

2.2.3. Reason for admission

APDC separations were categorised as mental health-related if the primary diagnosis recorded for the admission was for a mental disorder (i.e. ICD-10 Chapter V [F00–F99]). Separations were otherwise classified as being for a physical health condition.

2.3. Costing

Costs of hospital separations were assessed for each child by age-band ($0 \leq 1$ years to $12 \leq 13$ years), with each separation individually costed by the assigned AR-DRG recorded in the APDC dataset. The AR-DRG is assigned by clinical coders based on the patient's diagnoses (principal and secondary), surgical procedures performed, and/or other routinely collected data (including age, and whether the separation is same-day or not). While year-specific average costs and cost breakdowns per AR-DRG are available since 1996–97, preliminary analyses revealed that over 20,000 separations (~ 10 %) were unable to be costed according to the year the cost was incurred. All separations were therefore costed using national estimates for AR-DRG Version 6.0x from Round 17 (2012–13) of the National Hospital Data Collection (Independent Hospital Pricing Authority (IHPA) (2015)), with < 1 % unable to be

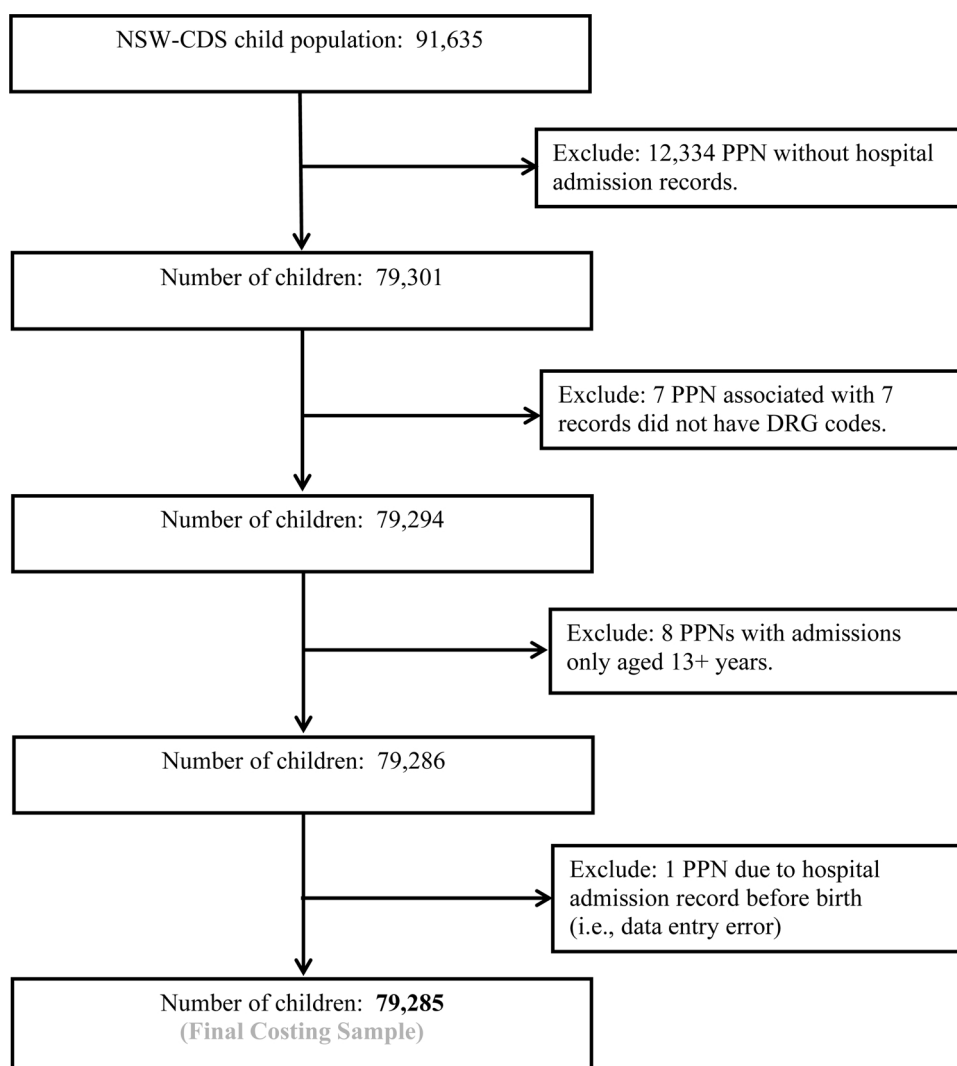


Fig. 1. Flow Chart of APDC AR-DRG Cost Study Sample.

costed. Public hospital weights were used for both public and private hospital separations as only public hospital costs include all cost categories (e.g., medical practitioner costs). Costs were expressed in 2015-16 Australian dollars (AUD) and deflated using the government final consumption expenditure (GFCE) for hospitals and nursing homes (Australian Institute of Health & Welfare, 2017). Costs were then aggregated by the reason for admission (mental health or physical health), and child protection status, based on age at separation.

2.3.1. Excess costs associated with child protection contact

The net present value of the excess costs of hospitalization associated with child protection contact (i.e., any child protection contact and/or placement in OOHC) was estimated as the difference in the cumulative *discounted* mean costs of hospitalizations (from birth until 13 years) between children with exposure to child protection services and/or OOHC placements, compared to those without. Discounting to present values is the process of weighting future costs (and benefits) to account for ‘time preference’: the differing valuation of costs and benefits depending upon when they are incurred or received. (The typical time preference is to postpone costs and to receive benefits sooner rather than later, known as a *positive rate* of time preference.) Discounting to present values enables comparison of cost (and benefit) trajectories at a single point in time. In our assessment, we employed discounting in advance, with discount rates of 3 % and 5 % (Australian Government. Department of Health, 2016; Gold et al., 1996; Neumann et al., 2018).

Table 1

Number and proportions of children with hospital separations per age-band, NSW-CDS sub-population with costed separations (N = 79,285).

Age band (Years)	All Children (n = 79,285)		Unknown to Child Protection Services (n = 59,556; 75.1% _{all})			Known to Child Protection Services (n = 19,729; 24.9% _{all})			Placed in OOHC (n = 1,957; 2.5% _{all})		
	n	%	n	% _{unknown}	% _{all}	n	% _{known}	% _{all}	n	% _{OOHC}	% _{all}
0 ≤ 1	75,119	94.7	56,463	94.8	75.2	18,656	94.6	24.8	1791	91.5	2.4
1 ≤ 2	11,657	14.7	8178	13.7	70.2	3479	17.6	29.8	392	20.0	3.4
2 ≤ 3	9389	11.8	6587	11.1	70.2	2802	14.2	29.8	318	16.2	3.4
3 ≤ 4	8226	10.4	5864	9.8	71.3	2362	12.0	28.7	276	14.1	3.4
4 ≤ 5	7816	9.9	5606	9.4	71.7	2210	11.2	28.3	248	12.7	3.2
5 ≤ 6	6847	8.6	4957	8.3	72.4	1890	9.6	27.6	227	11.6	3.3
6 ≤ 7	6060	7.6	4414	7.4	72.8	1646	8.3	27.2	185	9.5	3.1
7 ≤ 8	5487	6.9	3964	6.7	72.2	1523	7.7	27.8	168	8.6	3.1
8 ≤ 9	4880	6.2	3472	5.8	71.1	1408	7.1	28.9	150	7.7	3.1
9 ≤ 10	4311	5.4	3088	5.2	71.6	1223	6.2	28.4	134	6.8	3.1
10 ≤ 11	4097	5.2	2882	4.8	70.3	1215	6.2	29.7	135	6.9	3.3
11 ≤ 12	3694	4.7	2574	4.3	69.7	1120	5.7	30.3	128	6.5	3.5
12 ≤ 13	2251	2.8	1530	2.6	68.0	721	3.7	32.0	97	5.0	4.3

Note: OOHC = Out-of-home care.

2.4. Statistical analysis

SAS Version 9.4 was used to calculate the frequency and costs of 203,445 separations. The rates for at least one separation (any, physical health, mental health) per 10,000 children by age-band were assessed relative to the number of children within the respective child protection sub-grouping. Mean annual costs per child (population mean costs) were similarly assessed relative to the corresponding sample population or child protection sub-group, by reason for admission for each age-band (Supplement 1, Equation 1). Mean annual costs per admitted child were assessed relative to the number of children experiencing at least one separation within the given sub-grouping in each age-band (Supplement 1, Equation 2). Differences between groups for rates of children hospitalized were assessed using independent samples t-tests. For physical and mental health costs per child and per admitted child, we assessed and compared arithmetic means using non-parametric bootstrapping with 1000 replicates with consideration to child protection and OOHC strata given that these cost data were significantly skewed.

3. Results

3.1. Sample characteristics

The socio-demographic characteristics of the children included in the sample are provided in Supplementary Table 1, for the total child cohort, and according to child protection status. Sub-groups of children according to child protection status were comparable in terms of sex distribution, socio-economic disadvantage, and Aboriginal and Torres Strait Islander representation. The mean age of first report was 4.14 years (SD = 3.37 years), with peak first reports occurring in children aged 1–2 years.

3.2. Hospital separations

The number and proportion of children hospitalized in each age-band are presented in Table 1 (see also Supplementary Tables 2–4). Population rates of children hospitalized (at least one hospital separation) per age-band are illustrated in Fig. 2, for the full sample (A), and according to child protection status (B). Tests of group differences (according to child protection status) in the rates of children hospitalized per 10,000 children for physical health and mental health admissions are presented in Tables 2 and 3, respectively.

Around 95 percent of the entire sample were hospitalized in the first year of life, while 91.5 % of OOHC children were hospitalized during this period (Table 1). After the first year of life, the proportion of children hospitalized declined with age in all sub-groups except for children within the OOHC sub-group at 10 ≤ 11 years.

Across all age-bands a majority of children were hospitalized at some time for physical health conditions (Fig. 2), with the rate reducing with age for all sub-groups, except for the OOHC sub-group at 10 ≤ 11 years (Fig. 2, Table 2). In the first year of life, the rates of children hospitalized for physical health reasons were not significantly different between children unknown and known to child protection services (9480.3 children/10,000 population; 9456.1 children/10,000 population, respectively; $p = 0.192$), but were significantly lower for children ever placed in OOHC (9151.8 children/10,000 population; $p < 0.0001$) (Table 2). From 1 ≤ 2 years, the rates of children hospitalized for physical health reasons were significantly higher for both children known to child protection services ($p < 0.0001$), and those ever placed in OOHC ($p = 0.02$ to < 0.0001), compared with children unknown to child protection services.

The population rate for children hospitalized for mental health reasons was orders of magnitude lower than for physical health reasons for the entire sample, and ranged from 2.8 children per 10,000 population at 6 ≤ 7 years (Fig. 2) to 15.9 children per 10,000

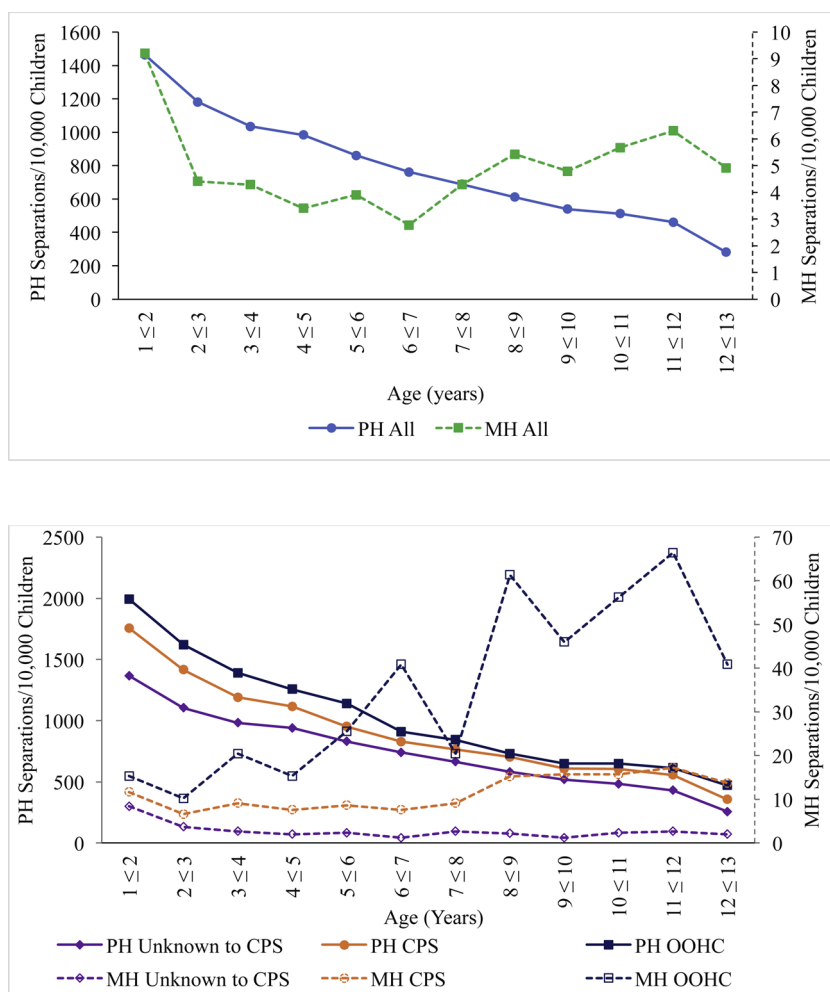


Fig. 2. Population rates (per 10,000 children) for at least one physical health and mental health hospital separation by age-band (A), and by age-band, and child protection status (B) from 1 year, NSW-CDS Sample (N = 79,285).

Abbreviations: CPS = Child Protection Services; MH = mental health; PH = physical health.

Data for children 0 ≤ 1 year of age were not displayed given scaling issues.

Table 2

Rates of at least one physical health hospitalization per 10,000 population per age-band, for children (A) unknown to child protection services, (B) known to child protection services, and (C) with at least one OOHHC placement before age 13 years, NSW-CDS sample.

Age band (Years)	Rates of separation per 10,000				Difference tests (A vs B)		Difference tests (A vs C)	
	All	A	B	C	t-value (df)	p value	t-value (df)	p value
0 ≤ 1	9474.3016	9480.3210	9456.1306	9151.7629	-1.31 (33130)	0.192	5.16 (2038)	< 0.0001
1 ≤ 2	1463.7069	1366.9488	1755.7910	1992.8462	-12.74 (31072)	< 0.0001	-6.85 (2052)	< 0.0001
2 ≤ 3	1181.1818	1103.3313	1416.1894	1619.8263	-11.19 (30960)	< 0.0001	-6.13 (2050)	< 0.0001
3 ≤ 4	1034.7481	982.9404	1191.1399	1389.8825	-7.98 (31496)	< 0.0001	-5.14 (2052)	< 0.0001
4 ≤ 5	983.5404	939.9557	1115.1097	1257.0261	-6.90 (31710)	< 0.0001	-4.18 (2057)	< 0.0001
5 ≤ 6	860.6924	830.3110	952.4051	1139.4992	-5.14 (32057)	< 0.0001	-4.25 (2054)	< 0.0001
6 ≤ 7	762.0609	740.3116	827.7155	909.5554	-3.91 (32336)	< 0.0001	-2.57 (2064)	0.010
7 ≤ 8	688.7810	663.4092	765.3708	843.1272	-4.74 (31953)	< 0.0001	-2.82 (2060)	0.005
8 ≤ 9	611.9695	581.6375	703.5329	730.7103	-5.92 (31393)	< 0.0001	-2.50 (2061)	0.013
9 ≤ 10	539.8247	517.4961	607.2279	648.9525	-4.66 (31722)	< 0.0001	-2.33 (2061)	0.020
10 ≤ 11	512.4551	482.0673	604.1867	648.9525	-6.39 (30971)	< 0.0001	-2.96 (2054)	0.003
11 ≤ 12	461.4997	430.3513	555.5274	613.1834	-6.84 (30635)	< 0.0001	-3.33 (2049)	0.001
12 ≤ 13	280.6332	255.5578	356.3282	470.1073	-6.86 (29768)	< 0.0001	-4.44 (2028)	< 0.0001

Note: OOHHC = Out-of-home care.

Table 3

Rates of at least one mental health hospitalization per 10,000 per age-band, for children (A) unknown to child protection services, (B) known to child protection services, and (C) with at least one OOHC placement before age 13 years.

Age band (Years)	Rates of separation per 10,000				Difference tests (A vs B)		Difference tests (A vs C)	
	All	A	B	C	t-value(df)	p value	t-value(df)	p value
0 ≤ 1	15.8920	14.7760	19.2610	30.6592	−1.28 (30384)	0.200	−1.26 (2019)	0.208
1 ≤ 2	9.2073	8.3955	11.6580	15.3296	−1.21 (29707)	0.228	−0.78 (2027)	0.437
2 ≤ 3	4.4145	3.6940	6.5893	10.2197	−1.46 (27425)	0.146	−0.90 (2003)	0.369
3 ≤ 4	4.2883	2.6865	9.1236	20.4394	−2.86 (23692)	0.004	−1.73 (1973)	0.083
4 ≤ 5	3.4054	2.0149	7.6030	15.3296	−2.73 (23286)	0.006	−1.50 (1973)	0.133
5 ≤ 6	3.9099	2.3507	8.6168	25.5493	−2.87 (23394)	0.004	−2.03 (1968)	0.043
6 ≤ 7	2.7748	1.1754	7.6030	40.8789	−3.19 (21783)	0.001	−2.75 (1960)	0.006
7 ≤ 8	4.2883	2.6865	9.1236	20.4394	−2.86 (23692)	0.004	−1.73 (1973)	0.083
8 ≤ 9	5.4235	2.1828	15.2060	61.3183	−4.59 (21635)	< 0.0001	−3.35 (1961)	0.001
9 ≤ 10	4.7928	1.1754	15.7129	45.9888	−5.09 (20715)	< 0.0001	−2.93 (1959)	0.003
10 ≤ 11	5.6757	2.3507	15.7129	56.2085	−4.63 (21717)	< 0.0001	−3.18 (1961)	0.002
11 ≤ 12	6.3064	2.6865	17.2335	66.4282	−4.80 (21802)	< 0.0001	−3.47 (1961)	0.001
12 ≤ 13	4.9190	2.0149	13.6854	40.8789	−6.86 (29768)	< 0.0001	−2.69 (1962)	0.007

Note: OOHC = Out-of-home care.

population at 0 ≤ 1 years (at 0 ≤ 1 years, mental health separations were predominantly for sleep disorder, and in the early childhood years (1 ≤ 5 years) the most prominent diagnoses were sleep disorders, developmental disorders including autism, and oppositional defiant/conduct disorders. There was no consistent trend in the population rate for children hospitalized for mental health reasons according to child protection status. The most marked similarities were a reduction in rates among all children between 0 ≤ 1 years and 1 ≤ 2 years, with a divergence in rates from age 3 ≤ 4 years and again from 8 ≤ 9 years for all children known to child protection services as well as for children in OOHC, relative to children unknown to child protection services. The difference in separation rates was significantly higher from 3 ≤ 4 years for children known to child protection services and at 5 ≤ 6 years, 6 ≤ 7 years, and from 8 ≤ 9 years for children in OOHC, compared to those unknown to child protection services (Table 3).

Peak rates of children hospitalized for mental health reasons varied across sub-groups. As shown in Table 3, peak rates occurred in the first two years of life for children unknown to child protection services (14.8 and 8.4 children with separations per 10,000 population, respectively), at 0 ≤ 1 and 11 ≤ 12 years for all children known to child protection services (19.3 and 17.2 children per 10,000 population, respectively), and at 11 ≤ 12 years and 8 ≤ 9 years for children placed in OOHC (66.4 and 61.3 children per 10,000 population, respectively) (Fig. 2b). The rates of children hospitalized for mental health reasons at 8 ≤ 9 and 11 ≤ 12 years in children unknown to child protection services (2.2 and 2.7 children per 10,000 population respectively) were more than 25-fold less than for children ever placed in OOHC. Meanwhile, the rate of children hospitalized for mental health reasons at 0 ≤ 1 years in children unknown to child protection services was just over half that for children ever placed in OOHC (30.7 children per 10,000 population).

3.3. Mean annual costs of hospitalization per child

The mean annual costs of hospitalization per child for each age-band, according to the reason for hospitalization, are illustrated in Fig. 3, for the full sample (A), and according to child protection status (B). Tests of differences in sub-group mean costs per child by age-band, for physical health and mental health separations, are presented in Tables 4 and 5, respectively.

The mean annual costs per child for physical health hospitalizations reduced with increasing age (Fig. 3). Mean costs per child were significantly greater for children known to child protection services and those ever placed in OOHC, compared with children unknown to child protection services, for all age-bands (Table 4). Point estimates of the mean costs per child for physical health hospitalizations were somewhat higher for children ever placed in OOHC, relative to all children known to child protection services, except for the age bands 9 ≤ 10 years to 11 ≤ 12 years (e.g. AUD362 for children placed in OOHC and AUD381 for children known to child protection services at 9 ≤ 10 years) (Table 4).

The mean annual costs per child for mental health hospitalizations showed two apparent trends by age-band; 0 ≤ 5 years (“decreasing”), and > 5 years (“increasing”) (Fig. 3a). The decrease between 0 ≤ 5 years was primarily driven by the children unknown to child protection services (Fig. 3b; Table 5). The increase in mean costs per child for the entire sample from > 5 years was driven by increases for children known to child protection services, particularly those ever placed in OOHC. Significant differences in mean costs per child for mental health hospitalizations were found for children known to child protection services and children ever placed in OOHC compared with those unknown to child protection services, with the most marked differences occurring from 8 ≤ 9–10 ≤ 11 years. Point estimates of mean costs per child for mental health hospitalizations were always highest for OOHC, followed by children known to child protection services in each age-band. However, several age-bands (particularly 3 ≤ 4 years) appear to be critical for children known to child protection services but not placed in OOHC based on comparisons of these groups presented in Table 5.

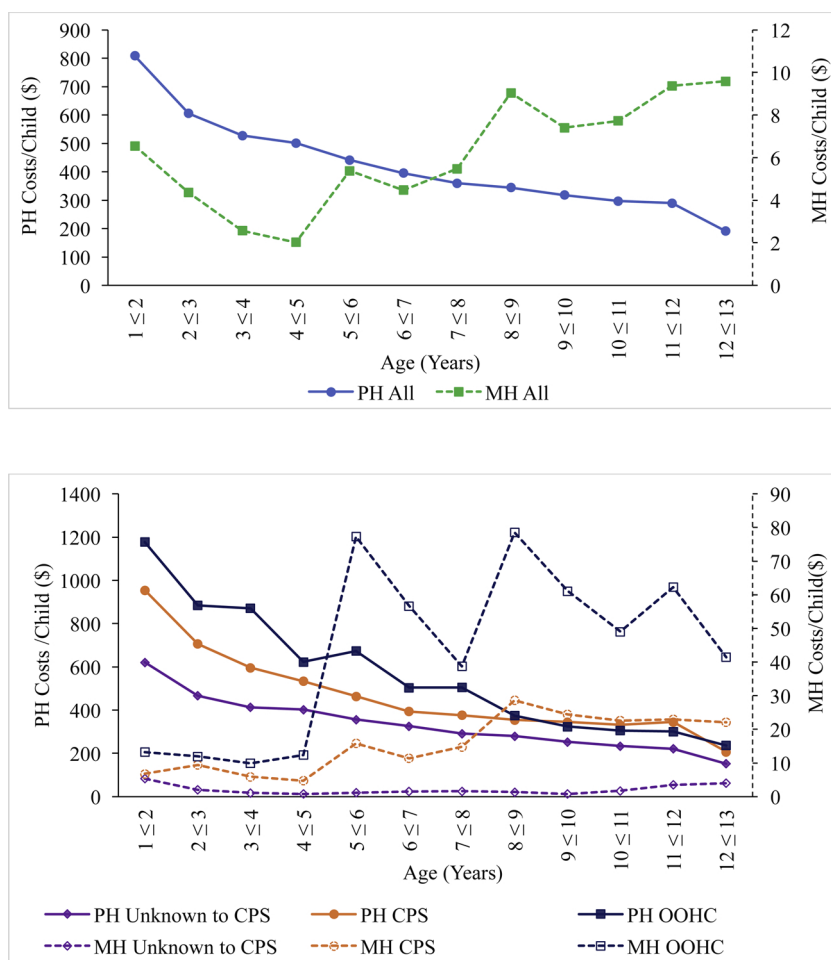


Fig. 3. Population mean costs per child for all, physical health and mental health separations by age-band (A), and by age-band and child protection status (B) from 1 year, NSW-CDS Sample (N = 79,285) (2015-16 AUD).

Abbreviations: CPS = Child Protection Services; MH = mental health; OOHC = out-of-home care; PH = physical health; AUD = Australian dollars; \$ = Australian dollars.

Data for children 0 ≤ 1 year of age were not displayed given scaling issues.

3.4. Number of children hospitalized and mean annual costs of hospitalization per admitted child

The number of children hospitalized and mean annual costs per admitted child, according to age-band and child protection status, are illustrated in Fig. 4, and detailed in Supplementary Tables 2, 3 and 4 for all separations, physical health separations, and mental health separations respectively. Tests of differences in mean annual costs for physical and mental health hospitalizations per admitted child are presented in Table 6 (for all children) and Table 7 (according to child protection status).

From 1 ≤ 2 years onwards the proportions of children hospitalized who were known to child protection services and ever placed in OOHC were higher than expected based on sample distribution (24.9 % and 2.5 % respectively; Table 1 and Supplementary Table 2). Proportions were maximal at 12 ≤ 13 years, when these groups comprised 32.0 % (721/2251) and 4.3 % (97/2251) of children with separations (1.3- and 1.7-fold greater than expected, respectively, based on population composition). A similar pattern was observed for physical health separations (Supplementary Table 3), and is reflected above in the rates of children hospitalized (Fig. 2).

Of the 535 children hospitalized for mental health reasons, 277 (51.8 %) were unknown to child protection services, 258 (48.2 %) were known to child protection services, and 67 (12.5 %) had been placed in OOHC (Supplementary Table 4). Mental health separations in turn occurred in 0.5 % (277/59566), 1.3 % (258/19729) and 3.4 % (67/1957) of the respective populations during the first 13 years of life (Supplementary Tables 2 and 4). At 0 ≤ 1 years children known to child protection services comprised 30.2 % of children with all mental health separations (38/126) (Supplementary Table 2), and 68.0 % at 11 ≤ 12 years (34/50). Higher proportions, up to 81.6 % (3.3-fold greater than expected) were reached after 8 ≤ 9 years but cannot be delineated given restrictions on reporting small cell sizes. Up to 26.0 % of the children known to child protection services and hospitalized for mental health reasons were children placed in OOHC during the study period (67/258).

Table 4

Population mean costs for physical health hospital separations per age-band, for children (A) unknown to child protection services, (B) known to child protection services, and (C) with at least one OOHC placement before age 13 years (2015-16 AUD), based on boot-strapped samples.

Age band (Years)	Mean annual costs per child (AUD)			Difference tests (A vs B)		Difference tests (A vs C)	
	A (n = 59556)	B (n = 18656)	C (n = 1956)	Bootstrapped t-statistic	p value	Bootstrapped t-statistic	p value
0 ≤ 1	6776	8691	12,015	−262.45	< 0.0001	−174.52	< 0.0001
1 ≤ 2	728	1053	1316	−197.63	< 0.0001	−139.88	< 0.0001
2 ≤ 3	548	779	989	−189.73	< 0.0001	−153.38	< 0.0001
3 ≤ 4	485	658	973	−151.75	< 0.0001	−68.29	< 0.0001
4 ≤ 5	472	589	696	−104.70	< 0.0001	−90.09	< 0.0001
5 ≤ 6	418	511	753	−109.45	< 0.0001	−82.66	< 0.0001
6 ≤ 7	383	435	563	−72.08	< 0.0001	−71.03	< 0.0001
7 ≤ 8	341	415	564	−92.61	< 0.0001	−61.30	< 0.0001
8 ≤ 9	328	391	418	−81.24	< 0.0001	−44.01	< 0.0001
9 ≤ 10	297	381	362	−71.72	< 0.0001	−48.68	< 0.0001
10 ≤ 11	274	365	341	−141.48	< 0.0001	−45.12	< 0.0001
11 ≤ 12	260	381	336	−115.09	< 0.0001	−51.27	< 0.0001
12 ≤ 13	179	228	264	−75.34	< 0.0001	−67.41	< 0.0001

Note: AUD = Australian dollars.

Table 5

Population mean costs for mental health hospital separations per age-band, for children (A) unknown to child protection services, (B) known to child protection services, and (C) with at least one OOHC placement before age 13 years (AUD 2015-16), based on boot-strapped samples.

Age band (Years)	Mean annual costs per child (AUD)			Difference tests (A vs B)		Difference tests (A vs C)	
	A (n = 277)	B (n = 258)	C (n = 67)	Bootstrapped t-statistic	p value	Bootstrapped t-statistic	p value
0 ≤ 1	17	24	25	−16.99	< 0.0001	−26.03	< 0.0001
1 ≤ 2	6	7	15	−20.08	< 0.0001	−34.97	< 0.0001
2 ≤ 3	2	10	13	−42.65	< 0.0001	−67.59	< 0.0001
3 ≤ 4	1	7	11	−75.09	< 0.0001	−27.25	< 0.0001
4 ≤ 5	1	5	14	−51.42	< 0.0001	−51.23	< 0.0001
5 ≤ 6	1	17	86	−99.91	< 0.0001	−117.60	< 0.0001
6 ≤ 7	2	13	63	−64.13	< 0.0001	−50.76	< 0.0001
7 ≤ 8	2	16	43	−107.83	< 0.0001	−75.16	< 0.0001
8 ≤ 9	2	32	88	−131.01	< 0.0001	−110.17	< 0.0001
9 ≤ 10	1	27	68	−113.17	< 0.0001	−142.72	< 0.0001
10 ≤ 11	2	25	55	−111.07	< 0.0001	−125.71	< 0.0001
11 ≤ 12	4	25	70	−113.75	< 0.0001	−92.68	< 0.0001
12 ≤ 13	5	24	46	−98.28	< 0.0001	−77.63	< 0.0001

Note: AUD = Australian dollars.

The mean annual costs per child admitted ranged from \$5107 at 4 ≤ 5 years to \$7674 in the first year of life (Supplementary Table 2). Mean annual costs per child admitted for physical health reasons similarly ranged from \$5098 at 4 ≤ 5 years to \$7655 in the first year of life (Table 6, Supplementary Table 3). However, the mean annual costs per child admitted for mental health reasons ranged from \$5932 at 4 ≤ 5 years to \$19,489 at 12 ≤ 13 years (Table 6, Supplementary Table 4). Mean annual costs per child admitted for mental health reasons were always higher than the mean annual costs per child admitted for physical health reasons across each age-band (Table 6).

Across the child protection sub-groups, the mean annual costs per child admitted were also highest during the first year of life overall (Supplementary Table 2), and overall for physical health reasons (Table 7, Supplementary Table 3). Mean costs for physical health reasons were significantly higher for those ever placed in OOHC and all those known to child protection services as compared with children unknown to child protection services (\$13,129; \$9191 and \$7147 respectively; Table 7, Supplementary Table 3). Mean costs per child admitted for physical health reasons differed between child protection sub-groups at all ages (Table 7); however, from 9 ≤ 10 years these costs were lowest for children ever placed in OOHC, and at 12 ≤ 13 years highest in children unknown to child protection services (Fig. 4). Differences were not, however, marked in absolute terms, at most \$5982 during the first year of life between children in OOHC and children unknown to child protection services.

The mean annual costs per child admitted for mental health reasons displayed more volatility than for physical health separations (Fig. 4), and were significantly different between children known to child protection services and those ever placed in OOHC compared with children unknown to child protection services, except for children ever placed in OOHC at 6 ≤ 7 years ($p = 0.67$)

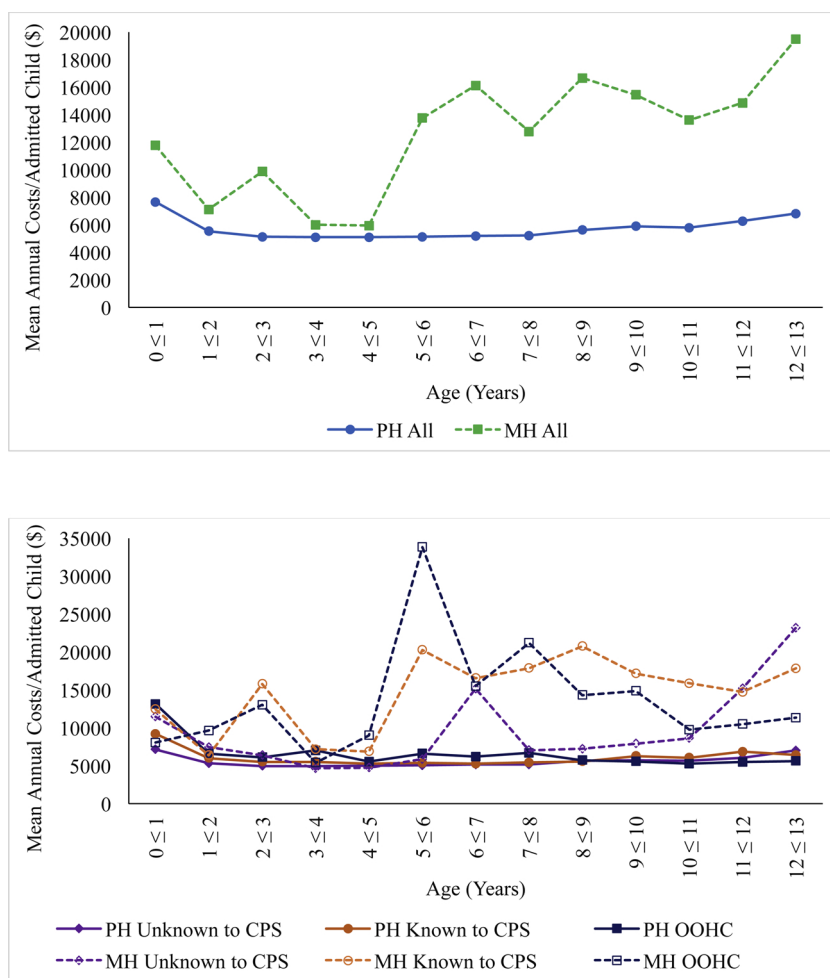


Fig. 4. Mean annual costs per child admitted for physical health (PH) and mental health (MH) separations by age-band (A), and by age-band and child protection status (B) (2015-16 AUD).

Abbreviations: CPS = Child Protection Services; MH = mental health; OOHHC = out-of-home care; PH = physical health; AUD = Australian dollars; \$ = Australian dollars.

Table 6

Tests for differences in mean annual costs per admitted child for physical health and mental health separations (all children).

Age band (Years)	Physical Health			Mental Health			Bootstrapped	
	Costs (AUD)	Standard Error	Number	Costs (AUD)	Standard Error	Number	t-statistic	p-value
0 ≤ 1	7655	61	75,117	11,767	1994	126	-41.77	< 0.0001
1 ≤ 2	5526	94	11,605	7111	771	73	36.71	< 0.0001
2 ≤ 3	5124	86	9365	9875	2593	35	20.62	< 0.0001
3 ≤ 4	5101	96	8204	5996	1077	34	-5.39	< 0.0001
4 ≤ 5	5098	99	7798	5932	1538	27	28.39	< 0.0001
5 ≤ 6	5129	93	6824	13,756	2767	31	-8.89	< 0.0001
6 ≤ 7	5192	118	6042	16,118	4165	22	-64.80	< 0.0001
7 ≤ 8	5223	106	5461	12,780	2051	34	-66.95	< 0.0001
8 ≤ 9	5623	152	4852	16,668	2597	43	-73.69	< 0.0001
9 ≤ 10	5887	175	4280	15,451	2783	38	-56.16	< 0.0001
10 ≤ 11	5789	114	4063	13,602	2214	45	-50.02	< 0.0001
11 ≤ 12	6278	189	3659	14,858	1782	50	-94.48	< 0.0001
12 ≤ 13	6815	276	2225	19,489	2911	39	-63.48	< 0.0001
Grand Mean	12,333	89	79,275	13,731	973	535	146.35	< 0.0001

Note: AUD = Australian dollars.

Table 7

Tests for difference in mean annual costs per admitted child for children (A) unknown to child protection services, (B) known to child protection services, and (C) with at least one OOHC placement before age 13 years, based on bootstrapped samples.

Age band (Years)	Physical Health (3 subgroup data as per Supplementary Table 3)				Mental Health (3 subgroup data as per Supplementary Table 4)			
	A v B		A v C		A v B		A v C	
	Bootstrapped t-statistic	p value	Bootstrapped t-statistic	p value	Bootstrapped t-statistic	p value	Bootstrapped t-statistic	p value
0 ≤ 1	-321.11	< 0.0001	-258.73	< 0.0001	-5.97	< 0.0001	37.64	< 0.0001
1 ≤ 2	-97.83	< 0.0001	-84.71	< .0001	26.95	< 0.0001	-18.86	< 0.0001
2 ≤ 3	-83.97	< 0.0001	-90.05	< .0001	-45.65	< 0.0001	-58.10	< 0.0001
3 ≤ 4	-83.22	< 0.0001	-56.26	< .0001	-39.52	< 0.0001	-6.89	< 0.0001
4 ≤ 5	-35.49	< 0.0001	-35.49	< .0001	-24.82	< 0.0001	-33.57	< 0.0001
5 ≤ 6	-50.83	< 0.0001	-62.14	< .0001	-102.43	< 0.0001	-135.04	< 0.0001
6 ≤ 7	-14.42	< 0.0001	-51.30	< .0001	-3.79	0.0002	0.42	0.6728
7 ≤ 8	-37.08	< 0.0001	-50.70	< .0001	-98.82	< 0.0001	-71.29	< 0.0001
8 ≤ 9	9.11	< 0.0001	-5.11	< .0001	-114.80	< 0.0001	-69.31	< 0.0001
9 ≤ 10	-37.36	< 0.0001	11.95	< .0001	-76.81	< 0.0001	-72.86	< 0.0001
10 ≤ 11	-44.35	< 0.0001	26.59	< .0001	-65.58	< 0.0001	-14.86	< 0.0001
11 ≤ 12	-59.33	< 0.0001	29.59	< .0001	5.87	< 0.0001	47.89	< 0.0001
12 ≤ 13	37.16	< 0.0001	64.42	< .0001	25.51	< 0.0001	56.60	< 0.0001
Grand Mean	-264.91	< 0.0001	-273.09	< 0.0001	-126.63	< 0.0001	-92.03	< 0.0001

(Table 7). Differences in mean costs per admitted child for mental health reasons between child protection status sub-groups peaked at \$27,951 for children ever placed in OOHC and children unknown to child protection services at $5 \leq 6$ years (\$33,818 - \$5687; see Supplementary Table 4).

3.5. Excess costs associated with child protection contact

The excess costs of hospitalization associated with child protection contact was estimated to be \$3576 (\$15,111–\$11,535) over the first 13 years of life undiscounted; \$3348 when discounted at 3 % and \$3224 when discounted at 5 % (Supplementary Table 2). The excess costs of hospitalization associated with OOHC placement were estimated at \$8654 (\$20,189–\$11,535) undiscounted, \$8220 when discounted at 3% and \$7980 when discounted at 5 %.

4. Discussion

This study provides the first detailed assessment of rates of physical and mental health hospitalizations and costs trajectories for a child population cohort according to child protection status, and an estimate of excess costs among children with child protection notifications across the first 13 years of life. For physical health separations, we found decreasing rates of hospitalization and costs per child with increasing age for all children regardless of child protection status; however, rates of physical health separations were always higher among children with child protection involvement from $1 \leq 2$ years, and mean population costs for physical health separations were significantly higher for children known to child protection services and those with an OOHC placement, compared with children unknown to child protection services. This finding was in part due to higher costs per admitted child in the first eight years of life for children known to child protection services and those ever placed in OOHC. Mental health separations occurred in 0.5 %, 1.3 %, and 3.4 % of children unknown and known to child protection services, and those ever placed in OOHC, respectively. Children known to child protection services comprised almost half of all children with mental health separations, and children with OOHC placement comprised one eighth; this is, respectively, 2-fold and 5-fold greater than children who did not have contact with child protection services. Rates and mean costs of mental health separations per child initially decreased, then increased with age. This was driven by significantly greater rates of mental health hospitalizations among children known to child protection services from $3 \leq 4$ years, with a sharp increase at $8 \leq 9$ years and consistently greater rates from this point onwards in children with OOHC placement, and significantly higher costs per admitted child in those known to child protection services between $2 \leq 3$ years and $10 \leq 11$ years, compared to those unknown to child protection services. Overall, the higher rates of separations for both physical health (all years) and mental health (from age 3 years) among children known to child protection services is consistent with findings from Western Australia (O'Donnell et al., 2010) and from the first systematic assessment of the costs of maltreatment from the US (Florence et al., 2013). However, we did not always find higher expenditures per case as in the US (Florence et al., 2013), which is reflected in both physical health costs per admitted child at $12 \leq 13$ years and mental health costs per admitted child from $11 \leq 12$ years. For children ever placed in OOHC, the most striking findings included the highest mean annual cost for physical health admissions for any sub-group and age-band at \$13,120 in the first year of life, and the highest mean annual cost for mental health admissions (\$33,818 at age $5 \leq 6$ years).

Costs of hospitalization associated with child protection contact over the first 13 years of life (when discounted at 5 %) were greater than for children without child protection contact (estimated at \$3224), and even greater for children with an OOHC

placement (estimated at \$7980). This finding is in stark contrast to the previously estimated short-term health costs of \$36 per maltreated Australian child (McCarthy et al., 2016), which was based on costs due to injury (inclusive of hospitalizations). Meanwhile, in the US, Fang et al. (2012), estimated short-term health care costs of maltreatment at \$32,648 (United States Dollars) only for those aged between 6 and 17 years, on the basis that the median case age was 6 years. However, our data suggest that around 80 % of health costs up to age 13 years are incurred in the first six years, suggesting a potentially significant underestimation in published US data (Fang et al., 2012). Current assessments of the short-term costs of maltreatment are thus greatly underestimated, and may be undermining the potential value ascribed to early intervention strategies. Our findings also support the need for longitudinal individual level analysis to assess the costs of maltreatment in Australia and elsewhere, using linked administrative data where possible (Courtney, 1999).

The reducing rates of hospitalization and costs per child for all separations, and physical health separations, are largely consistent with a modelled analysis from Canada (Forget, Roos, Deber, & Walld, 2008), as well as a simulated analysis from the US (Alemayehu & Warner, 2004), and cross-sectional analysis from the Netherlands (Meerding, Bonneux, Polder, Koopmanschap, & van der Maas, 1998). However, age-associated reductions in physical health separations (and costs per child) irrespective of child protection status has not been previously reported. The high costs of physical health separations in the first year of life among children known to child protection services, particularly those with an OOHC placement, is consistent with high expenditures in children first reported to child protection services at 0–2 years as identified in US Medicaid data (Campbell et al., 2016). Together, these results suggest the need to ascertain specific factors accounting for differences in early-life health care costs for children reported to child protection services, which may serve as opportunities for the provision of targeted healthcare support.

In sum, these Australian data are generally consistent with several studies from the US which have reported increased costs of inpatient care and non-inpatient psychiatric care among maltreated children (Florence et al., 2013), and increased mental health care (not limited to hospitalizations) for children placed in OOHC (Clark et al., 2011) and among those with mental disorder diagnoses (Campbell et al., 2016). Furthermore, health service use and expenditure in the US have been shown to increase with age, based on cross-sectional analysis, with mean mental health costs reported to be 23 % higher for children aged 10 years than children aged 4 years with positive expenditures (Clark et al., 2011). In contrast, we found rates of mental health separations per 10,000 children 3.7-fold higher at $10 \leq 11$ years than at $4 \leq 5$ years among children ever placed in OOHC, while the costs per admitted child were 8 % higher. These results should be viewed in light of marked increases in the rate of mental health presentations at $3 \leq 4$ years and $8 \leq 9$ years in all children known to child protection services, consistent with our findings of a 3-fold increase in risk of mental disorder diagnoses (of any kind) between the ages of 6–13 years, among children known to child protection services by age 5 years, relative to children with no such contact (Green, Hindmarsh et al., 2019). Since most mental health conditions begin in childhood (Kessler et al., 2007), and have long-term trajectories and pervasive impacts (Gilbert et al., 2009; Neil, Carr, Mihalopoulos, Mackinnon, & Morgan, 2014), it is imperative that policy and practice of human service agencies acknowledge this strong link between childhood maltreatment and the development of mental disorders.

While this study represents the most comprehensive longitudinal analysis of the short-term costs associated with ‘child maltreatment’ published to date, capturing systematic differences in morbidity patterns, socio-economic status and service use by child protection status, there are several limitations which should be noted. First, health costs have been conservatively estimated, with the use of public sector costs only, irrespective of sector of provision (public/private). Second, in using Round 17 costs only of the National Hospital Costs Data Collection, we have effectively assumed no technological change or no change in relative prices in services provided over the study period; (undiscounted) cost differences are thus solely attributable to differences in utilisation. Third, this study was restricted to severe health conditions requiring hospitalization, and thus does not capture total short-term health costs, particularly costs associated with milder forms of illness. Fourth, we have not considered the onset of health conditions relative to the age of first child protection reporting and/or OOHC placement/s, that may be relevant to understanding the health impact of cumulative harm. However, we note that the vast majority of children who entered OOHC in the NSW-CDS cohort had their first placement within the first year of life (73 %: see these and other characteristics of children placed in OOHC in (Green, Hindmarsh et al., 2019)). Fifth, we chose not to restrict child protection status to substantiated reports given that resource limitations of Australian child protection agencies often preclude the capacity for case-workers to follow-up many reports (up to 70 % of those received) that reach threshold for ‘risk of significant harm’ (i.e., the threshold required for further to follow-up in which a report is substantiated or not). Furthermore, recent evidence suggests that there are no significant differences in developmental and mental health outcomes between groups of children with substantiated and unsubstantiated child protection reports (Hussey et al., 2005; Kohl, Jonson-Reid, & Drake, 2009), as per recent reports of associated health admissions and economic costs (Florence et al., 2013; Lanier et al., 2010). Sixth, we have limited our analysis to the age 13 years, due to data limitations associated with the need for prospective data collection after the establishment of the cohort. Finally, we recognise the inherent limitations of using administrative data as a proxy for prevalence for mental health treatment given that utilisation of mental health resources and exposure to the child protection system may be bidirectional. In particular, exposure to the child protection system may itself increase mental health costs given that children in OOHC are likely to have greater access to services than similar children in the general population, while children who are receiving mental health interventions may also be more exposed to the child protection system than similar children who are not being treated.

5. Conclusion

Longitudinal assessment of the short-term costs of severe health impacts in children known and unknown to child protection services in the Australian state of NSW shows decreasing total costs and costs for physical health separations per child from birth until

13 years, with significantly higher costs for children known to protection services. Increases in rates of children experiencing mental health hospitalizations and costs per child were evident at $3 \leq 4$ years and $8 \leq 9$ years, with point estimates highest among children with at least one OOHC placement (relative to all children known to child protection services) suggesting critical periods for the onset and/or identification of mental disorders among children known to child protection services. The net present value of excess short-term costs was assessed at \$3224 per child exposed to child protection contact over the first 13 years of life. Children known to child protection services, 25 % of this population cohort, comprised almost half of all children with mental health separations across childhood, which is 2-fold greater than expected. Mental health separations for OOHC children, 2.5 % of the cohort, were 5-fold greater than expected. It is therefore imperative that the mental health care of children known to child protection services be given a very high priority in order to avert the major long-term sequelae implicit in this early morbidity.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.chiabu.2019.104280>.

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