University of South Australia

Causal Inference in the AEDC

- Analysis of the impact of ECEC attendance on Child Development

Commissioned Report for Playgroup Australia

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Contents

Contents 3
Foreword 4
Introduction 6
Background 6
Early Childhood Education and Care (ECEC) in Australia 6
ECEC and early childhood development 7
Causal impact of ECEC programs 8
Method 10
Data Source, outcomes, exposures, and confounders 10
Causal Inference 11
Parametric G-Formula 11
Results 12
Sample characteristics 12
Model results 15
Discussion 17
Conclusion 21
References 22
Appendix A 24
Appendix B 25

Foreword

It is with pleasure that I share this research from the University of South Australia about the impact of playgroup attendance on children's learning and development outcomes.

Building on previous research using the 2021 Australian Early Development Census (AEDC), this piece achieves two things; it strengthens the evidence base about the benefits of playgroup; and it identifies what mixes of early childhood intervention (preschool, playgroup and day care) stack the odds in favour of children starting school developmentally on track. It does this with the use of causal modelling. Causal modelling provides a framework for attributing causation using observational data, without the need for randomised controlled trials. It is a technique well-established in health, but is relatively novel in early childhood policy research, particularly in Australia.

In this report, the researchers examine the causal impact of children's attendance in daycare, preschool, and playgroups, as well as combinations of these prior to the child's first year of formal school, on developmental vulnerabilities and strengths by applying the technique of g-computation. This allows the researchers to assess the causal impact of children's exposure to different Early Childhood Education and Care (ECEC) services and offers realistic estimates of outcomes if such ECEC programs were to be adopted system wide. This in turn allows us to evaluate the causal effect of ECEC attendance on child development as measured by the AEDC as if we have conducted a Randomised Control Trial (RCT).

RCTs are held up as the gold standard for research, but they are difficult and expensive to implement. They are premised on the need for one group to receive the intervention and another group with exactly the same attributes to not receive it. For early childhood interventions like preschool, playgroup and day care, RCTs pose significant ethical challenges; imagine telling one family they can come to playgroup, and another they can't, because they are needed for the 'null hypothesis'!

Causal modelling, using the AEDC data, allows us the insights of an RCT without having had to run one.

I am very pleased to share this research, which finds that:

- Playgroup attendance reduces the risk of being developmentally vulnerable on one or more domains by 40%, and developmentally vulnerable on two or more domains by 50%, a result similar to preschool.
- Attending any intervention, (i.e. preschool, playgroup or day care) reduces the risk of developmental vulnerability, but a combination of playgroup and preschool reduces the risk the most, by 60% for developmentally vulnerable on one or more domains and by 70% for developmentally vulnerable on two or more domains.

- The intervention/s which shows the largest benefit is attending playgroup and preschool together, which increases the chances of being developmentally on track on all five domains by 1.7 times.
- Preschool on its own, and playgroup on its own increase the chances of being developmentally on track on all five domains by 1.4 times. Day care increases the chances by a more modest 1.2 times.

In a context of increasing Government focus on early childhood, and, in particular, a focus on closing the gaps in outcomes and access to ECEC, this research contributes valuable insights to the discussion.

I commend this report to policy makers and communities to ensure their children have access to the services which stack the odds in favour of children's optimal learning and development.

Felicity Dunn

Chair, Playgroup Australia

Introduction

Background

The early years of a child's life are fundamental to their ongoing development and long-term wellbeing. The skills and capabilities with which each child begins school form the foundation for their school experience, predicting their school achievement as well as longer term outcomes such as their attainment of further education, stable employment, and physical and mental wellbeing (1, 2).

A complex mix of individual, family and social factors influence a child's development. Children born into families experiencing socioeconomic disadvantage or other challenges are much more likely to be developmentally vulnerable on one or more domains (3-5). However, an increasing wealth of evidence shows that children provided with stimulating play and learning opportunities in early childhood are more likely to thrive, irrespective of their family circumstances (6, 7).

In Australia, the primary indicator of child development is through the Australian Early Development Census (AEDC). Conducted once every three years, the AEDC provides a population-wide snapshot of Australian children's development within the first formal year of the child's full-time schooling. Completed in schools by the child's teacher, the AEDC measures five key developmental domains; physical health and wellbeing, social competence, emotional maturity, language and cognitive skills (school-based), and communication skills and general knowledge. On each of these domains, developmental level is then classified as *developmentally vulnerable, developmentally at risk,* or *developmentally on track*. Contextual information for each child, including demographic, and geographic data, care arrangements, and participation in early childhood education programs prior to starting school, is also collected (8).

Early Childhood Education and Care (ECEC) in Australia

In Australia, latest statistics estimate approximately ninety per cent of children participate in some form of early childhood education and care (ECEC), including playgroup, childcare and preschool. However, participation rates differ by socioeconomical factors, area, and cultural and linguistic factors (9, 10). Providers of ECEC programs include government and community organisations, private (for-profit) companies, and schools. Providers, particularly of preschool, varying significantly between jurisdictions (11). Preschool in Australia is subsidised for all children in the year before they start school (at fifteen hours per week). NSW and Victoria further have universal subsidised preschool programs beginning two years before the start of school (and thus entering preschool around the age of 3 years), with South Australia in the process of implementing following recommendations of the Royal Commission into ECEC. Daycare is subsidised by the federal government at varying levels dependent on family income.

Preschool, also sometimes referred to as kindergarten, is generally defined as structured play-based educational programs delivered to children between three and five years old by qualified early childhood teachers. Daycare and preschool in Australia are both regulated by the National Quality Framework (NQF), including the Early Years Learning Framework (EYLF) which guides curriculum and pedagogy (12), however daycare offerings are much more varied, ranging from small family daycare to large centres, catering to children from six weeks of age, and incorporating a range of modes of delivery, duration, and level of training of educators.

In contrast, playgroups are a form of ECEC specifically designed to include both children and their parents/carers in play and social activities. Playgroups are regular informal gatherings that provide a flexible and supportive environment for young children and their parents to socialise, play, and learn together. Playgroup offerings in Australia are diverse and take place in a range of settings; they may be community or service-based, led by parents or paid facilitators, and be targeted broadly or for particular groups. The Australian federal and all state and territory governments provide funding support to playgroups, although there is much variation in funding level, mechanism and target (9). In Tasmania, a universal playgroup offering, 'Launch into Learning' (LiL), is provided by the Department for Education, Children and Young People for children from birth to five years old. These are weekly sessions, guided by a trained early childhood teacher, and offered at every government primary school in the state.

ECEC and early childhood development

The relationship between various modes of early childhood education and care on children's early development has been widely investigated, both within the Australian context and globally. Preschool has generally been found to be beneficial to children's early development, with outcomes varying by program quality, dosage (length of time attended), intensity (hours per day/week) and the sociodemographic characteristics of families (13, 14). Daycare has been more varied in association with various aspects of early development; and as with preschool, outcomes varied with the quality, dosage and intensity of daycare and sociodemographic factors (15). Although playgroups also encompass a diverse range of offerings (for example, as mentioned above, in format, focus, and whether professionally- or parent-led), research into playgroups has consistently found them to be associated with benefit for children's development as well as for caregivers and families more broadly (16).

Most studies of ECEC and development have focused on a single mode of ECEC. Some studies have considered more than one mode, usually daycare and preschool, but comparisons have tended to focus on quality and access (for example, see E4kids summary report (17)). There has been relatively little research specifically comparing how various modes of ECEC differ with regards to early developmental outcomes. An interesting exception, utilising the longitudinal study of Australian

children (LSAC) linked to the 2009 AEDC collection, considered children's attendance at preschool, long daycare without preschool, or neither, at each of 3 years and 4 years of age. After adjusting for sociodemographic factors, those who had attended long daycare without preschool at both 3 and 4 years of age were almost twice as likely to be developmentally vulnerable on one or more domains than those who had attended preschool at both 3 and 4 years of age (18). Another Australian study, based on 2018 AEDC data, focused on the developmental domains of language and cognitive skills (school-based) and communication and general knowledge, finding that, irrespective of other factors, children who had attended preschool were more likely to be developmentally on track in those domains than those who did not, while those who had attended daycare were slightly more likely to be developmentally on track than those who did not (19).

More recent reports prepared for Playgroup Australia modelled the associations between attendance at playgroup, preschool and daycare in the year before starting school, and developmental vulnerability and strengths, utilising all AEDC data collections from 2012-2021 (9). After adjusting for sociodemographic factors, children who attended preschool were 80% more likely to be developmentally on track on all five domains than those who did not, and the those who attended playgroup were 50% more likely to be developmentally on track on all five domains than those who did not. There was a small negative association between daycare attendance and being on track on all five domains. However, this analysis did not specifically consider combinations of attendance types and, as with the previously mentioned studies, the findings were unable to imply a causal relationship as attendance to ECEC programs was not randomised. As it is known that children from families of high socioeconomic background and educational ambition for their children are more likely to send their children to ECEC services, it is difficult to disentangle the impact of the ECEC services on child development versus the impact of family background without more advanced statistical analysis techniques.

Causal impact of ECEC programs

While the relationships between modes of ECEC and child development have been widely explored, limited work has been done to establish causal relationships between ECEC and later outcomes. To determine causality generally requires a Randomised Control Trial (RCT), whereby children (or communities) are randomly allocated to receive the ECEC supports of not. This randomisation removes the influence of confounding variables, ensuring that differences in outcomes between the groups are due to the ECEC program itself, rather than other factors. This controlled setup helps establish a cause-and-effect relationship (20). RCT's are not without their own limitations however, namely, they can be costly when compared to other evaluation methods, generalisability to out of trial populations can be difficult, and for longitudinal RCT's it can be difficult to manage participants over an extended period of time (21).

In the field of ECEC most Randomised Controlled Trials (RCT) have been undertaken outside of Australia, with high quality educational interventions in early childhood found to have largely positive benefits for children's development (See CESE report for overview (14)). Early RCTs tended to find strong effects, but more contemporary RCT's testing more specific aspects of early childhood learning have found more moderate impacts as both interventions and measurements have refined (13). There is however a theme of strong impact for children from poor or disadvantaged family environments where less of the holistic needs of the child are met (22, 23).

Recently, the statistical advent of causal modelling now provides a framework for attributing causation using observational data, without the need for randomised controlled trials. Developed over the last 30 years, causal methods (sometimes known as G-methods) allow for advanced confounding adjustment. These new techniques now present a great opportunity for statisticians and researchers to use previously collected data to infer causal inference for policy relevant research (24). Where RCTs may not be feasible, either due to cost or other factors, causal modelling can be applied to reasonably assess causation, and modelled results can be extrapolated to wider populations through emulation (21).

To date there have only been a few Australian studies applying statistical techniques to infer causal relationships of ECEC services from observational data. For example, Chor et al. (25) applied a difference-in-difference approach to estimate the impact of prekindergarten on four-year-olds' cognitive and socioemotional development. Using cohorts from before and after the elimination of a universal prekindergarten program in Queensland in 2007, and comparing to children in other states, this study found that universal prekindergarten improved children's school readiness, with socioemotional benefits for girls but not boys. Warren & Haisken-DeNew (26) applied a kernel matching technique to LSAC data and found that attending preschool had a significant positive effect on children's year 3 NAPLAN results, with the results also suggesting that those in the cohort who did not attend preschool would have received even higher benefits from attendance.

In this report, we examine the causal impact of children's attendance in daycare, preschool, and playgroups, as well as combinations of these prior to the child's first year of formal school, on developmental vulnerabilities and strengths by applying the technique of g-computation. G-computation, also known as G-formula or standardisation allows us to assess the causal impact of children's exposure to different ECEC services and offers realistic estimates of outcomes if such ECEC programs were to be adopted system wide. This allows us to evaluate the causal effect of ECEC attendance on child development as measured by the AEDC as if we have conducted a RCT.

Method

Data Source, outcomes, exposures, and confounders

Data for this study utilises the Australian Early Development Census (AEDC) unit level data. Data is available at aggregate level (https://www.aedc.gov.au/data-explorer/) or at unit level upon request (https://www.aedc.gov.au/). The AEDC is a triennial census of children in their first year of full-time schooling. The full census has been run nationally since 2009. For this analysis we utilise all data waves currently available from 2009 – 2021. Originally developed from the Early Development Instrument (EDI), the AEDC measures five domains of holistic child development, Language and Cognitive Skills (school-based), Communication skills and General Knowledge, Emotional Maturity, Social Competence, and Physical Health and Wellbeing. Teachers complete the checklist for each child, with a minimum requirement of having known the child for at least one month.

Primary outcomes for this study utilise three AEDC indicators of child development, the first two, Developmental vulnerable on one or more domains (DV1), and Developmental vulnerable on two or more domains (DV2), indicate that the child has scored in the bottom 10^{th} percentile in at least one or two or more domains respectively. The third indicator, developmentally on track on five domains (OT5) is defined as the child being developmentally on-track (25^{th} percentile and above) on all five domains and is a positive complement to DV1 and DV2.

In terms of exposure, the AEDC collects teacher reported attendance to various types of ECEC. In this analysis we use playgroup, preschool, and long daycare as our exposures of choice. Teachers respond according to their knowledge of the child's attendance in the year prior to their first year of full-time schooling. As teachers' knowledge of the child's attendance to these ECEC types are not always known, the teacher may also indicate 'don't know' as a valid response. For this study we censor all individuals where the teacher did not know the child's prior ECEC attendance pattern. Further work will look at unbiased methods to include 'don't know' responses to better improve precision of causal estimates.

We considered the following confounders of outcome and exposure a priori: Socio-Economic Status (SES), as measured by Socio-Economic Indexes for Areas (SEIFA), remoteness, state or territory, child's age, and year of census. SES is indicated using SEIFA, an Australian Bureau of Statistics-developed measure that ranges from 1 (least advantaged) to 5 (most advantaged), based on the area's income and services as measured by the Australian Census. The AEDC is also linked to the Australian Standard Geographical Classification (ASGC) Remoteness Areas, which indicate whether a child is in a geographically remote, outer regional, inner regional, or major city area. These confounders were selected as previous reports commissioned by Playgroup Australia found differences based on the Australian state or territory, due to the varying support and governance systems for different ECEC

types. Additionally, slight changes in effect over time have been observed since the AEDC data collection began, suggesting that the year of collection is also a confounder.

All analyses were conducted in Stata/SE 18.0. For single point interventions, as applied within this analysis, no extra software was required, however for more complex cases such as time-varying exposures or confounders, packages have been developed by CAUSALab for R and SAS (27).

Causal Inference

Although previous reports commissioned by Playgroups Australia have utilised the AEDC to investigate relationships of Playgroup attendance and child development outcomes, these have been associational studies where true causal impact was unable to be unbiasedly evaluated. These studies found a strong positive relationship with Playgroup attendance and risk of developmentally vulnerability, using simple model adjustment for the effect of socio-economic status and geographic area, both confounders of ECEC attendance and child development. With the development of causal techniques – a new opportunity to make causal inference from large databases such as the AEDC has become possible.

Parametric G-Formula

First proposed by Robbins in 1986, the parametric G-formula, sometimes also known as standardisation or g-computation, is a method which recreates exchangeability within non-random exposures (28). While other techniques such as Inverse Probability Weighting (IPW) are popular, G-formula allows us to compare multiple different treatment exposures while only specifying a single model, as opposed to IPW where at minimum a model for the outcome and a model for each exposure would be required. Therefore, the more exposure comparisons estimated the greater the likelihood of model misspecification if using IPW.

Although explained at length elsewhere (See Hernan & Robbins, *What if?* for comprehensive overview of Causal Inference techniques (29)), the standardisation process is as follows – first, for each exposure tested a complete copy of the dataset is created with the outcome set to missing, including a copy for no treatment. In these copies, we modify every individual to receive the exposure, thereby creating a counter-factual population where all observations receive the exposure. Likewise, for the non-exposure copy, the counterfactual population has no one receiving the exposure. We then use our original data to model the outcome, including an interaction term of all exposures and all confounders. Using this model, we then predict the risk of the outcome in all copies of the dataset, in essence standardising the set of confounders across exposures and creating the exchangeability condition required for causal inference. The predicted risk can then be compared for each exposure copy, where risk ratios, and risk differences can be calculated. In this study, we compare all risks of exposure to the non-exposure copy. As no elegant variance estimator exists for estimates using G-

formula, bootstrapping must be used to estimate 95% confidence intervals. For all outcomes, 1000 replications of resampling with replacement were calculated.

Results

Sample characteristics

Table 1 shows the characteristics of the sample by different exposures. As can be seen in the proportion in each exposure level, some ECEC exposures have many more observations than others, for example, nearly 30% of the entire sample attend preschool only, whereas less than 2% attend playgroups only. 10% of the sample attended no ECEC at all. Looking more closely at the non-attenders, 40% are in the SEIFA category of least advantage, as opposed to 15-25% for attenders of ECEC programs, suggesting non-random selection of ECEC attendance (i.e. children residing in low socioeconomic areas are less likely to attend ECEC services than those from high socioeconomic areas). Table A1 within the appendix shows the sample characteristics of children whose teacher indicated 'don't know' versus those children were ECEC details were known. No large discrepancies can be observed between the two characteristic tables, with teachers seemingly slightly more likely to know the child's ECEC background if they were from areas outside the metropolitan areas and for those residing in lower socioeconomic areas. Table 2 shows the proportion of children developmentally vulnerable on one or more domains, developmentally vulnerable on two or more domains, and proportion of children developmentally on track on five domains for the analysis sample only.

Table 1, Characteristics of analysis sample by exposure

	Exposure								
	No ECEC	Playgroups	Preschool	Daycare	Playgroups and Preschool	Preschool and Daycare	Playgroups and Daycare	Playgroups, Preschool, and Daycare	Total
N	38,314 (10.0%)	6,280 (1.6%)	112,464 (29.3%)	9,005 (2.3%)	69,515 (18.1%)	95,185 (24.8%)	2,079 (0.5%)	50,981 (13.3%)	383,823 (100.0%)
Gender									
Male	20,427 (53.3%)	3,141 (50.0%)	58,628 (52.1%)	4,734 (52.6%)	34,823 (50.1%)	50,148 (52.7%)	1,073 (51.6%)	25,723 (50.5%)	198,697 (51.8%)
Female	17,887 (46.7%)	3,139 (50.0%)	53,836 (47.9%)	4,271 (47.4%)	34,692 (49.9%)	45,037 (47.3%)	1,006 (48.4%)	25,258 (49.5%)	185,126 (48.2%)
Aboriginal and/or Torres Strait Islander									
No	32,922 (85.9%)	5,742 (91.4%)	101,744 (90.5%)	8,365 (92.9%)	65,956 (94.9%)	89,317 (93.8%)	1,983 (95.4%)	48,542 (95.2%)	354,571 (92.4%)
Yes	5,390 (14.1%)	538 (8.6%)	10,702 (9.5%)	640 (7.1%)	3,553 (5.1%)	5,862 (6.2%)	96 (4.6%)	2,434 (4.8%)	29,215 (7.6%)
Special Needs									
No	35,911 (93.7%)	5,940 (94.6%)	106,157 (94.4%)	8,543 (94.9%)	66,330 (95.4%)	90,675 (95.3%)	1,983 (95.4%)	48,711 (95.5%)	364,250 (94.9%)
Yes	2,403 (6.3%)	340 (5.4%)	6,307 (5.6%)	462 (5.1%)	3,185 (4.6%)	4,510 (4.7%)	96 (4.6%)	2,270 (4.5%)	19,573 (5.1%)
English as a Second Language									
No	26,603 (69.4%)	5,115 (81.4%)	90,600 (80.6%)	7,392 (82.1%)	63,620 (91.5%)	81,539 (85.7%)	1,826 (87.8%)	46,072 (90.4%)	322,767 (84.1%)
Yes	11,711 (30.6%)	1,165 (18.6%)	21,864 (19.4%)	1,613 (17.9%)	5,895 (8.5%)	13,646 (14.3%)	253 (12.2%)	4,909 (9.6%)	61,056 (15.9%)
Language Background other than English									
No	24,207 (63.2%)	4,757 (75.7%)	83,172 (74.0%)	6,797 (75.5%)	60,354 (86.8%)	75,622 (79.4%)	1,707 (82.1%)	43,143 (84.6%)	299,759 (78.1%)
Yes	14,107 (36.8%)	1,523 (24.3%)	29,292 (26.0%)	2,208 (24.5%)	9,161 (13.2%)	19,563 (20.6%)	372 (17.9%)	7,838 (15.4%)	84,064 (21.9%)
Place Of Birth									
Australia	32,972 (86.1%)	5,696 (90.7%)	104,505 (92.9%)	8,452 (93.9%)	66,334 (95.4%)	90,086 (94.6%)	1,958 (94.2%)	48,364 (94.9%)	358,367 (93.4%)
Other Country	3,888 (10.1%)	355 (5.7%)	5,345 (4.8%)	346 (3.8%)	1,638 (2.4%)	3,108 (3.3%)	57 (2.7%)	1,264 (2.5%)	16,001 (4.2%)
Other English-Speaking Country	1,300 (3.4%)	219 (3.5%)	2,302 (2.0%)	196 (2.2%)	1,461 (2.1%)	1,865 (2.0%)	61 (2.9%)	1,269 (2.5%)	8,673 (2.3%)
State									
ACT	170 (0.4%)	24 (0.4%)	1,419 (1.3%)	45 (0.5%)	582 (0.8%)	701 (0.7%)	9 (0.4%)	441 (0.9%)	3,391 (0.9%)
NSW	15,191 (39.6%)	1,830 (29.1%)	37,199 (33.1%)	4,005 (44.5%)	13,258 (19.1%)	37,588 (39.5%)	672 (32.3%)	13,594 (26.7%)	123,337 (32.1%)
NT	358 (0.9%)	60 (1.0%)	2,110 (1.9%)	55 (0.6%)	1,044 (1.5%)	643 (0.7%)	8 (0.4%)	436 (0.9%)	4,714 (1.2%)
QLD	15,473 (40.4%)	3,156 (50.3%)	19,706 (17.5%)	3,963 (44.0%)	13,215 (19.0%)	36,211 (38.0%)	959 (46.1%)	16,532 (32.4%)	109,215 (28.5%)
SA	637 (1.7%)	134 (2.1%)	4,588 (4.1%)	109 (1.2%)	5,327 (7.7%)	1,701 (1.8%)	33 (1.6%)	2,342 (4.6%)	14,871 (3.9%)
TAS	209 (0.5%)	81 (1.3%)	2,250 (2.0%)	24 (0.3%)	4,194 (6.0%)	859 (0.9%)	24 (1.2%)	1,975 (3.9%)	9,616 (2.5%)
VIC	3,849 (10.0%)	428 (6.8%)	23,820 (21.2%)	412 (4.6%)	17,082 (24.6%)	8,981 (9.4%)	209 (10.1%)	7,995 (15.7%)	62,776 (16.4%)
WA	2,427 (6.3%)	567 (9.0%)	21,372 (19.0%)	392 (4.4%)	14,813 (21.3%)	8,501 (8.9%)	165 (7.9%)	7,666 (15.0%)	55,903 (14.6%)
Remoteness									
Inner Regional Australia	7,481 (19.5%)	1,363 (21.7%)	22,357 (19.9%)	1,706 (18.9%)	16,046 (23.1%)	18,249 (19.2%)	355 (17.1%)	10,162 (19.9%)	77,719 (20.2%)
Major Cities of Australia	24,523 (64.0%)	3,560 (56.7%)	71,819 (63.9%)	6,386 (70.9%)	40,219 (57.9%)	66,903 (70.3%)	1,460 (70.2%)	33,654 (66.0%)	248,524 (64.7%)
Outer Regional Australia	4,823 (12.6%)	978 (15.6%)	13,044 (11.6%)	775 (8.6%)	9,437 (13.6%)	8,599 (9.0%)	192 (9.2%)	5,450 (10.7%)	43,298 (11.3%)
Remote Australia	766 (2.0%)	197 (3.1%)	2,686 (2.4%)	72 (0.8%)	2,106 (3.0%)	892 (0.9%)	36 (1.7%)	1,009 (2.0%)	7,764 (2.0%)
Very Remote Australia	721 (1.9%)	182 (2.9%)	2,558 (2.3%)	66 (0.7%)	1,707 (2.5%)	542 (0.6%)	36 (1.7%)	706 (1.4%)	6,518 (1.7%)
SEIFA Category									
1 (Least advantaged)	15,594 (40.8%)	1,919 (30.6%)	29,603 (26.4%)	2,317 (25.8%)	11,727 (16.9%)	18,475 (19.5%)	420 (20.3%)	7,679 (15.1%)	87,734 (22.9%)
2	9,266 (24.3%)	1,421 (22.7%)	23,138 (20.6%)	1,924 (21.4%)	13,084 (18.9%)	19,161 (20.2%)	381 (18.4%)	9,524 (18.7%)	77,899 (20.3%)

3	6,081 (15.9%)	1,223 (19.5%)	21,505 (19.2%)	1,684 (18.8%)	14,216 (20.5%)	19,602 (20.6%)	421 (20.3%)	10,431 (20.5%)	75,163 (19.6%)
4	4,513 (11.8%)	962 (15.4%)	19,722 (17.6%)	1,653 (18.4%)	15,059 (21.7%)	19,349 (20.4%)	422 (20.4%)	11,251 (22.1%)	72,931 (19.0%)
5 (Most advantaged)	2,740 (7.2%)	737 (11.8%)	18,202 (16.2%)	1,397 (15.6%)	15,302 (22.1%)	18,394 (19.4%)	427 (20.6%)	11,963 (23.5%)	69,162 (18.1%)

Table 2, Proportion of outcomes, Developmental vulnerability on one or more domains, Developmental vulnerability on two or more domains, and developmentally on track on five domains

	Summary
N	383,823
Developmentally vulnerable on one or more domains	
No	277,435 (76.4%)
Yes	85,703 (23.6%)
Developmentally vulnerable on two or more domains	
No	318,203 (87.5%)
Yes	45,551 (12.5%)
Developmentally on track on five domains	
No	169,626 (46.7%)
Yes	193,917 (53.3%)

Model results

Tables 3-5 contain predicted risks, Risk Differences (RD), and Risk Ratio (RR) of all exposures of ECEC attendance estimated for each outcome respectively. Exposure 0 contains the risk if no children attended any ECEC modality and is the denominator of all estimated RRs. Exposures 1-3 contain the risk if attendance to each ECEC type is independent, that is the child only attends a single ECEC type and no other, exposures 4-7 contain all remaining combinations of ECEC attendance possible. Baseline risk indicates the models predicted risk over the entire population (natural course) if no specific exposure was specified. It can be useful to compare the predicted natural course risk to the real risk of the outcome found in the data (Table 2) as a quick test of model specification - In our case the estimated natural course risks are largely compatible across all outcomes.

The predicted risk if no intervention (0) is followed results in a 39% risk of being developmentally vulnerable on one or more domains. When compared to the exposure of attending playgroups, the risk reduces by 40%. A similar result is found for attending preschool. If the exposure is daycare only, the risk reduces by 21%. Combinations of ECEC types find that the largest reduction in risk comes from attending Playgroups and Preschool, where the risk of developmental vulnerability on one or more domains reduces by 60%. Combinations of Preschool and Daycare, and Playgroups and Daycare reduces the risk by approximately 37% respectively. By simultaneously attending all three ECEC types, the risk of developmental vulnerability on one or more domains reduces by 51%.

Table 3, Predicted risks for outcome of Developmental vulnerability on one or more domains.

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.25	(0.20, 0.30)				
(0) No ECEC	0.39	(0.38, 0.40)	1		0	
(1) Playgroups only	0.24	(0.22, 0.25)	0.6	(0.56, 0.65)	-0.15	(-0.17, -0.14)
(2) Preschool only	0.23	(0.23, 0.24)	0.6	(0.58, 0.61)	-0.16	(-0.17, -0.15)
(3) Daycare only	0.31	(0.30, 0.32)	0.79	(0.75, 0.83)	-0.082	(-0.098, -0.066)
(4) 1 and 2 combined	0.16	(0.15, 0.16)	0.4	(0.39, 0.41)	-0.23	(-0.24, -0.23)
(5) 2 and 3 combined	0.24	(0.24, 0.25)	0.62	(0.61, 0.64)	-0.15	(-0.16, -0.14)
(6) 1 and 3 combined	0.25	(0.22, 0.28)	0.63	(0.56, 0.71)	-0.14	(-0.17, -0.11)
(7) 1 - 3 combined	0.19	(0.19, 0.20)	0.49	(0.48, 0.51)	-0.2	(-0.21, -0.19)

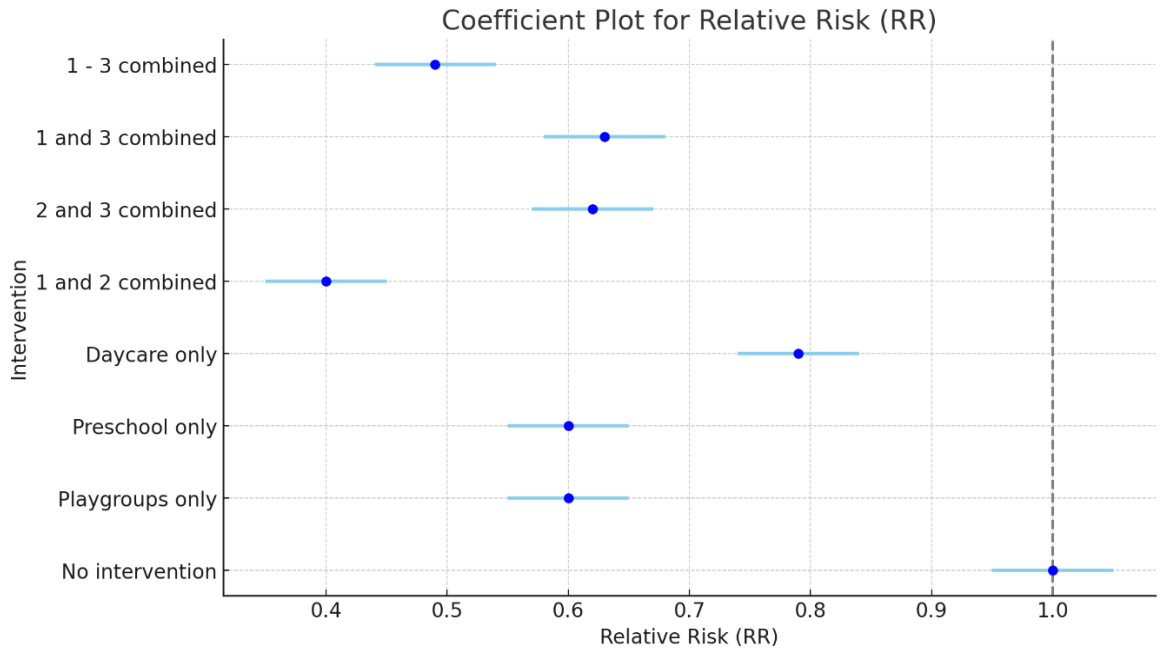

Figure 1, Coefficient plot of estimated RR for each exposure and outcome Developmental Vulnerability on one or more domains.

We find similar patterns of results for developmental vulnerability on two or more domains (Table 4) although the estimated risk of outcomes is smaller as the prevalence of being developmentally vulnerable on two or more domains is lower. Attending only playgroups results in a risk reduction of 52% and is largely comparable to attending only preschool which also reduces risk by nearly 50%. Attending only daycare reduces risk of DV2 by 21%. The strongest effects are found by the combination of attending Playgroups and Preschool together, which reduces the risk of developmental vulnerability on two or more domains by 70%. By attending all three ECEC modalities, the risk reduces by 60%.

Table 4, Predicted risks for outcome of Developmental Vulnerability on 2 or more domains.

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.13	(0.12, 0.13)				
(0) No ECEC	0.23	(0.23, 0.24)	1		0	
(1) Playgroups only	0.11	(0.10, 0.12)	0.47	(0.42, 0.52)	-0.12	(-0.14, -0.11)
(2) Preschool only	0.12	(0.12, 0.12)	0.52	(0.50, 0.54)	-0.11	(-0.12, -0.11)
(3) Daycare only	0.18	(0.17, 0.20)	0.79	(0.75, 0.83)	-0.05	(-0.064, -0.036)
(4) 1 and 2 combined	0.069	(0.066, 0.072)	0.3	(0.28, 0.31)	-0.16	(-0.17, -0.16)
(5) 2 and 3 combined	0.13	(0.13, 0.14)	0.57	(0.54, 0.60)	-0.11	(-0.12, -0.11)
(6) 1 and 3 combined	0.13	(0.12, 0.13)	0.56	(0.54, 0.59)	-0.1	(-0.11, -0.09)
(7) 1 - 3 combined	0.091	(0.088, 0.095)	0.39	(0.38, 0.41)	-0.14	(-0.15, -0.13)

For the outcome of developmentally on track on five domains the RR all become larger than 1 as the outcome is positively framed. This indicates the interventions show increase in 'risk' (probability) of being developmentally on track on five domains. Exposure 4 shows the largest benefit with 1.7 times

the probability of being developmentally on track on five domains by attending Playgroups and Preschool together. By attending all three ECEC programs, this reduces to 1.5 times. Attending playgroups or preschool independently will increase probability of being developmentally on track on five domains by 1.4 times respectively, however attending both simultaneously will not improve likelihood beyond that.

Table 5, Predicted risks of outcome developmentally on track on five domains.

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.53	(0.53, 0.54)				
(0) No ECEC	0.37	(0.36, 0.38)	1		0	
(1) Playgroups only	0.53	(0.51, 0.54)	1.4	(1.3, 1.5)	0.15	(0.13, 0.17)
(2) Preschool only	0.53	(0.53, 0.54)	1.4	(1.4, 1.5)	0.16	(0.15, 0.17)
(3) Daycare only	0.46	(0.44, 0.47)	1.2	(1.2, 1.3)	0.087	(0.070, 0.10)
(4) 1 and 2 combined	0.62	(0.62, 0.63)	1.7	(1.6, 1.7)	0.25	(0.24, 0.26)
(5) 2 and 3 combined	0.52	(0.51, 0.52)	1.4	(1.3, 1.5)	0.14	(0.13, 0.15)
(6) 1 and 3 combined	0.52	(0.51, 0.52)	1.4	(1.4, 1.5)	0.14	(0.13, 0.15)
(7) 1 - 3 combined	0.57	(0.57, 0.58)	1.5	(1.5, 1.6)	0.2	(0.19, 0.21)

Discussion

The association between attending playgroups and other ECEC services and child development outcomes as measured by the AEDC has been explored at length within reports prepared for Playgroups Australia, the Royal Commission into ECEC in South Australia, and Settlement Services International (see Lam et al 2023 for Playgroup Australia report, Howells et al. 2022 for Royal Commission into ECEC report for general summary of ECEC in Australia, and Lam et al. 2024 for SSI report for broad analysis of ECEC in context of Culturally and Linguistically Diverse Children). In short summary, evidence of association between ECEC attendance and child development outcomes has largely been positive, but attendance has varied significantly by jurisdiction, area, socioeconomic factors, and cultural context. Furthermore, there is a wealth of evidence to suggest that ECEC when done well and of high-quality results in better holistic outcomes for children, particularly for those in inequitable situations. However, there has been very limited evidence in the Australian context showing explicit causal impact of ECEC attendance on developmental outcomes. In this regard, this analysis is novel in terms of the causal interpretability of the results.

In terms of magnitude of impact, we find that our results do not differ remarkedly from previous findings, that is, ECEC attendance is associated with positive developmental outcomes. Furthermore, the association of ECEC regardless of the mode on early child development remains positive, with ECEC attendance associated with reduced risk of developmental vulnerability, and increased likelihood of being developmentally on track. Where our results differ is the ability for us to quantify the estimates causally. In terms of impact, there is strong policy relevance as these estimates allow for reasonable estimates of the impact if these programs were to be rolled out universally. The result of

using causal techniques confirm that attending any ECEC is better than not attending any, however we also find that some ECEC programs may be more beneficial than others.

G-formula was chosen as the primary methodology for analysis due to the ability to estimate effects of different combinations of exposures. Similar analyses within epidemiological studies to compare causal impact of various exposures within cohorts have been done (Taubman et al., 2009; Vangen Lonne, et al., 2018, provide examples of application within health contexts (30, 31)), but has not been widely applied to early childhood development or education. As a statistical tool, it is also useful to unbiasedly determine optimal treatment patterns to achieve the most impact, particularly for drug and lifestyle interventions. In this analysis we found that within all outcomes assessed, exposure 4 which assessed the effect of attending playgroups and preschool together saw the best outcomes. Attending both services simultaneously more than halved the risk of developmental vulnerability with a 60% reduction in risk of developmental vulnerability on one or more domains, and 70% reduction of risk for developmental vulnerability on two or more domains. It also showed children attending both would be 1.7 times more likely to be developmentally on track on all five domains.

The second-best combination was found to be if children attended all three ECEC services (exposure 7), the relative benefit was estimated as a 50% and 44% reduction in risk on DV1 and DV2 respectively, and 1.5 times more likely to be developmentally on track on five domains. As our results also provide the raw estimated risk of each exposure, it is possible to roughly calculate the risk ratio relative to different exposures by simple division. For example, comparing the effect of attending all three exposures to just attending playgroups and preschool can be calculated by $\frac{Risk(Exposure\ 4)}{Risk(Exposure\ 7)}$; the resulting risk ratio would be 1.19, suggesting a relative 19% increase in risk of DV1 for that frame of comparison. This crude calculation does not account for confidence intervals but offers a simple estimate that maybe useful for other frames of comparison.

Our results suggest there is an upper limit of benefit for attending more programs within the context of the three measured exposures, it is difficult to pinpoint exactly why this is the case without supplementary information not available within the AEDC such as precise dosage of each ECEC system attended. Within the literature there is evidence to suggest attending ECEC programs and spending less time at home may not always result in development benefits across all areas, rather having a mix of both high-quality programs and home environments maximises returns (32).

Furthermore, there is strong evidence to suggest that not all programs are equal. Programs involving community and caregivers in the child's learning may be more beneficial than those without community involvement. Other investigations of the causal effect of ECEC attendance on child development have largely consisted of RCTs based in the USA. Interestingly, many of the studies conducted in the 60s and 70s found large positive effects for preschool programs that included

complementary interventions such as parenting programs. Further, it has been observed that the components of the interventions aimed at parents may have increased the effectiveness of the ECEC component (14). This resonates with our finding that each of preschool and daycare have a larger positive effect on children's early developmental outcomes when they are combined with playgroup attendance, and its holistic family approach to play and learning. Nonetheless, the availability of services offerings will depend heavily on jurisdiction and area of the family. In which case, attendance to even basic offerings may be better than no attendance at all.

Within our analysis there is evidence to suggest that combinations of exposures that included long daycare tended to result in similar benefit compared to the same exposures without the combination of daycare. For example, for the outcome of being developmentally on track on five domains, probability was 1.4 times higher for both playgroups, preschools, and the combinations of playgroups & daycare, and preschool & daycare. Compared to the combination of playgroups & preschool, there is a lack of evidence suggesting benefit of sending children to daycare in addition to other programs. However, attending daycare alone is still more beneficial than attending no ECEC service at all prior to the first year of full-time schooling.

In contrast to previous analysis of ECEC attendance and child development that found that attending long daycare had limited benefits generally (9), this analyses shows that there is still relative benefit to daycare attendance when compared to no attendance at all, but not at the same magnitude as preschool or playgroups. It is likely previous analysis failed to show the relative benefit of daycare due to the lack of adjustment for the child's attendance to other ECEC programs concurrent with daycare. As shown in table 1, there is significant overlap of attendance to multiple programs, and in fact, attending daycare alone only consists of 2% of the entire sample. This is problematic analytically as other ECEC programs then become a confounder for daycare attendance.

Though the methodology of G-computation is robust in providing population level estimates, a limitation is that it is in relative terms, data intensive. For example, to accurately predict the probability of developmental vulnerability of a child who had only attended playgroups and no other intervention, there must be enough data of children who actually attend playgroups only. Within causal literature this is known as the assumption of positivity, that is, all combinations of the exposure must have positive probability of being assigned across all levels of covariates. Near violations of positivity can result in biased and unreliable estimates as the model can no longer make accurate predictions of risk (33). As such, while we attempted to model all outcomes stratified by State and Territory (Appendix B), only jurisdictions where there was enough data was present could be modelled and presented. Of the jurisdictions successfully modelled, results were largely in line with the national findings, with only slight differences in differential impact of different ECEC service offerings. This is likely due to the varied level of jurisdictional support certain programs have.

Additional limitations of the methodology include the difficulty in investigating effect modifiers. Prior research has shown that equity issues including access and quality remain for most ECEC services in Australia. For example, children in regional or rural settings are less likely to have access to services and of those services that do exist they are less likely to be of high quality (11, 34).Previous reports have been unable to partition the effects of poor access to quality services and the effects of poor socioeconomic background. Although this report is better able to unpack these differential effects the methodology used in this report is still unable to causally tell us if children in more disadvantaged SES areas would see larger benefit than children in more advantaged SES areas. To estimate this, effect modifiers would need to be specified in the original predictive model, requiring enough data to not violate positivity.

It is also important to acknowledge that the AEDC is not a definitive indicator of attendance in ECEC programs. The data relies on the teacher's best knowledge of the child's ECEC attendance pattern prior to school. As such, it is possible that teachers over or underestimate attendance. To minimise a teacher guessing or making data up, the census includes 'don't know' as a valid response. Nationally in 2021, 65% of teacher's indicated 'don't know' for the child's attendance in Playgroups. Furthermore, 'don't know' responses for other ECEC modalities were approximately 11% for Preschool, and 32% for daycare. Within the current analyses, observations with a 'don't know' response in any ECEC category were censored, this resulted in a significantly smaller sample than the entire sample frame. Further work will use causal methods to extrapolate the results from this analysis to children where ECEC attendance is not certain (35). This further analysis will allow for estimates to be nationally representative. However, it is recommended that education system's improve enrolment records so that prior ECEC attendance patterns can be collected from parents. As Australia continues to invest heavily in ECEC it is increasingly important to be able to soundly evaluate the impacts on child development.

Considering the changing landscape of ECEC in Australia, the findings from this report add to the evidence that playgroup continues to significantly benefit children, both in its own right, and as an addition to other service offerings. Currently, policy changes across jurisdictions are increasingly offering system level implementations of ECE. Both NSW and Victoria are now offering forms of formal three-year old ECE, and South Australia having just completed a Royal Commission into ECEC is set to do so also. The evidence from this report shows that universal roll-out of preschool would likely halve developmental vulnerability on one or more domains, and attending playgroup on top of this would reduce it by a further 20%. This suggests that in addition to universal preschool, additional programs such as playgroups which encompasses both the parents/caregivers, and the community, will lead to even stronger supports for children across Australia.

Conclusion

Although most research has focussed on the associational relationship between ECEC attendance and child development outcomes – little work in the Australian context has quantified directional causal impact. By applying causal techniques to the AEDC unit record data, this report has confirmed that ECEC attendance, regardless of the modality, results in a reduction in risk of developmental vulnerability, and increases the probability of being developmentally on track. The evidence provided in this report also shows that the type of ECEC program, and combinations of programs is an important consideration to achieving the maximum beneficial impact for children. Playgroups, while being an informal program, provides a platform for both parent, caregiver, and community involvement in the child's developmental pathway. This, in combination with formal preschool, offers the most substantial benefits for early childhood development. As Australia continues to expand ECEC access, integrating these findings into policy will enhance outcomes for all children, particularly those most at risk of developmental vulnerabilities.

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Appendix A

Table A1, Summary characteristics of children with ‘don’t know’ and ‘known’ responses in Playgroups, Preschool, or Daycare

Table A1, Summary characteristics of children with ‘don’t know’ and ‘known’ responses in playgroups, preschool, or daycare.

	Summary	
	Don’t Know	Known
N	853,813	383,823
Gender		
Male	437,318 (51.2%)	198,697 (51.8%)
Female	416,495 (48.8%)	185,126 (48.2%)
ATSI		
No	809,465 (94.8%)	354,571 (92.4%)
Yes	44,164 (5.2%)	29,215 (7.6%)
Special Needs		
No	814,050 (95.3%)	364,250 (94.9%)
Yes	39,763 (4.7%)	19,573 (5.1%)
ESL		
No	711,883 (83.4%)	322,767 (84.1%)
Yes	141,930 (16.6%)	61,056 (15.9%)
State		
ACT	18,819 (2.2%)	3,391 (0.9%)
NSW	273,723 (32.1%)	123,337 (32.1%)
NT	8,812 (1.0%)	4,714 (1.2%)
QLD	159,937 (18.7%)	109,215 (28.5%)
SA	65,028 (7.6%)	14,871 (3.9%)
TAS	15,877 (1.9%)	9,616 (2.5%)
VIC	230,076 (26.9%)	62,776 (16.4%)
WA	81,531 (9.5%)	55,903 (14.6%)
Remoteness		
Inner Regional Australia	145,524 (17.0%)	77,719 (20.2%)
Major Cities of Australia	628,301 (73.6%)	248,524 (64.7%)
Outer Regional Australia	64,726 (7.6%)	43,298 (11.3%)
Remote Australia	9,908 (1.2%)	7,764 (2.0%)
Very Remote Australia	5,344 (0.6%)	6,518 (1.7%)
SEIFA Category		
1 (Least advantaged)	165,103 (19.4%)	87,734 (22.9%)
2	161,813 (19.0%)	77,899 (20.3%)
3	171,566 (20.2%)	75,163 (19.6%)
4	176,142 (20.7%)	72,931 (19.0%)
5 (Most advantaged)	176,811 (20.8%)	69,162 (18.1%)

Appendix B

Table B1, Predicted risk of Developmental vulnerability on one or more domains (SA)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.25	[0.24, 0.26]				
(0) No ECEC	0.47	[0.41, 0.53]	1		0	
(1) Playgroups only	0.18	[0.06, 0.29]	0.37	[0.12, 0.62]	-0.29	[-0.42, -0.16]
(2) Preschool only	0.3	[0.28, 0.32]	0.64	[0.55, 0.73]	-0.17	[-0.23, -0.11]
(3) Daycare only	0.39	[0.25, 0.52]	0.82	[0.52, 1.12]	-0.08	[-0.23, 0.06]
(4) 1 and 2 combined	0.19	[0.17, 0.21]	0.41	[0.34, 0.47]	-0.28	[-0.34, -0.22]
(5) 2 and 3 combined	0.3	[0.27, 0.33]	0.63	[0.53, 0.73]	-0.17	[-0.24, -0.11]
(6) 1 and 3 combined	0.07	[-0.10, 0.25]	0.16	[-0.22, 0.53]	-0.4	[-0.58, -0.21]
(7) 1 - 3 combined	0.19	[0.16, 0.21]	0.4	[0.32, 0.48]	-0.28	[-0.35, -0.22]

Table B2, Predicted risk of Developmental vulnerability on one or more domains (NSW)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.22	[0.22, 0.22]				
(0) No ECEC	0.36	[0.35, 0.37]	1		0	
(1) Playgroups only	0.22	[0.20, 0.25]	0.62	[0.55, 0.70]	-0.14	[-0.16, -0.11]
(2) Preschool only	0.21	[0.20, 0.21]	0.57	[0.55, 0.59]	-0.15	[-0.17, -0.14]
(3) Daycare only	0.25	[0.23, 0.27]	0.69	[0.63, 0.74]	-0.11	[-0.13, -0.09]
(4) 1 and 2 combined	0.15	[0.14, 0.16]	0.42	[0.39, 0.45]	-0.21	[-0.22, -0.19]
(5) 2 and 3 combined	0.21	[0.21, 0.22]	0.59	[0.56, 0.61]	-0.15	[-0.16, -0.13]
(6) 1 and 3 combined	0.23	[0.19, 0.27]	0.64	[0.52, 0.76]	-0.13	[-0.17, -0.08]
(7) 1 - 3 combined	0.17	[0.16, 0.18]	0.48	[0.45, 0.51]	-0.19	[-0.20, -0.17]

Table B3, Predicted risk of Developmental vulnerability on one or more domains (WA)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.22	[0.22, 0.23]				
(0) No ECEC	0.42	[0.39, 0.45]	1		0	
(1) Playgroups only	0.25	[0.20, 0.30]	0.59	[0.45, 0.73]	-0.17	[-0.23, -0.11]
(2) Preschool only	0.25	[0.24, 0.26]	0.6	[0.55, 0.65]	-0.17	[-0.20, -0.14]
(3) Daycare only	0.36	[0.29, 0.43]	0.86	[0.68, 1.04]	-0.06	[-0.13, 0.02]
(4) 1 and 2 combined	0.16	[0.15, 0.17]	0.37	[0.34, 0.41]	-0.26	[-0.29, -0.23]
(5) 2 and 3 combined	0.21	[0.20, 0.23]	0.51	[0.46, 0.56]	-0.21	[-0.24, -0.17]
(6) 1 and 3 combined	0.2	[0.11, 0.30]	0.48	[0.25, 0.72]	-0.22	[-0.31, -0.12]
(7) 1 - 3 combined	0.18	[0.17, 0.19]	0.43	[0.38, 0.47]	-0.24	[-0.27, -0.21]

Table B4, Predicted risk of Developmental vulnerability on one or more domains (QLD)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.26	[0.26, 0.27]				
(0) No ECEC	0.41	[0.40, 0.42]	1		0	
(1) Playgroups only	0.24	[0.22, 0.26]	0.59	[0.53, 0.64]	-0.17	[-0.19, -0.14]
(2) Preschool only	0.23	[0.22, 0.24]	0.55	[0.53, 0.58]	-0.18	[-0.20, -0.17]
(3) Daycare only	0.35	[0.33, 0.37]	0.85	[0.80, 0.91]	-0.06	[-0.08, -0.04]
(4) 1 and 2 combined	0.16	[0.15, 0.17]	0.39	[0.36, 0.42]	-0.25	[-0.27, -0.24]
(5) 2 and 3 combined	0.27	[0.26, 0.28]	0.65	[0.63, 0.68]	-0.14	[-0.16, -0.13]
(6) 1 and 3 combined	0.27	[0.23, 0.31]	0.65	[0.55, 0.75]	-0.14	[-0.19, -0.10]
(7) 1 - 3 combined	0.21	[0.20, 0.22]	0.5	[0.47, 0.53]	-0.2	[-0.22, -0.19]

Table B5, Predicted risk of Developmental vulnerability on one or more domains (VIC)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.22	[0.21, 0.22]				
(0) No ECEC	0.42	[0.40, 0.44]	1		0	
(1) Playgroups only	0.27	[0.21, 0.33]	0.65	[0.50, 0.80]	-0.15	[-0.21, -0.08]
(2) Preschool only	0.23	[0.22, 0.24]	0.55	[0.52, 0.59]	-0.19	[-0.21, -0.16]
(3) Daycare only	0.37	[0.31, 0.43]	0.88	[0.72, 1.04]	-0.05	[-0.12, 0.02]
(4) 1 and 2 combined	0.15	[0.14, 0.16]	0.35	[0.32, 0.38]	-0.27	[-0.30, -0.25]
(5) 2 and 3 combined	0.25	[0.23, 0.26]	0.59	[0.54, 0.63]	-0.17	[-0.20, -0.15]
(6) 1 and 3 combined	0.24	[0.15, 0.32]	0.57	[0.37, 0.78]	-0.18	[-0.27, -0.09]
(7) 1 - 3 combined	0.18	[0.16, 0.19]	0.42	[0.38, 0.46]	-0.24	[-0.27, -0.22]

Table B6, Predicted risk of Developmental vulnerability on one or more domains (TAS)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.22	[0.21, 0.22]				
(0) No ECEC	0.42	[0.40, 0.44]	1		0	
(1) Playgroups only	0.27	[0.21, 0.33]	0.65	[0.50, 0.80]	-0.15	[-0.21, -0.08]
(2) Preschool only	0.23	[0.22, 0.24]	0.55	[0.52, 0.59]	-0.19	[-0.21, -0.16]
(3) Daycare only	0.37	[0.31, 0.43]	0.88	[0.72, 1.04]	-0.05	[-0.12, 0.02]
(4) 1 and 2 combined	0.15	[0.14, 0.16]	0.35	[0.32, 0.38]	-0.27	[-0.30, -0.25]
(5) 2 and 3 combined	0.25	[0.23, 0.26]	0.59	[0.54, 0.63]	-0.17	[-0.20, -0.15]
(6) 1 and 3 combined	0.24	[0.15, 0.32]	0.57	[0.37, 0.78]	-0.18	[-0.27, -0.09]
(7) 1 - 3 combined	0.18	[0.16, 0.19]	0.42	[0.38, 0.46]	-0.24	[-0.27, -0.22]

Table B7, Predicted risk of Developmental vulnerability on one or more domains (NT)

Exposure	Risk	Risk (95% CI)	RR	RR (95% CI)	RD	RD (95% CI)
Baseline risk	0.47	[0.45, 0.49]				
(0) No ECEC	0.63	[0.55, 0.70]	1		0	
(1) Playgroups only	0.6	[0.41, 0.78]	0.95	[0.61, 1.30]	-0.03	[-0.23, 0.17]
(2) Preschool only	0.49	[0.46, 0.52]	0.78	[0.66, 0.90]	-0.14	[-0.22, -0.06]
(3) Daycare only	0.5	[0.33, 0.66]	0.79	[0.50, 1.09]	-0.13	[-0.31, 0.05]
(4) 1 and 2 combined	0.44	[0.40, 0.49]	0.71	[0.60, 0.83]	-0.18	[-0.26, -0.10]
(5) 2 and 3 combined	0.42	[0.36, 0.49]	0.68	[0.54, 0.82]	-0.2	[-0.30, -0.10]
(6) 1 and 3 combined	0.61	[0.39, 0.83]	0.98	[0.57, 1.38]	-0.02	[-0.25, 0.22]
(7) 1 - 3 combined	0.36	[0.29, 0.43]	0.57	[0.43, 0.72]	-0.27	[-0.37, -0.16]