The quality, type and time spent in child care in the first three years of life and children's cognitive and socio-emotional development at school entry

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Contents

Abstract

Background: Evidence from decades of research suggests that children's experiences before starting school are crucial foundations for learning and behaviour across the life course. During the preschool years, children spend a large proportion of their time both in the family home and in the non-parental child care environment. The family home and non-parental child care settings are the key caregiving environments where infants and toddlers learn and build healthy relationships prior to commencing school. Previous research, mainly from the USA, suggests that the type, time and quality of child care influences children's development, but there is little or no information describing the effects of these different aspects of child care on children's development within the Australian context.

Aim: The overarching aim of this thesis was to investigate the association between the type, time and quality of child care experienced by infants (0-1 years) and toddlers (2-3 years) and these children's cognitive (receptive vocabulary, task attentiveness, academic literacy and maths proficiency) and socio-emotional development (emotional regulation, internalising and externalising behaviours) when they started school (aged 4-5 and 6-7). Specifically the aims were:

- To determine whether the total amount of time spent in child care through the first three years of life was associated with children's cognitive and socio-emotional development at age 4-5 years and whether this association varied according to the primary type of child care;

- To determine whether the quality of formal child care at age 2-3 years was associated with children's cognitive and socio-emotional development at age 4-5 and 6-7 years;

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- To establish if higher quality child care was associated with better cognitive and socio-emotional outcomes at school entry for children from lower compared to higher income families.

Method: Data for this thesis were drawn from the Longitudinal Study of Australian Children, a national study following the health and development of a population-representative sample of children recruited in their first year of life (age range 3 to 19 months). The analytic approaches to answer the aims of this thesis included multiple imputation, regression, propensity score matching, effect measure modification, and the absolute and relative slope differences within strata of income.

Results: In the first study, more time in child care through the first three years of life was not associated with children's receptive vocabulary ability but was associated with higher levels of parent-reported and teacher-reported externalising problem behaviours and lower levels of parent-reported internalising problem behaviours at age 4-5 years. These effects were concentrated among children who experienced predominately centre-based child care.

In the second study, the quality of relationships in formal child care at age 2-3 years was associated with children's task attentiveness, emotional regulation, receptive vocabulary, literacy and maths proficiency, internalising and externalising behaviours at age 4-5 years, and these effects, although weaker, continued to exert their influence at age 6-7 years after two years of formal schooling. The quality of activities in formal child care was only associated with children's emotional regulation and there was no evidence that provider or program characteristics of care were associated with children's developmental outcomes.

In the third study, after adjusting for confounding, there was some evidence of effect measure modification on the additive and multiplicative scales of child care quality by income. Specifically, higher quality child care, in terms of relationships with child care providers, was more strongly associated with better cognitive and socio-emotional

outcomes among children from lower income than those from higher income families, suggesting that higher quality child care matters more for lower income children.

Conclusions: Findings from this thesis present the first comprehensive, longitudinal analysis of the type, time and quality of child care on children's development using a nationally representative sample of children relevant to the Australian experience. The findings are consistent with overseas research showing that child care may influence children's development in both positive and negative ways. Most notably, these findings suggest that higher quality relationships in child care support children's positive cognitive and socio-emotional development at school entry, particularly in relation to children from disadvantaged backgrounds.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other institution and affirms that to the best of my knowledge, the thesis contains no material previously published or written by another person, except where due reference is made in the text of thesis. In addition, I certify that no part of this work will, in the future be used in a submission for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree.

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Date: …………06/07/2015……….............................

Publications contributing to this thesis

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Child care quality and children's cognitive and socio-emotional development: an Australian longitudinal study. Early Child Development and Care 2014; 184(7):1-21.

- Gialamas A, Sawyer ACP, Mittinty MN, Zubrick SR, Sawyer MG, Lynch J. Quality of child care influences children's attentiveness and emotional regulation at school entry. The Journal of Pediatrics 2014; 165(4):813-819.

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- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Social inequalities in child care quality and their effects on children's development at school entry: findings from the Longitudinal Study of Australian Children. Journal of Epidemiology and Community Health 2015 doi:10.1136/jech-2014-205031.

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- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Social inequalities in child care quality and the effects on children's development at school entry. Society for Research in Child Development Biennial Meeting, Philadelphia, Pennsylvania, United States of America, March 2015.

- Gialamas A, Sawyer, ACP, Mittinty MN, Zubrick SR, Sawyer MG, Lynch J. Quality of child care influences children's attentiveness and emotional regulation at school entry. Public Health Association of Australia (South Australia Branch) State Population Health Conference, Adelaide, October 2014.

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Time spent in different types of child care and children's cognitive and socio-emotional development at school entry. School of Population Health Seminar Series, Adelaide, November 2013.

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Time in child care and children's cognitive and socio-emotional development at school entry. Public Health Association of Australia (South Australia Branch) State Population Health Conference, Adelaide, October 2013.

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Quality of child care and children's cognitive and socio-emotional development. School of Population Health Seminar Series, Adelaide, September 2012.

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Quality of non-parental child care and children's receptive vocabulary and academic achievement at age 4-5 and 6-7 years. The University of Adelaide, Faculty of Health Sciences Postgraduate Research Conference, Adelaide, August 2012.

- Gialamas A, Lynch J, Mittinty MN, Sawyer MG, Zubrick SR. Can we develop a measure to define the quality of non-parental child care which predicts children's receptive vocabulary and social-emotional outcomes? 12th Australian Institute of Family Studies Conference: Family Transitions and Trajectories, Melbourne, Australia, July 2012.

- Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Does the type, quality and time spent in child care influence children's cognitive and social development? School of Population Health Seminar Series, Adelaide, September 2011.

Coverage of findings arising from this thesis

- "Day care is more than child's play", Daily Telegraph, Sydney, 6 September 2014.

- Radio interview, "Quality child care makes quality children", 2SER Radio, New South Wales, 04 September 2014.

- "Good relationships: good beginnings", EarlyChildhood Australia WebWatch #195, 03 September 2014.

- Radio interview, "Quality of child care influences children's attentiveness and emotional regulation at school entry", Radio Adelaide, Adelaide, 29 August 2014.

- "Child care, emotional security linked", Campus Review, 27 August 2014.

- "Best care helps move to school", The Advertiser, Adelaide, 26 August 2014, pg 15.

- "High-quality childcare helps kids be more attentive and better deal with their emotions, study shows", The Australian, Australia, 26 August 2014.

- "High-quality childcare helps kids be more attentive and better deal with their emotions, study shows", Herald Sun, Victoria, 26 August 2014.

- "High-quality childcare helps kids be more attentive and better deal with their emotions, study shows", Adelaide Now, 25 August 2014.

- Television interview, Channel 9 National News, 25 August 2014.

- Television interview, Channel 10 National News, 25 August 2014.

- Radio interview, 891 ABC Adelaide, Adelaide, 25 August 2014.

- Interview with Dr Wendy Craik, Presiding Commissioner, Productivity Commission Inquiry into Child Care and Early Childhood Learning, 19 December 2013.

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Abbreviations

ARIA	Accessibility and Remoteness Index of Australia
ARS	Academic Rating Scale
ATT	Average Treatment Effect on the Treated
CCB	Child Care Benefit
CCR	Child Care Rebate
CI	Confidence Interval
DAG	Directed Acyclic Graph
ECERS-R	Early Childhood Environment Rating Scale – Revised
EPPE	Effective Provision of Pre-School Education Project
EMM	Effect Measure Modification
IQR	Interquartile range
K6	Kessler 6 Scale
LSAC	Longitudinal Study of Australian Children
NICHD	National Institute of Child Health and Development
OECD	Organisation for Economic Co-operation and Development
ORCE	Observational Record of the Caregiving Environment
PPVT	Peabody Picture Vocabulary Test
RII	Relative Index of Inequality
SD	Standard Deviation
SDQ	Strength and Difficulties Questionnaire
SII	Slope Index of Inequality
UK	United Kingdom of Great Britain and Northern Ireland
USA	United States of America

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1   Introduction

The first three years of a child's life are an important influence on their future health, development and well-being [1]. This period is thought to be fundamental in laying strong foundations for cognitive, social and emotional capacities on which further learning and development is built [2]. Historically, young children in western cultures have primarily been cared for by their parents, usually their mother, before they start school. However, over the past few decades an increasing number of children are spending regular time in non-parental child care settings [3].

The many types of child care available to parents for children under the age of 3 years can be broadly categorised into formal or informal child care. Formal child care refers to paid care away from the child's home, such as long day care (centre-based child care) and family day care (registered carers paid to deliver care in their home for small groups of children) [4]. Most formal child care services in Australia are regulated by the government [5]. The role of government in regulation includes funding a quality assurance system to ensure the quality of child care and licensing services to meet minimum standards of care (for example, number of staff and their qualifications) [5]. Informal child care is non-regulated care in or away from the child's home and includes relative and non-relative care [4]. Australian children aged between 3-5 years also have access to early education through a preschool setting. Services are delivered in a mix of contexts, including centre-based child care, stand-alone preschools, early learning centres, community organisations and preschool programs within the school sector [6]. Children attending preschools (also known as kindergartens) were not considered in this thesis, as in Australia, they are administratively classified as belonging to the education sector unlike child care services

[6]. Furthermore, unlike child care for children under the age of 3 years, preschool is usually delivered by a degree-qualified teacher on a sessional basis between 10-12 hours per week mainly in the year before children start full-time schooling [6]. The broad aim of this thesis was to examine the association between the type, time and quality of child care experienced by infants (0-1 years) and toddlers (2-3 years) and these children's cognitive and socio-emotional development as they commenced school (4-5 and 6-7 years).

The proportion of Australian children spending time in child care progressively increases from birth, peaking at age 2 to 3 years and decreasing thereafter as children start school at age 4 to 5 years [7]. There is clear evidence of growth when examining trends of child care use over time. Among children not yet in school, the proportion using child care increased from 61% to 74% between 1996 and 2011 [7, 8], and this may be partly attributed to greater female participation in the workforce. According to an Australian longitudinal study, there has been substantial growth in the use of child care for children with employed mothers between 1984 and 2011 [9]. Most notably, the use of formal child care has significantly grown over the past two decades [9]. The Australian government is strongly encouraging increased workforce participation, particularly of women, to improve economic productivity [10] therefore it is reasonable to assume that the trend of increasing child care use will only continue to rise.

Another likely explanation for the rise in child care use, particularly formal care is the perception by parents that child care may facilitate better school readiness by fostering children's early learning, intellectually, emotionally and socially [11]. There is widespread agreement that children with better developed cognitive and socio-emotional skills are better ready to be engaged in school [1, 12, 13]. Children with better socio-emotional skills are better able to pay attention, follow directions and have less difficulty getting

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along with teachers and other children [14]. Prior research also suggests that children's academic ability at school entry is associated with later school achievement [15, 16].

Formal child care exposes children to educational resources, social interactions with same age peers and may help them learn skills and behaviours they require in school. However, not all children have an equal opportunity to participate in child care with children from higher income families more likely to experience non-parental care [17]. A recent analysis of data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey revealed that 36% of households in the highest three deciles of socioeconomic advantage used formal child care compared with 22% of households in the lowest three deciles [18]. Children from lower income families are also more likely to start school with poorer cognitive skills and more socio-emotional problems than their more advantaged peers [19, 20]. As such, formal child care may be particularly beneficial for lower income children who may be more likely to experience less cognitively stimulating home environments and caregiving than children from higher income families [21]. These social inequalities highlight the critical role that government have in supporting equitable access of child care services for all children.

Child care is a core component of the Australian government's commitment to support universal access to quality early childhood education [22]. Despite this, government investment in child care services has been lacking. In 2008, the first report card that evaluated and compared early childhood services across 25 OECD countries revealed that Australia only met two of the 10 minimum standards of care (subsidised and regulated child care for 25% of children <3 years; 50% of staff in accredited early education services being tertiary educated with relevant qualification) placing us third to bottom on the league table [3]. Similar to the USA and the UK, Australia only spent 0.2 percent of Gross Domestic Product (GDP) on early childhood services whilst Northern European countries

including Sweden, Denmark and Norway spent at least 1.0 percent of GDP in the area and importantly, met eight or more minimum standards of care [3].

Since the release of the OECD report, there has been a shift in government support for early childhood education and care. In 2009, the Council of Australian Governments (COAG) established the first National Early Childhood Development Strategy [23]. The overarching vision of this strategy is to "ensure that by 2020 all children have the best start to life to create a better future for themselves and for the nation" [23]. Key goals of the strategy are to reduce the impact of risk factors on children's development, reduce inequalities in outcomes between groups and to improve outcomes for all children. In order to progress these goals, the need to build a robust evidence base regarding how early childhood programs and services contribute to positive outcomes for children was highlighted as one of six priorities of the national strategy [23]. COAG also endorsed a 'National Quality Agenda' to improve the quality, affordability and accessibility of child care [24]. The National Quality Agenda sets standards for the structural components of child care including the requirement for qualified staff and the establishment of the Australian Children's Education and Care Quality Authority (ACECQA) to oversee the regulation and quality assessment of child care services at a national level [5, 25]. With increasing numbers of children using child care in their formative years, government commitment to the quality and affordability of child care is an important step towards recognising that early education and care may contribute to children's learning, development and successful transition to school.

The research evidence indicates that cognitive and socio-emotional skills are both important when children commence school [1]. Children who start school with a strong vocabulary, positive social skills and the ability to pay attention and regulate their emotions are better ready to take advantage of the opportunities offered by formal

education [1, 13, 14]. Children learn a great deal about reading, writing [26] and how to relate to others prior to commencing school. Whilst family characteristics such as household income, maternal education, parenting practices and the quality of the home environment are widely considered the most important influences on children's development [27-31], the child care environment may also contribute to children's development.

The influence of child care on children's cognitive and socio-emotional development has been the subject of research and debate for the past three decades. As will be detailed in the literature review in this thesis, considerable research from the USA [32-41], has informed questions about the effects of child care on children's development. However, only a handful of Australian studies have examined the effects of the type, time and quality of child care on children's development [42-48]. Of these, only two examined specific aspects of child care longitudinally using a nationally representative sample of children [46, 47].

In summary, there are a significant and growing number of children spending time in child care during their preschool years. However, there is both little research describing the effects of different aspects of child care on children's developmental outcomes within the Australian context, and a need to expand the evidence base relevant to the Australian setting. Building stronger evidence regarding how early childhood programs and services contribute to children's healthy development is a goal of the National Early Childhood Development Strategy [23]. A focus on improving the quality and affordability of child care for all Australian families is also a policy focus of the government [5]. On a societal level, research in this area may provide valuable local evidence to inform government public policy.

1.1 Thesis aim

The overall aim of this thesis is to investigate the association between the type, time and quality of child care experienced by infants (0-1 years) and toddlers (2-3 years) and these children's cognitive and socio-emotional development when they start school (aged 4-5 and 6-7 years). The four specific aims to be addressed in this thesis are as follows:

1. Is the total amount of time in child care through the first three years of life associated with children's cognitive (receptive vocabulary) and socio-emotional development (externalising and internalising behaviours) at age 4-5 years, and does this association vary according to the primary type of child care?

2. Is the quality of formal child care at age 2-3 years associated with children's cognitive (receptive vocabulary, academic literacy and numeracy proficiency) and socio-emotional development (externalising and internalising behaviours) at age 4-5 and 6-7 years?

3. Is the quality of formal child care at age 2-3 years associated with children's task attentiveness and emotional regulation at age 4-5 and 6-7 years?

4. Is higher quality child care associated with better cognitive and socio-emotional outcomes at school entry for children from lower compared to higher income families?

To achieve these aims, secondary data analysis of a nationally representative dataset was performed. The Longitudinal Study of Australian Children (LSAC); is a population-based study including a sample of children born in Australia between March 2003 and February 2004, recruited at birth (age range 3 to 19 months). As well as child care data (type, time and quality), details on socioeconomic circumstances, the home learning environment and child health and development is available, providing a rich source of information to enhance our understanding of the child care experience in the Australian context, and the implications for children and society.

1.2 Thesis outline

The remainder of the thesis is organised as follows. In Chapter 2, I review the relevant literature that provides the context to the specific aims, introduced above. The review describes the prevalence of children using different types of child care in the Australian context and the family factors that influence parental child care choices. An overview of the time spent in child care and a definition of quality and how it is measured is discussed. The focus then moves to what is known about the type, quality and time spent in child care and how each of these aspects contributes to children's cognitive and socio-emotional development. Government policies that have shaped the provision of child care services to date are then highlighted.

Chapter 3 introduces the Longitudinal Study of Australian Children, the variables selected to operationalise type, time and quality of child care and the analytical approach to address each of the specific aims of this thesis. Publications arising from this thesis are included in Chapters 4, 5, and 6. Chapter 4 presents the results of analyses examining the association between total amount of time spent in child care and the primary type of child care through the first three years of life and children's cognitive and socio-emotional development at school entry. Chapter 5 explores the effects of the quality of formal child care at age 2-3 years on children's development at multiple time points. As no direct observation of quality was available in the LSAC, a measure of child care quality, using a set of multidimensional indicators, was created to assess the extent to which such quality influences different aspects of children's development considered relevant for early school success. Results regarding the influence of child care quality on children's receptive vocabulary; academic literacy and numeracy proficiency, externalising and internalising behaviours, task attentiveness and emotional regulation are included in Chapter 5. Chapter 6 presents the moderating effect of family income and child care quality on children's

cognitive and socio-emotional development in order to examine whether the quality of

formal child care can function as a protective factor for children who may be at risk of

poorer development.

Finally, a general discussion of the results, potential areas requiring future research and

concluding remarks are given in Chapter 7.

2   Literature review

2.1 Child care in Australia

Over recent decades, for a variety of demographic, social and economic reasons, increasing numbers of children are spending more time in non-parental child care during their preschool years [3]. As shown in Figure 2.1, the proportion of Australian children spending time in child care steadily increases from birth, peaking at age 2 to 3 years with more than 70% of children in care, and declining thereafter as children start school at age 4 to 5 years [7].

Figure 2.1: Proportion of children in child care, 2011
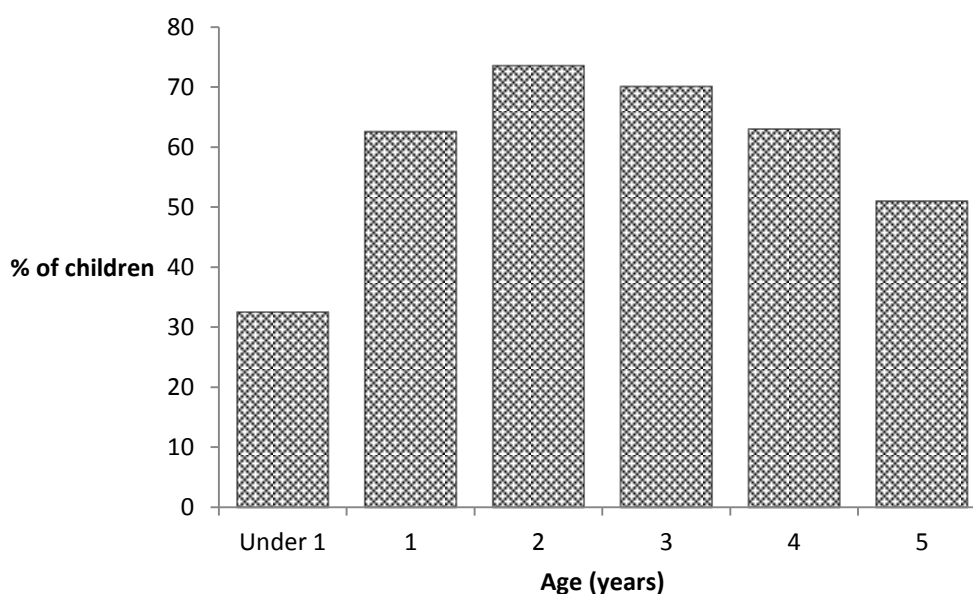
The overall proportion of children not yet in school using child care has increased from 61% in 1996 [8] to 74% in 2011 [7]. This large increase in the use of child care may reflect greater female participation in the workforce. Indeed, according to Australian Census data, the workforce participation rate of mothers with children aged 0 to 14 years climbed from 59% in 1986 to 64% in 2006, but participation varied substantially according

to the age of their youngest child. For example, of those mothers with children aged ≤4 years 52% were in paid employment compared to 71% whose youngest child was aged 5 to 9 years and 77% for those whose youngest child was 10 to 14 years [49]. A recent Australian longitudinal study exploring the association between maternal employment and use of child care over the past two decades (1984 to 2011) found considerable growth in the use of child care for children with employed mothers, although the trend was not consistent across ages [9]. No change in child care participation rates were seen for children aged ≤1 year but a progressive increase in participation was observed for children aged between 2 and 3 years. Most notably, over the past two decades the use of formal child care, regardless of mothers' employment status, has significantly grown [9].

The increase in child care, particularly formal care, may then relate to the idea that child care might facilitate better school readiness by fostering children's early learning, intellectually, emotionally and socially [11]. Children who are physically, socially and emotionally healthy with basic cognitive and communication skills are better prepared to enter school and take advantage of their first formal learning environment [12, 14, 50]. Formal child care exposes children to educational resources and social interactions and may help them learn skills and behaviours they require in school. Findings from the LSAC showed that the majority of parents reported using child care for work-related purposes (25% of parents of children aged 0-1 years; 40% of children aged 2-3 years) but a significant proportion of parents with a child aged between 2 and 3 years also reported using child care for their children's benefit (1.7% of parents of children aged 0-1 years; 18% of children aged 2-3 years) [17].

2.2 Type of child care

There are numerous types of child care available to parents. These can be grouped into two main categories, formal care and informal care. There is no universal definition of what comprises formal or informal child care but classification is usually based on three criteria: relationship of carer to child, location of care and financial cost [51]. As defined by the Australian Bureau of Statistics, formal child care refers to paid care away from the child's home such as long day care (centre-based child care) and family day care (registered carers paid to deliver care in their home for small groups of children) [4]. Informal child care is non-regulated care in or away from the child's home and includes relative and non-relative care [4]. Table 2.1 provides a description of the most common formal and informal types of child care utilised in Australia.

Table 2.1: Types of formal and informal child care

Type of Child Care	Description
Formal	
Long Day Care	Services are provided in a centre, usually by a mix of qualified and other staff. Centres generally operate for eight to twelve hours per day, five days per week, for a minimum of 48 weeks per year.
Family Day Care	Services are provided by a registered carer in their home for small groups of children. The care may include weekend or evening care.
Informal Care	
Occasional care	Services are provided in a centre, on a sessional or irregular basis. Care may be provided in formal, government regulated child care centres or through unlicensed providers such as church groups.
Nanny	Providers of unregulated, paid care in a child's home, at any time of the day or night. Nannies are employed by the family.
Relative Non-relative	Providers of unregulated paid or unpaid care based in a home, at any time of the day or night.

Most centre-based and family day care services comply with regulations set by the Australian government [5]. The role of government in regulation includes funding a quality assurance system to ensure the quality of child care and licensing services to meet minimum standards of care (e.g. number of staff and their qualifications) [5]. Families only receive government assistance for the cost of child care if the service is government approved or registered. Approved child care providers must have a license to operate, have qualified staff, meet minimum operating hours and participate in the Australian government's quality assurance arrangements [52]. Registered child care providers are usually informal carers such as relatives and nannies who provide child care for work-related purposes. Carers need to register with the Australian government and meet child care legislative requirements of the state/territory [53].

Informal child care is usually non-educational in focus and in many cases a child receives care whilst the carer goes about their normal daily activities [36]. Family day care strives to provide care in a 'home-like' setting for a small group of children. Centre-based child care is least likely to be 'home-like' and usually provides care for larger groups of children. Centres are more likely to have qualified staff, a greater number of resources (toys and books), more space, more opportunity for social interactions, and more structured adult-directed activities than home-based child care environments [36]. It is perhaps for these reasons that centre-based child care is considered to provide a more 'educational' experience for children than other types of child care.

Like many other countries, the type of child care children use varies by age [54]. As shown in Figure 2.2, only 7.6% of Australian children under the age of 1 year spent time in formal child care while 28.7% used informal care. However, by the time children were 2 years of age, over 50% spent time in formal child care and 40% in informal care [7].

Figure 2.2: Type of child care by age, 2011
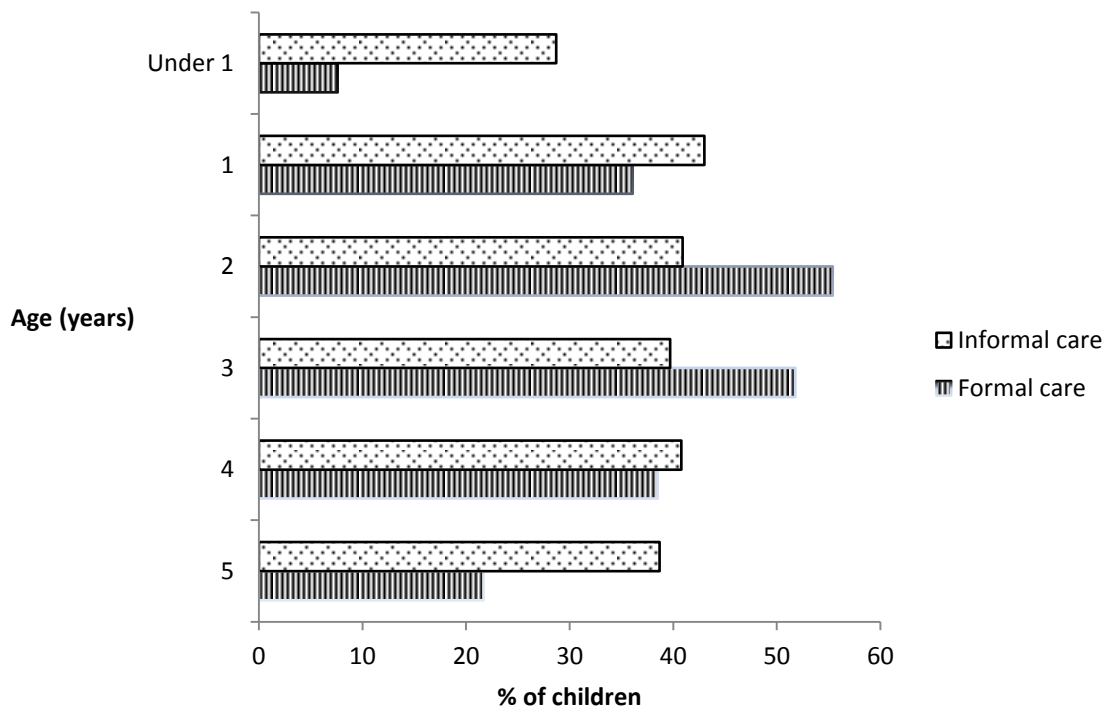
These patterns of child care experienced by Australian infants and toddlers are also seen in a recent analysis using the LSAC. The results indicated that infants were regularly cared for in one type of care, commonly informal home-based care with a relative (15.6%). The next most common type of care was formal child care, which was attended by 10.4% of infants. However, by the time children were aged 2-3 years, the number of children attending formal child care had increased from 10.4% to 40.4%, with centre-based care the most common type of care [55].

Many factors influence the type of child care parents choose for their young children. Studies have found characteristics, such as age of child, cultural norms, parental education, income and maternal employment, to be associated with parental choices of care [54, 56-58]. As illustrated in Figure 2.2, the majority of Australian infants are cared for by informal carers, most likely a relative such as a grandmother. This pattern of greater informal care at infancy is consistent across countries and has been a type of care that has remained steady for decades [59]. However, the proportion of infants in centre-based child care in Australia is relatively small in comparison to the proportion of children from the USA (7.6% of Australian children ≤1 year [7] compared to 12.0% of American children [60]). As children get older, they are more likely to experience formal child care, particularly centre-based care, possibly reflecting parental preferences for a more educational/social environment as children get closer to starting school [36, 54]. Cross-national comparisons show a more similar pattern of participation for toddlers, with 51.8% of 3 year old Australian children using centre-based care [7] compared to 42.5 % of 3 year old American children [60].

Reasons why parents choose particular types of child care for their children has received limited research attention in Australia. The limited evidence available suggests that mothers using informal child care are more likely to report personal characteristics of the caregiver such as the carer being someone she could trust as a reason for choosing this type of care. In comparison, mothers using formal types of child care are more likely to describe the quality of the environment such as stimulating activities and equipment rather than characteristics of the carer as a reason for choosing care [61].

In addition to parental preferences, maternal education and income are strongly associated with child care choices, with more highly educated mothers and higher income families more likely to select centre-based child care [36, 54, 57, 62, 63]. A recent analysis of data from the HILDA Survey revealed that 36% of households in the highest three deciles of socioeconomic advantage used formal child care compared with 22% of households in the lowest three deciles [18]. This finding of a greater proportion of higher income families enrolling their children in formal child care is not unique to Australia [63] but there are important differences when comparing participation rates by income group between countries. For instance, selection of centre-based child care in the USA has been shown to have a non-linear association to income, with families in poverty having greater access to centres as high income families [36, 64]. In the USA most public resources for child care are targeted at children living in poverty [65]. In contrast, the Australian government assists with the costs of child care for most families, with no additional targeted support for low income children [66]. The Australian government provides child care assistance in the form of payments to families to help with the costs of child care. The two major payments include the Child Care Benefit (CCB) and Child Care Rebate (CCR), paid to families using government approved or registered care. The CCB was introduced in 2000 and is a means-tested payment directed at low to middle income families. The amount of CCB each family receives is determined by a number of factors including family income; number of hours used; number of children and the type of child care [67, 68]. The CCR was introduced in 2004, to provide further support for families using approved child care. The CCR is not means-tested and provides up to 50% of families out-of-pocket expenses for approved child care after any CCB is removed, up to a maximum of $7500 per child per year [68, 69].

Children from lower income families are more likely to start school with poorer cognitive skills and more socio-emotional problems than their more affluent peers [19, 20, 70]. These early differences widen as children progress through school [71] and may influence later life course outcomes, including school completion rates [72], adult health and earnings [73], highlighting the importance of intervening early to prevent problems before they become entrenched. Children's outcomes may be influenced by low income through limited means to invest in resources such as books that are crucial for language and cognitive development [72, 74, 75]. Another pathway linking income to poorer outcomes involves parents' health and the parent-child relationship [70]. Studies have shown that lower income parents are more likely to have mental health issues [76], thus increasing negative parenting behaviours [74] that potentially lead to more internalising and externalising behaviour problems in children [70]. Therefore, formal child care may be especially beneficial for lower income children who may be more likely to experience less cognitively stimulating home environments and caregiving than children from higher income families [19, 21]. The greater use of formal child care among higher educated and higher income families has raised concerns among organisations such as UNICEF, which state that, without specific policies to ensure the availability and affordability of high quality child care services for all children, there is a danger of widening inequalities in cognitive, social and emotional competencies between the richest and poorest children in our societies [77].

2.3 Time spent in child care

Although the rise in the use of child care outside the family home is increasing globally, there is considerable cross-national variation in the amount of time children spend in child care. The majority of Australian children participating in child care do so for very few hours per week. Children in Australia in child care spend on average, 17 hours per week in care [7] compared to 29 hours per week for children living in the USA [60]. Furthermore, of children who participate in formal child care, 47% are in it for less than 10 hours per week and of children in informal child care, 58% are in it for less than 10 hours per week [78]. Very few children (7% of those in formal care and 12% of those in informal care) participate in child care for more than 35 hours per week [78]. These government statistics are supported by a recent study by Coley et al [54] who found Australian children more likely to be in part-time rather than full-time child care when they were infants and toddlers compared to American children.

There are a multitude of factors that may explain variations in the time spent in child care within and between countries including parental preferences, employment status, economic pressures, and differences in social policies that support parental leave entitlements. For example, a 2009 report reviewing the national policies of 21 high income countries showed that Australia provided guaranteed job-protected leave for one full year compared to the USA who offered only six months protected leave [79], and this may partly explain the higher proportion of infants from the USA using child care compared to Australia. Furthermore, relative to other OECD countries Australia has very high part time employment rates [9]. Based on 2006 OECD data, only the Netherlands had a higher rate of part time employment for both men and women [78]. More specifically, the percentage of Australian women working part time was approximately 39% compared to 19% of women from Sweden and 18% of women from the USA; however, Australian rates were

more comparable with those of the UK and New Zealand where 38% and 35% were working part time [78]. Such high rates of part time employment in Australia may also explain the relatively fewer hours children spend in child care.

2.4 Quality of child care

With a significant and growing number of children spending regular time in child care, it is essential to consider the quality of that care. There is no universal definition or measure of child care quality but it can be defined by considering both structural and process characteristics of care [80]. Structural quality generally refers to characteristics of child care that underpin the processes that children experience. These include staff qualifications, number of children in a group, and staff-to-child ratios. Process quality refers to practices that directly affect children's experiences including interactions between carer and child [81]. Important aspects of high quality child care include warm and responsive relationships between carer and child [38, 80, 82] as well as being actively engaged in activities that fosters children's early learning, including their development intellectually, emotionally and socially [43, 83]. While structural aspects of child care such as educational qualifications and staff-to-child ratios have been found to be predictive of positive caregiving in some studies [84, 85] their direct associations with children's developmental outcomes has been far less consistent [28, 85].

2.5 Measurement of child care quality

Many researchers have measured the quality of the child care environment by directly observing and quantifying the process characteristics of care such as the interactions and activities in which children and staff are engaged, as well as documenting the structural elements of care including staff-to-child ratios and staff qualifications [80, 85]. Instruments including the Early Childhood Environment Rating Scale-Revised (ECERS-R) [86] and the Observational Record of the Caregiving Environment (ORCE) [33, 34, 84]

have been used in the major child care studies to examine the association between child care quality and developmental outcomes. The ECERS-R is designed to measure overall classroom quality and comprises 43 items that assesses seven areas of centre-based child care. The seven areas include: space and furnishings (e.g. furniture for routine care, play and learning), personal care routines (e.g. health practices), language reasoning (e.g. books and pictures, encouraging children to communicate), activities (e.g. fine motor, dramatic play), interaction (e.g. staff-child interactions, discipline), program structure (e.g. group time, free play) and parents and staff (e.g. provisions for parents) [87]. The ORCE was specifically developed for the National Institute of Child Health and Development study into early child care (NICHD study) and focuses on an individual child's experience in any type of non-maternal care at 6, 15, 24, 36 and 54 months of age [33] rather than the experiences of the group as a whole. Observers assess carer and child behaviours using a frequency checklist that consists of items such as the carers' sensitivity and responsiveness to the child. In addition, ratings of the carers' behaviours that take into consideration the quality of the carer's behaviour relative to the child's behaviours are documented [88].

Assessments based on direct observations of child care quality are not practical for most large, population-based studies due to costs and time constraints. However, research assessing the reliability and validity of alternative assessment methods, such as carer self-reporting of child care quality is scarce, with a search of the peer-reviewed literature identifying only four studies [43, 89-91]. One of these studies investigated the extent to which accurate information on child care quality could be obtained from carer reports [89]. Findings revealed a high level of agreement between carer report and direct observation of child care quality with carers' reports classifying over 89% of the care in terms of "poor" "mediocre" or "developmentally appropriate" compared to the measures of the ECERS-R. This suggests reasonable validity of carer reporting in assessing child care quality [89].

Other methods used to assess the quality of the child care environment include measuring the carers' perception of their relationship with individual children [38]. A widely-used instrument includes the Student Teacher Relationship Scale (STRS); a self-report instrument comprised of 15 items rated on a five-point Likert scale that describes a teacher's perception of his/her relationship with the child. The STRS can be summed into two sub-scales, known as the closeness and conflict sub-scales [92]. The closeness items describe the extent to which a relationship is perceived to be warm, affectionate with open communication and the conflict indicators ascertain the perceived negativity within the relationship [92]. Instruments that focus on specific aspects of quality, such as the STRS, are important to use in child care research, as they provide specific information about the environment that contributes towards children's developmental outcomes and may better inform program interventions [93].

Increasing concern regarding the measurement of child care quality has emerged in recent years [80, 93-95]. Researchers have argued that many quality measures have been developed conceptually but not psychometrically [94]. Gordon et al. [95] in 2012 found little evidence for the validity of the ECERS-R using data from the Early Childhood Longitudinal Study Birth Cohort (ECLS-B). The authors, using factor analysis, found no evidence that the ECERS-R measured a single overall aspect of quality or six subscales of quality (the parent and staff quality area was not included in their analysis as it was not collected in the ECLS-B). Additionally, there was limited evidence of criterion validity, with the ECERS-R total score and its factor scores infrequently associated with children's developmental outcomes [95]. A recent compendium outlining the reliability and validity of existing quality measures also highlighted that most were designed to be used in centre-based settings and for children aged between 3 and 5 years, therefore potentially limiting the measurement of quality of home-based care that many infants and low income children experience [96]. The main purpose of this part of the review is to highlight that no single

measure is without limitations and that work regarding how to best measure quality in child care is required.

In summary, Sections 2.1 through 2.4 have provided an overview of the growing number of children using child care, the different types of child care available to parents and the factors that influence the type of child care parents choose for their young children. The time spent in child care and the definition of quality and how it is measured were outlined. Against this backdrop, research examining family and child care factors associated with children's development will now be reviewed.

2.6 Family factors and children's development

Child development is a complex process shaped by the interplay of biological factors and a range of social, economic and environmental factors [97]. Family factors such as household income, mother's education and the quality of the home environment are strongly associated with children's developmental outcomes [28, 32, 70, 98, 99]. Children from socioeconomically advantaged backgrounds are more likely to experience higher quality home environments that in turn support healthy learning and development [31, 70, 100]. Mother's education is widely recognised as a key predictor of children's cognitive ability [101, 102]. Findings from a study that investigated three measures of socioeconomic position (income, mother's education and father's education) found that education was the best predictor of children's intellectual achievement [103]. Similar evidence comes from the Canadian National Longitudinal Survey of Children and Youth that found an increase of 6.5% of a standard deviation in children's receptive language ability for each additional year of education [31].

There is strong evidence that family factors such as maternal education and the home learning environment are more strongly predictive of children's cognitive ability and socio-emotional competence than child care factors [27, 29, 30, 32, 104, 105]. Nevertheless, due to the increasing prevalence of children spending time in child care even small effects may have significant implications at the population level. For instance, research has shown that the effects of extensive child care influence not only the child but their classroom peers with little or no exposure to such care [106].

2.7 Child care and children's development

The influence of child care on children's cognitive and socio-emotional development has been the subject of research and debate for the past three decades. Considerable research mainly from the USA [32-41], has informed questions about the effects of child care on children's development. The landmark NICHD study established in 1991 is the largest and most comprehensive longitudinal study of early child care to date. This review focuses largely on this study as it has provided some of the best evidence regarding the longitudinal effects of child care. Prior to the NICHD study most research in this area has been hampered by methodological weaknesses including small sample sizes, attrition bias and the failure to control for important confounding factors [107, 108] and is therefore not reviewed. This section of the review aims to evaluate the key research evidence over the last two decades regarding whether the type, time and quality of child care in the first three years of life influence children's cognitive and socio-emotional development at school entry and beyond.

As outlined in Section 2.2 of the literature review, there are numerous types of child care arrangements available to parents. To better understand how different types of child care influence children's cognitive and socio-emotional outcomes consideration also needs to be paid to the quality and the amount of time spent in that setting. Findings from the

NICHD study that recruited 1364 children from hospitals at 10 sites in the USA (Little Rock, AR; Irvine, CA; Lawrence, KS; Boston, MA; Philadelphia, PA; Pittsburgh, PA; Charlottesville, VA; Morganton, NC; Seattle, WA and Madison, W1) [35] have consistently shown that centre-based child care (but not other types of care) is associated with children's developmental outcomes [109]. For example, in a study that examined three types of child care (centre-based care, child care homes and relatives) for children aged 3-54 months, the authors demonstrated that after controlling for family factors and child care quality, only hours in centre-based child care were associated with children's cognitive and social development at 54 months of age [36]. More specifically, children who spent more time in centre-based care during each developmental period (1-17 months, 18-35 months and 36-54 months) were reported at 54 months of age to have higher externalising behaviour problems than other children [36]. In addition, increased hours in centre-based care at infancy was associated with lower language scores whereas more hours for children ≥3 years was associated with higher language scores [36]. Further analysis using the NICHD cohort found that compared to children with no centre care, more time in centre-based care at 15, 24 and 36 months was associated with better cognitive and language outcomes and more positive peer interactions but also with more behaviour problems by 54 months of age [109]. Problem behaviours continued to be observed for children who experienced centre-based child care up to sixth grade [32]. However, by the time children were 15 years of age, time spent in centre-based care was no longer associated with children's development [37].

The NICHD study findings of increased behavioural problems with greater time in centre-based child care at infancy and toddlerhood were not replicated in a recent study using a nationally representative cohort of American children (n=6000) [40]. In this study, centre-based child care at infancy (9 months of age) predicted higher teacher-reported and parent-reported externalising problems at kindergarten when compared to parent care but there

was no association between time in centre-based child care in toddlerhood (2 years of age) and children's later externalising behaviour [40]. The lack of an effect in toddlerhood compared to findings from the NICHD study may reflect the different age categories used.

It is also important to consider the cumulative amount of time spent in child care on children's development. Cumulative time spent in child care across the first 4.5 years of life has been shown to be associated with higher levels of problem behaviours for children at 54 months of age [34]. But continued follow up of the NICHD cohort found that more time spent in child care on the matter of externalising problem behaviours diminished by the time children were in third [110] and sixth grade [32].

Research in the UK has also shown a link between centre-based child care and children's socio-emotional development. Stein et al. [99] using data from the Families, Children and Child Care Study found that more time in child care centres was associated with greater problem behaviours, specifically hyperactivity, at school entry. However, unlike other studies, children cared for by a grandparent were more likely to have peer problems at school entry [99]. In terms of cognitive outcomes, Cote et al. [111] using data from the UK Millennium Cohort Study (n=13,000) found that children who were in any type of child care during infancy (9 months of age) experienced better cognitive outcomes than those in parental care. In particular, centre-based care compared to informal care was associated with better cognitive development at school entry but this effect did not extend to 7 years of age [111]. Similarly, results from a smaller study in the UK found that children in centre-based care had a higher number of different word combinations than children cared for by a relative or by a parent [112]. These effects were still apparent at age three [113].

Unlike research from the USA [36, 40, 109] and the UK [99] research in Norway has found no link between time in child care and children's socio-emotional development. A longitudinal study of 935 Norwegian children found no association between time spent in child care in the first 4.5 years of life and children's social competence and externalising problem behaviours at approximately 54 months of age [114]. Another study using a population-based Norwegian sample of 75,271 children found no association between maternal reports of hours in child care and children's externalising problems at 18 and 36 months of age [115]. The authors in both these studies argued that the absence of an effect comparable to the findings from the USA possibly reflected variations in family policies, child care quality and regulations governing child care [114, 115].

There is a paucity of Australian research on the influence on children's development of the time spent in different types of child care. There are only a handful of studies (n=5), but the majority suggest that time spent in centre-based child care is associated with behaviour problems. However, in contrast to the USA and the UK, the limited research from Australia provides mixed results regarding the effect of time spent in formal child care and children's cognitive ability as children start school [47, 48]. In the largest study, Coley et al. [47] analysed data from the LSAC and found that child care at infancy (3-19 months) was not associated with children's later cognitive development. However, children who experienced centre-based care during toddlerhood (15-29 months) scored more highly in academic and language skills at age 6-7 years compared to children in other types of care [47]. Conversely, a longitudinal study of child care choices of 677 families residing in metropolitan and rural New South Wales, found that children attending formal child care for longer hours per week in the year before starting school experienced lower literacy scores [48].

In terms of socio-emotional outcomes, Yamauchi and Leigh [46] used the LSAC data to examine the use of different types of child care at age 0-1 year and 2-3 years on children's behavioural development using the Short Temperament Scale for Infants at age 2-3 years. The results showed that after adjustment for potential confounding, full time use (≥20 hours per week) of centre-based child care was associated with negative behavioural outcomes, but the association between behaviour problems and other types of care (family day care, informal care, preschool/kindergarten) was negligible [46]. Similarly, the NSW longitudinal study of child care that used the Strengths and Difficulties Questionnaire to assess problem behaviours [116] found that more hours in formal child care was associated with teachers ratings of more socio-emotional difficulties [48]. In contrast, a longitudinal study of 147 first-born children residing in Sydney, Australia found no association between type or quantity of child care at 12 months and mother-rated behaviour problems using the Child Behavior Checklist at 30 months and 5 years of age [42]. These contradictory findings could be explained by the different constructs used to measure developmental outcomes. For example, of 52 studies investigating various aspects of child care and children's socio-emotional development 57 different measures were used [117].

Based on the review of the literature, there is little existing evidence of the developmental effects of time spent in different types of child care in the Australian setting. Furthermore, what has not been studied in the Australian context is the cumulative amount of time spent in child care and the effect it has on children's cognitive and socio-emotional outcomes as they start school.

There is widespread agreement that the quality of child care is important for children's development. High quality care and education has been recognised by the United Nations human rights charter as one of the most effective ways to develop children's cognitive and socio-emotional capabilities [118]. Early childhood interventions designed for at-risk children (e.g. Early Head Start [119], Perry Preschool Project [120] and the Abecedarian Project [121]) provide convincing evidence that quality early child care and education are related to improved social and cognitive competence with some positive effects lasting into adulthood [122]. Research from the large-scale NICHD study also provides good evidence that high quality child care plays an important role in contributing to children's healthy development [33, 35, 36, 109, 110, 123]. However, other research, has found no association between child care quality and child outcomes [30, 124] signalling the need for local Australian evidence regarding the importance of child care quality given the diversity of family characteristics and the variations in child care systems in different countries.

Findings from the NICHD study have consistently shown positive outcomes for children enrolled in centres that provide a cognitively stimulating experience, have smaller group sizes and carers who are more sensitive and responsive [33, 35, 37, 109, 125]. Higher quality child care (using the ORCE positive caregiving composite that is calculated as the mean of five 4-point ratings including sensitivity to child's non-distress signals, stimulation of cognitive development, positive regard for the child, emotional detachment [reverse-scored] and flatness of affect [reverse scored]) was associated with better cognitive and linguistic competence in children at 54 months of age [33]. However, in this study the quality of care was not associated with children's socio-emotional outcomes (social skills and behaviour problems) after adjusting for a range of family characteristics [33].

In another analysis of the NICHD cohort, the overall quality of child care for children from birth to 4.5 years of age was again found to be associated with children's cognitive, social and emotional development [35]. However, when the authors examined specific aspects of quality (language stimulation; positive physical contact; positive talk; positive interaction with other children and stimulating physical materials) by outcome, higher quality child care was only associated with cognitive outcomes and not social and emotional skills [35]. A study of centre-based child care in four states in the USA (Cost, Quality and Child Outcomes in Child Care Centers Study) utilised the closeness factor of the STRS as one measure of child care quality. Findings showed that teachers who rated their relationship with the child as closer (e.g. sharing a warm and affectionate relationship) had children with higher language and math scores and who were rated as having lower problem behaviours through second grade [38]. Findings from both these studies highlight the importance of examining specific aspects of quality and not simply total summary scores, since identifying what quality area is linked to children's development may better inform policy and program interventions and investments [93].

More recently, evidence of the longer term effects of child care quality have been investigated by Belsky et al. [32] who reported that children who experienced higher quality child care at approximately 27 months had higher vocabulary scores in fifth grade but the effect on reading although strong at 54 months of age was weak by fifth grade. In contrast, Vandell et al. [37] found that the effects of quality continued to exert their influence on adolescent functioning. In this study, quality of care that was of moderate quality or better was associated with cognitive-academic outcomes at age 15 years. Furthermore, higher quality child care was linked to less externalising problem behaviours at age 15 years [37].

Child care is increasingly being touted as a promising intervention for enhancing human capital, particularly for disadvantaged children [126]. However, any benefit is conditional on the quality of care: exposure to low quality child care may adversely influence developmental outcomes such as cognition and socio-emotional well-being, placing children at an early disadvantage [126]. A study by Dowsett et al. [127] found that lower income children aged 2 and 3 years had fewer adult interactions and received less language and cognitive stimulation in child care than children from higher income families. As highlighted in Section 2.2, research suggests that children from lower income families remain more likely to experience poorer quality care than those from higher income families [63, 127], yet it is they who are believed to gain the most [77].

Evidence regarding whether the association between quality of child care and children's development varies as a function of family income is mixed. Dearing et al. [74] using a global measure of child care quality that summed a number of quality domains, including carer sensitivity and responsiveness to a child, found higher quality care protective of children in low income families, thus supporting their school readiness (e.g. letter identification). However, Burchinal et al. [39] analysing three large-scale child care studies conducted in the USA found limited support for the hypothesis that child care quality matters more for children experiencing social risk factors including poverty. As a result, the association between child care quality for low income children younger than three years of age and their development remains unclear.

There is a lack of Australian research evaluating the effects of child care quality on children's cognitive and socio-emotional development. A search of the peer reviewed literature identified only four Australian studies investigating the developmental effects of child care quality. Of these, two provided a cross-sectional snapshot of the effects of child care quality on children's socio-emotional outcomes [43, 44] and two examined the effects

longitudinally [42, 46]. No Australian study has investigated the influence of child care quality on children's cognitive development.

The Australian research to date has identified a positive link between child care quality and children's development. Research by Harrison [43] using the Longitudinal Study of Australian Children found that children aged 2-3 years in smaller groups (1-5 children) had higher carer rated scores for social competence [43]. Furthermore, carers who reported spending more time in active engagement with children had higher parent and carer scores for social competence at 2-3 years of age [43]. However, as noted by Harrison [43], the study did not adjust for important confounding influences related to the use and selection of child care, so given the strong associations between parent, family and home characteristics that influence parental child care choices and children's developmental outcomes, these findings are likely a biased estimation of effect. Yamauchi and Leigh [46] in their study regarding time in different types of child care also investigated four aspects of structural quality: the carer-child ratio; share of staff with early childhood qualifications; accreditation status and scores from the government's quality assessment and children's behavioural outcomes at age 2-3 years. They found that the negative association between full time centre-based child care and child outcomes was mitigated for children who attended centres with higher carer-child ratios [46]. There was no association between any other structural aspects of child care and children's behavioural outcomes.

In summary, Section 2.7 has reviewed evidence of the effects of the type, time and quality of child care on children's development in a number of global contexts. The most consistent effects were seen for observed child care quality where higher quality was associated with better cognitive and social-emotional outcomes for children. For example, child care effect sizes in the NICHD study ranged from 0.01 to 0.41 [109]. Modest effect sizes were also seen for the association between time in child care and children's

development. For instance, in the NICHD study, children who spent more hours per week in child care showed modestly more social skills at 24 months (d= 0.29) but more problem behaviours at 36 months (d=0.29) and at 54 months (d=0.42) [109]. Finally, in terms of effect sizes associated with type of child care, more time in centre-based care was modestly associated with better cognitive outcomes at 24 months (d=0.20), better receptive vocabulary at 36 months (d=0.21) and better memory skills at 54 months of age (d=0.19) but more problem behaviours at 36 months (d=0.20) [109]. Overall, although the effects were small to moderate, they may have important implications at the population level due to the large proportion of children who spend significant amounts of time in childcare on a regular basis.

2.8 Quality of child care in Australia and the United States

As there is considerable variation in child care provisions across countries it is difficult to know whether the same effects of child care quality seen in the United States would exist in different countries [42]. Australia is one of few countries that has a national quality framework that provides quality assurance through an accreditation system for long day care and family day care services [128]. By accrediting child care centres the expectation is that centres will try to improve their service which in turn will facilitate children's learning and development and influence parent's choice of care [129]. As the quality improvement and accreditation system is attached to government funding, over 98% of services are accredited or registered in the system [130]. By way of contrast, less than 10% of child care centres in the United States are nationally accredited [129] with recent reviews indicating that many states do not meet the licensing laws or are exempt from them [100]. The differential compliance with standards may result in wider variations in quality indicating the need for studies in different countries.

2.9 The Australian policy context

Over the past four decades policy interest and commitment to child care has grown significantly. Prior to 1972, child care was widely considered a private responsibility, and the role of parents, usually the mother as the primary caregiver, therefore attracted little government attention [131]. Child care was portrayed as serving the needs of mothers with little developmental benefit for children. The work of Bowlby in the 1950s cautioned that separating young children from their mothers for extensive periods may lead to psychological harm [132] fuelling beliefs that child care was not in the best interests of the child. However, by the early 1960s increasing pressure was put onto the Commonwealth government to assist with the provision of child care services. The growing numbers of women in the workforce, concerns of children being left at home unsupervised and the women's liberation movement resulted in the introduction of the Commonwealth Child Care Act (Cth) in 1972 [131, 133]. The Act provided funding to non-profit child care services for working and sick parents and only in 1991 was monetary support extended to the private, for-profit child care sector to make government funded child care available to all children and to meet the growing demand [131].

By the late 1980s international research and debate regarding the developmental effects of child care [134] and particularly the quality of care were emerging [135]. Discussions about the quality of child care were also occurring at the political level, which, together with international evidence regarding the importance of quality for children's development, led to the government establishing a national quality accreditation system to ensure children would receive high quality care regardless of whether attending a profit or non-profit child care centre [133]. In 1993, the National Child Care Accreditation Council (NCAC) was established to facilitate quality assurance through an accreditation system for long day care centres which was then extended to family day care services in 2002 [128].

The primary objective of the NCAC was to implement quality standards that would ensure the best possible outcomes for all children [128]. The quality assurance process underwent several revisions but by 2005, seven quality areas (each containing a number of principles) for assessing child care services were in place and included:

1. Staff relationships with Children and Peers

2. Partnerships with Families;

3. Programming and Evaluation;

4. Children's Experiences and Learning;

5. Protective Care and Safety;

6. Health, Nutrition and Wellbeing;

7. Managing to Support Quality.

There were no nationally consistent Australian child care regulations; however, the child care quality assurance system managed by NCAC was designed to operate in conjunction with state and territory licensing regulations, with most child care services (98%) complying with the standards [128].

Child care has become a core component of the Australian government's commitment to support universal access to quality early childhood education [22]. However, political and financial investment in early care and education has been lacking. In 2008, the first report card that evaluated and compared early childhood services across 25 OECD countries revealed that Australia only met two of the 10 minimum standards of care (subsidised and regulated child care for 25% of children <3 years; 50% of staff in accredited early education services being tertiary educated with relevant qualification) placing us third to bottom on the league table [3]. Similar to the USA and the UK, Australia only spent 0.2 percent of Gross Domestic Product (GDP) on early childhood services whilst Northern

European countries including Sweden, Denmark and Norway spent at least 1.0 percent of GDP in the area and importantly, met eight or more minimum standards of care [3].

Since the release of the OECD report, there has been a shift in government support for childhood development and early childhood services. As highlighted in the Introduction of this thesis, in 2009, the COAG established the first National Early Childhood Development Strategy to "ensure that by 2020 all children have the best start to life to create a better future for themselves and for the nation" [23]. Key goals of the National Strategy are to reduce the impact of risk factors on children's development, reduce inequalities in outcomes between groups and to improve outcomes for all children. The value of high quality child care to optimise children's learning and development is recognised in the National Strategy and consequently a National Quality Agenda for Early Childhood Education and Care was endorsed with COAG committing more than $18 billion to improve the quality, affordability and accessibility of child care [24]. A key component of the National Quality Agenda includes the development of an integrated, nationally consistent accreditation system for child care services to be implemented by a national body (ACECQA) that has joint Commonwealth and state/territory governance arrangements [128]. The seven quality areas (each comprising a number of principles) deemed critical to the provision of quality child care include:

1. Educational program and practice;

2. Children's health and safety;

3. Physical environment;

4. Staffing arrangements, including staff-to-child ratios and qualifications;

5. Relationships with children;

6. Collaborative partnerships with families and communities;

7. Leadership and service management.

There are five rating levels: excellent; exceeding national quality standard; meeting national quality standard; working towards national quality standard and significant improvement required [136]. Every service receives a rating for each quality area and an overall rating. To further support high quality outcomes for children, the National Quality Agenda also requires higher staff qualifications and improved child-to-staff ratios that are being phased in between 2012 and 2020.

2.10 Research justification

There is growing interest in research examining the longer term effects of early childhood development such as, programs which can support better child development, and research on which approaches can close child development gaps for disadvantaged groups. Considerable evidence suggests that investments in the years before children enter formal school have the greatest rate of return than investments made at any other time [19, 137]. This literature review has demonstrated a significant and growing number of Australian children spending regular time in child care. However, the studies reviewed in this chapter have highlighted the gap in knowledge regarding the effects of child care on children's later development in the Australian setting. Most evidence regarding child care has come from the USA or the UK with little evidence as to whether these findings apply in Australia, where the social, regulatory and labour market context is different. The Australian government is making a substantial investment to improve the quality, affordability and accessibility of child care; yet the evidence-base relevant in the Australian setting is limited.

Furthermore, although findings from the studies reviewed in this chapter provide valuable information regarding the effects of child care on children's development there are study design issues that may limit the generalizability of results. For example, the NICHD study is not nationally representative with participating families having higher incomes, more education and less likely to be of a minority group than the general population [27]. For this reason, further research concerning the longitudinal effects of early child care on children's development is required.

An additional concern is that almost all evidence regarding the association between different aspects of child care and children's development has come from observational studies where assignment to treatment is not randomised. As noted in Section 2.7, prior to the NICHD study, most research in this area was plagued by methodological limitations including small sample sizes, attrition bias and the failure to control for important confounding factors [107, 108]. Only in recent years have researchers begun to use analytic methods including propensity score matching [40, 74] and multiple imputation [32, 74, 115] to better address the possibility of bias.

The topic of this thesis is the design, conduct and results of four studies using data from the LSAC. The studies will explore:

- The total time spent in child care in the first three years of life and its importance for children's cognitive and socio-emotional development;

- The effect of the main type of child care in the first three years of life on children's cognitive and socio-emotional development;

- The quality of formal child care at age 2-3 years and its effect on children's cognitive and socio-emotional development;

- Whether higher quality child care at age 2-3 years is associated with better cognitive and socio-emotional outcomes at school entry for children from lower compared to higher income families.

The findings of this thesis should fill a gap in knowledge about the longitudinal effects of child care on children's development within the Australian context.

3   The Longitudinal Study of Australian Children

In Chapters 1 and 2 the four aims of this thesis, a review of the literature and research justification were presented. This chapter describes the LSAC, the variables selected to operationalise type, time and quality of child care, the confounding variables, developmental outcomes and an analytical approach to answer each of the four aims of this thesis.

3.1 LSAC overview

The LSAC is the first national study following the health and development of two population-representative samples of children recruited in their first and fourth years of life [138]. The LSAC aims to assess a large range of individual, family and environmental factors of health and well-being to provide data that will inform policy and services within Australia [138].

The LSAC is rich in child care, socio-demographic, home, health and developmental factors related to the child and also to the parents. This presents the unique opportunity to examine various aspects of child care and their influence on children's cognitive and socio-emotional development in the early school years, adjusting for an extensive set of confounding factors, using a contemporary Australian cohort of children.

3.2 Sample design

Study participants were identified using Australia's national Medicare database in which >90% of infants are enrolled. A two-stage cluster design, based on postcodes was used as the sampling framework. The first stage included selecting postcodes and the second stage, selected children within these postcodes [139]. Stratification by state/territory and urban/rural status was undertaken to ensure the sample was geographically representative. Postcodes were randomly selected with probability proportional to size selection, and with equal probability for small population postcodes. For both cohorts, children were selected from the same 311 postcodes. In terms of the number of children selected within each postcode (cluster size), the aim was to recruit 10 to 20 children per cohort per postcode. Overall, the selection process ensured that children in each postcode had the same probability for being selected into the study (approximately 1 in 25). A mean number of 40 children per postcode in the larger states and 20 children in the smaller states and territories were selected to participate in the study. On most characteristics, the LSAC sample is broadly representative of the Australian population [139].

3.3 Participants

The reference population for this thesis include infants recruited in their first year of life, born between March 2003 and February 2004. At wave 1, 5107 infants were recruited into the LSAC and were reassessed at wave 2 (n=4606), wave 3 (n=4386) and wave 4 (n=4242). Major data collection was undertaken biennially and commenced in 2004. Data from face-to-face interviews and questionnaires from the child's parent (henceforth referred to as the primary caregiver), teacher and child care providers (henceforth referred to as non-parental carers) and direct child assessment were used. An overview of the LSAC study cohort and period of observation that informed the specific aims of this thesis is shown schematically in Figure 3.1.

Figure 3.1: Study timeline

Mean age 9 months IQR 7-11 months Wave 1, 2004	Mean age 34 months IQR 32-36 months Wave 2, 2006	Mean age 58 months IQR 56-60 months Wave 3, 2008	Mean age 82 months IQR 79-84 months Wave 4, 2010
Child care type	Child care type	Receptive vocabulary	Receptive vocabulary
Child care quantity	Child care quantity	Internalising behaviour	Literacy proficiency
Confounding factors	Child care quality	Externalising behaviour	Numeracy proficiency
	Confounding factors	Task attentiveness	Internalising behaviour
		Emotional regulation	Externalising behaviour
		Confounding factors	Task attentiveness
			Emotional regulation
			Confounding factors

3.4 Child care variables

The following section describes the variables I selected to operationalise type, time and quality of child care. This is also described in detail within each of the published articles in Chapters 4-6. To answer the aims of the thesis, questionnaire data collected at wave 1 (0-1 year) and wave 2 (2-3 years) were used. Between wave questionnaires (wave 1.5 and wave 2.5) were not used, as the number of hours spent in all types of child care were reported in categories and no information about the quality of the child care was obtained from child care providers.

Child care type and time

To address the first aim of this thesis detailed information concerning the type and time spent in child care was extracted from face-to-face interviews with the study child's primary caregiver (97% mothers) at age 0-1 years and again at age 2-3 years. At each time point, the primary caregiver reported whether over the past one month the study child had been looked after at regular times during the week by anyone other than the parent living in the home. If the response was "yes" then the regular type of care, the number of hours each week the child attended, and for how many months the child had been attending this care was ascertained for up to three different types of child care arrangements.

The primary caregiver was provided with 10 response options in wave 1 and 11 response options in wave 2 including: long day care; family day care; occasional care; gym, leisure, community centre; mobile care unit; grandparent; other relative; nanny; parent living elsewhere; other; or preschool (only asked at wave 2). The types of child care were categorised as: centre-based care (long day care); family day care; nanny or relative (parent living elsewhere, grandparent, other relative, or nanny); and other (occasional care, gym, leisure, community centre, mobile care unit, or other). We excluded a small proportion of children enrolled in preschool/kindergarten, as in Australia, they are administratively

classified as belonging to the education sector unlike child care services [6]. Furthermore, unlike child care for children aged ≤ 3 years, preschool/ kindergarten is usually delivered by a degree-qualified teacher on a sessional basis between 10-12 hours per week mainly in the year before children start full-time schooling at age 4-5 years [6]. The time spent in each type of child care was reported by the primary caregiver at age 0-1 and 2-3 years. Time spent in each type of child care was calculated as: Total Time (TT) = (total hours per week x 4.3 weeks in a month) x (total months in child care). A variable describing the cumulative time in child care was calculated as the sum of the time spent at the 0-1 and 2-3 year time period ($TT_{0-1}+TT_{2-3}$). For example, child X had been attending family care for 3 months at 6 hours/week at wave 1 (age 10 months). At wave 2 (age 34 months) the same child had been attending centre-based care for 12 months at 18 hours/week. The total time in non-parental care was estimated as 1006.2 hours across the 3 year period: (6 x 4.3) x (3) + (18 x 4.3) x 12.

The primary type of child care in which the child spent most time over the 0-3 year period was also calculated. If a child did not attend child care, a value of 0 was given. Children who did not attend any type of child care across the 0-3 year period were classified into the "primary caregiver only" category and were used as the reference group in all analyses.

Child care quality

To address aims two to four of this thesis a measure of child care quality was created. No direct observational measurement of child care quality was possible in the LSAC due to the size of the study and the geographic spread of participants. Instead, at the face-to-face interview, if the primary caregiver reported that the child spent eight or more hours per week in child care, a questionnaire was posted to the non-parental carer (if more than one child care arrangement was used, it was posted to the child care setting attended for the most number of hours) to capture information about the child care environment.

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As the type of child care could be provided in a formal or informal environment two types of questionnaires were developed by the LSAC consortium: a centre-based questionnaire sent to carers in a long day care centre and a home-based questionnaire sent to carers who provided regulated care in their home (family day care) or informal carers such as grandparents. As informal carers such as grandparents provide unregulated care in their home, they were not asked to report on aspects of their work environment, work experience, and professional development and since these are considered important indicators of quality, the quality of informal child care was not able to be assessed in this thesis.

In order to create a measure of child care quality, all indicators in the centre and home-based questionnaires were assessed. Three a priori domains of child care quality were generated using common indicators from the centre and home-based carer questionnaires. For this purpose, domains of child care quality were identified on the basis of a conceptual framework that considered Australian child care standards for centre and family day care, aspects of quality captured by direct observational methods, and, previous research on the key components of quality. Information on 57 potential indicators of child care quality was available from the questionnaires. A final list of 31 indicators that were judged to capture meaningful aspects of the quality of care with research evidence to support their inclusion was used [33, 43, 87]. As shown in Table 3.1, these 31 indicators represented structural (provider and program characteristics) and process (activities and carer-child relationship) characteristics of care.

Table 3.1: A priori domains and indicators of child care quality selected from the LSAC centre and home-based non-parental questionnaires (n=31 indicators)

Domain	Indicator	Response Category
Provider and program characteristics *(n=5)*	What is the highest educational qualification you have completed?	1= ≤ Secondary education 2= Advanced diploma/certificate 3= ≥ Bachelor degree
	Are you currently studying for a qualification that will expand your skills and knowledge in child care or early childhood education?	1=No 2=Yes
	In the last 12 months, what is your best estimate of your hours spent on professional development activities?	1=≤ 6hours 2=7 to12 hours 3=13 to18 hours 4=19 to 24 hours 5= ≥25 hours
	Counting this year, for how many years have you worked for 10 hours or more per week in child care settings, early education programs or school settings?	1= ≤ 8 years 2= ≥ 9 years
	How many children, including the study child, are usually present in the same room?	1= ≥21 children 2= 11-20 children 3=6-10 children 4= ≤5 children
Activities *(n=11)*	**How much of your usual daily work with the children is described by the following:**	
	Sitting and playing with children (puzzles, blocks, construction, drawing, etc.)	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Singing, telling stories, reading books	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Managing problem behaviour	1= Quite a lot/Very much 2 = Not At All/Somewhat
	Giving individual attention in routine care (helping child with feeding, toileting, dressing, sleep, etc.)	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Organising space, equipment or toys, food and drink	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Teaching good health practices (hand washing, healthy eating, sun protection, etc.)	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Taking part in children's active outdoor play (ball play, running, etc.)	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Watching or supervising child or children's play	1= Not At All/Somewhat 2 =Quite a lot/Very much
	Taking part in pretend play	1= Not At All/Somewhat 2 =Quite a lot/Very much
	On average, how many minutes per day does someone read books or sing songs to the children	1= ≤1 hour 2= >1 hour
	On average how much time was spent watching TV, videos, DVDs'	1= Daily 2= Less often 3= Never

Carer-child relationship *(n=15)*	**For each of the following statements please indicate the nature of your relationship with the study child (STRS):**	
	I share an affectionate, warm relationship with this child	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	This child and I always seem to be struggling with each other (i.e. having a hard time getting along)	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	If upset, this child will seek comfort from me	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	This child is uncomfortable with physical affection or touch from me	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	This child values his/her relationship with me	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	When I praise this child, he/she beams with pride	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	This child spontaneously shares information about himself/herself	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	This child easily becomes angry with me	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	It is easy to be in tune with what this child is feeling	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies
	This child remains angry or resistant after being disciplined	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	Dealing with this child drains my energy	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	When this child is in a bad mood, I know we're in for a long and difficult day	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	This child's feelings towards me can be unpredictable or can change suddenly	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	This child is manipulative with me	1=Applies somewhat/ Definitely applies/Neutral/Not sure 2= Definitely doesn't apply/Not really
	This child openly shares his/her feelings and experiences with me	1= Definitely doesn't apply /Not really/Neutral/Not sure 2=Applies somewhat / Definitely applies

Provider and program characteristics of child care

Five indicators were used to describe provider and program characteristics of child care. These were the carer's (1) highest educational qualification, (2) professional development in the last 12 months, (3) number years worked for ≥ 10 hours per week in child care settings, early education programs or school settings, (4) current participation in an educational program designed to expand their skills and knowledge in child care or early childhood education, and (5) number children, including the study child, usually present in the same room.

The carer's education was taken as the highest qualification achieved. This was coded as three categories, ranging from ≤secondary education; advanced diploma/certificate and, a bachelor's degree or higher. Carers' were asked to report their best estimate of hours spent on professional development activities in the last 12 months (0 hours; 1 to 6 hours; 7 to 12 hours; 13 to 18 hours; 19 to 24 hours; ≥25 hours) and was coded as five categories: ≤6 hours; 7 to 12 hours; 13 to 18 hours; 19 to 24 hours and ≥25 hours. The number of years the carer worked for 10 hours or more per week in child care settings, early education programs or school settings was coded as two categories: ≤8 years and ≥9 years. Carers were asked to report any current participation in an educational program designed to expand their skills and knowledge in child care or early childhood education (yes or no). Carers were also asked to report the number of children including the study child, usually present in the same room (only the study child; 1 to 5; 6 to 10; 11 to 20; 21 to 30; 31 or more) and was coded as four categories: ≤5 children; 6 to 10 children; 11 to 20 children and ≥21 children.

Activities in child care

Eleven indicators characterised activities in child care. Nine of the eleven indicators comprising the activities in child care domain were based on items from the NICHD study of early child care [84]. The carer was asked to report 'how much of their usual daily activity' was described by: (1) sitting and playing with the child, (2) singing, telling stories and reading books, (3) participating in active outdoor play, (4) pretend play, (5) providing individual attention in routine care, (6) teaching good health practices, (7) supervising children's play, (8) organizing space, equipment, toys, food and drink and (9) managing problem behaviours. Carers reported the amount of time they normally spent in each of the nine activities on a 4 point Likert scale (not at all; somewhat; quite a lot; and very much) and were coded as two categories: 'not at all/somewhat' and 'quite a lot/very much' as the distribution was concentrated at the higher end of the scale. The tenth activity described 'on average, how many minutes per day does someone read books or sing songs to the children?' and was coded as two categories: ≤1 hour and >1 hour. The eleventh activity described 'on average how much time was spent watching television, videos, DVDs and was reported on a 7 point Likert scale (less than 1 hour per day; 1 to 2 hours per day; 2 or more hours per day; few times a week; few times a month; less often and never) and was coded as three categories: daily; less often; and never.

Carer-child relationship

Fifteen indicators characterised the carer-child relationship. Non-parental carers reported on the quality of the relationship with the study child using the closeness and conflict scales from the short version of the STRS [92]. The closeness items describe the extent to which a relationship was perceived to be affectionate with open communication and the conflict indicators ascertained the perceived negativity within the relationship [92]. The carer was asked to indicate the nature of the relationship including: (1) I share an

affectionate, warm relationship with this child, (2) this child and I always seem to be struggling with each other, (3) if upset this child will seek comfort from me, (4) this child is uncomfortable with physical affection or touch from me, (5) this child values his or her relationship with me, (6) when I praise this child, he or she beams with pride, (7) this child spontaneously shares information about himself or herself, (8) this child easily becomes angry with me, (9) it is easy to be in tune with what this child is feeling, (10) this child remains angry or resistant after being disciplined, (11) dealing with this child drains my energy, (12) when this child is in a bad mood I know we're in for a long and difficult day, (13) this child's feelings towards me can be unpredictable or can change suddenly, (14) this child is manipulative with me, (15) this child openly shares his or her feelings and experiences with me. The original scale categorised responses on a 5 point Likert scale: definitely does not apply; not really; neutral/not sure; applies somewhat; and definitely applies. Due to very few carers reporting a negative relationship with the child these were coded as two categories: 'applies somewhat/definitely applies' and 'definitely does not apply/not really/ neutral/not sure'.

In order to assess our a priori conceptualisation of the 31 indicators selected to represent child care quality, exploratory factor analysis of the correlation matrix using maximum likelihood extraction methods with oblique rotation was conducted. Exploratory factor analysis was conducted rather than confirmatory factor analysis, because the structure of child care quality measured with these indicators had not been previously assessed. This approach was also used to establish whether indicators clustered together meaningfully into one or more factors. The number of factors identified was based on eigenvalues >1.50, detecting a break-point in the scree plot and interpretability. Indicators were considered to load on a factor if they had an absolute correlation of ≥0.47 with that factor [140].

Of the 11 indicators describing activities in child care, four indicators had factor loadings ≥0.47. The four indicators included: (1) singing, telling stories and reading books (factor loading 0.48), (2) participating in active outdoor play (0.53), (3) pretend play (0.55) and (4) teaching good health practices (0.51). Of the 15 indicators describing the carer-child relationship, eight indicators had factor loadings ≥0.47. The eight indicators included: (1) sharing an affectionate, warm relationship (0.51), (2) in tune with child's feelings (0.51), (3) child values relationship (0.48), (4) spontaneously shares information (0.54), (5) openly shares feelings and experiences (0.58), (6) child's feelings towards me can be unpredictable [reverse-coded] (0.48), (7) child drains my energy [reverse-coded] (0.54) and (8) this child and I struggle with each other [reverse-coded] (0.51).

Two factors were generated: one factor describing activities in child care and a second factor describing the carer-child relationship (see Table 3.2). For the quality of activities in child care internal consistency, as measured by Cronbach's alpha was 0.74. For the quality of carer-child relationship in child care internal consistency was 0.65. The activities in child care domain is the sum of (1) singing, telling stories and reading books, (2) participating in active outdoor play, (3) pretend play and (4) teaching good health practices. Activities that did not strongly load with the factor (correlation <0.47) were not retained and included: the amount of time spent sitting and playing with the children; providing individual attention in routine care; supervising children's play; organizing space, equipment, toys, food and drink; managing problem behaviours; minutes per day reading books or singing songs to the children and time spent watching television, videos or DVDs. The carer-child relationship domain is the sum of (1) sharing an affectionate, warm relationship, (2) in tune with child's feelings, (3) child values relationship, (4) spontaneously shares information, (5) openly shares feelings and experiences, (6) child's feelings towards me can be unpredictable [reverse-coded], (7) child drains my energy [reverse-coded] and (8) this child and I struggle with each other [reverse-coded].

Relationship indicators that did not strongly load with the factor (correlation <0.47) were not retained and included: if upset this child will seek comfort from me; this child is uncomfortable with physical affection or touch from me; when I praise this child, he or she beams with pride; child easily becomes angry with me; child remains angry or resistant after being disciplined; when this child is in a bad mood I know we're in for a long and difficult day; child is manipulative with me. The two factors – activities in child care and the carer-child relationship – accounted for 75% of the total variance. The Kaiser-Meyer-Olkin measure used to assess the strength of the linear association among the 31 indicators in the correlation matrix was 0.78.

Table 3.2: Final list of indicators identified using exploratory factor analysis, representing 'activities in child care' and 'carer-child relationship'

Factor-based domain	Indicator
Activities in child care	Singing, telling stories, reading books
	Taking part in children's active outdoor play
	Taking part in pretend play
	Teaching good health practices
Carer-child relationship	I share an affectionate, warm relationship with this child
	This child and I always seem to be struggling with each other (reverse-coded)
	This child values his/her relationship with me
	It is easy to be in tune with what this child is feeling
	This child spontaneously shares information about himself/herself
	This child openly shares his/her feelings and experiences with me
	This child's feelings towards me can be unpredictable or can change suddenly (reverse-coded)
	Dealing with this child drains my energy (reverse-coded)

We chose to sum the four unstandardized scores that loaded ≥0.47 for the activities in child care domain and the eight unstandardized scores that loaded ≥0.47 for the carer-child relationship domain. The domain score could range from 4 to 8 for activities in child care, with a maximum score of 8 indicating that the child participated in all four activities 'very much/quite a lot'. A higher score was considered to reflect higher quality care because

spending quite a lot/very much of the day in activities that foster learning and interaction were thought to have a positive effect on children's cognitive and socio-emotional development.

The domain score for the carer-child relationship could range from 8 to16, with a maximum score indicating that all relationship indicators 'applied somewhat/definitely applied' with the exception for reverse-coded indicators (child's feelings can be unpredictable, child drains my energy, child and I always seem to be struggling with each other) where 'definitely does not apply/not really/ neutral/not sure' indicated a more positive relationship. A higher score was considered to reflect higher quality child care because research shows when children have positive, warm relationships they can use their carer as a secure base and source for learning and social relationships [141, 142].

Indicators used to define provider and program characteristics of child care did not significantly load onto any factor. However, the five individual indicators were retained for later regression analyses because of a priori theoretical evidence [142, 143], and because it represents a domain of child care quality that regulating agencies and governments use to define child care quality (e.g. carer qualifications).

3.5 Confounding

Confounding is a major concern in investigating causality in observational studies. As discussed in the literature review there are a number of parent, family and home characteristics that influence parental child care choices and children's developmental outcomes. Adjusting for these characteristics is crucial when examining the effects of child care on children's development [32, 109]. The LSAC includes an extensive set of demographic, socio-demographic, health, and home environment characteristics concerning the child as well as the primary caregiver. The a priori criterion used for identifying potential confounding factors was based on known associations between the

developmental outcomes under investigation and the exposure (child care quality, type and time) of interest. The aim of this section is to provide an overview of the covariates chosen to address the issue of confounding.

Covariates were measured at baseline at the face-to-face interview when children were aged 0-1 years with the exception of variables representing the home environment that were measured when children were aged 2-3 years.

3.5.1 Demographic variables

Age and sex

The primary caregiver's age was given in years and child age was given in months. Child sex was given at wave 1.

Primary caregiver country of birth

The primary caregiver's country of birth was reported using The Standard Australian Classification of Countries [144] and was coded as two categories: Australia and other.

Accessibility and Remoteness Index of Australia

The Accessibility and Remoteness Index of Australia (ARIA) was used by LSAC as a measure of geographic remoteness [145]. Five groups of remoteness quantify urban, rural and remote communities including major cities (highly accessible to goods and services and opportunities for social interaction); inner regional (accessible); outer regional (moderately accessible); remote (very restricted) and very remote (very little accessibility to goods and services and opportunities for social interaction). Participants were coded as two categories: highly accessible and other.

3.5.2 Sociodemographic variables

Primary caregiver education

The primary caregiver's education was taken as the highest qualification achieved. This was coded as two categories: less than a bachelor's degree (<year 12, year 12, certificate, or advanced diploma/diploma) and a bachelors' degree or higher (bachelor degree, graduate diploma/certificate, or postgraduate degree).

Primary caregiver work status

The primary caregiver's work status was coded as three categories: full-time employment; part-time employment and not in the labour force.

Household income

In this thesis, two indicators of annual household income were used. Household income was derived from the primary caregiver's response to the question 'before income tax is taken out what is your present yearly income for you and your partner combined'. This variable was divided into the following three categories: ≤$41,548; $41,549-$77,999 and ≥$78,000. We chose these cut-points as they were similar to national household income data, where the bottom 20% of Australians received less than $769 per week, 40% received between $770 and $1362 per week, and 40% received over $1363 per week [146]. The continuous income variable was used to create income deciles for the analysis examining income-based inequalities in the quality of child care (aim four of the thesis).

Economic hardship

Economic hardship was assessed by the question 'over the last 12 months due to shortage of money have any of the following happened: not been able to pay gas, electricity or telephone bills on time; could not pay the mortgage or rent on time; adults or children have gone without meals; unable to heat or cool the home; pawned or sold something; sought

assistance from a welfare or community organisation; had financial limits on the type of food that could be bought'. Participants were categorised as experiencing no significant hardship (no report of economic hardship) and some significant hardship (one or more indicator of hardship reported).

3.5.3 Health variables

Birth weight

Child birth weight was self-reported in grams by the primary caregiver and was coded as two categories: <2500 grams and ≥ 2500 grams.

Concerns about child's development, learning and behaviour

The primary caregiver reported whether they had 'any concerns about the child's development, learning and behaviour' using the Parents' Evaluation of Developmental Status (PEDS). Responses were coded as two categories: no and yes a little/don't know.

Primary caregiver mental health

The primary caregiver reported their psychological distress by completing the six item Kessler Scale [147]. The primary caregiver was asked how often in the past four weeks they had felt:

- 'nervous';

- 'worthless';

- 'hopeless';

- 'restless or fidgety';

- 'so depressed that nothing could cheer you up';

- 'that everything you did was an effort'.

They rated their symptoms on a 5 point Likert scale ('1 all of the time' to '5 none of the time') and the mean score for the six questions indicated their psychological distress (with higher scores indicating less distress).

3.5.4 Primary caregiver–child relationship

Warmth towards the child

Primary caregivers' rated their level of warmth towards their child by reporting how often they:

- 'Enjoy doing things with the child';

- 'Feel close to the child';

- 'Share warm and close times together with the child';

- 'Hug child for no particular reason';

- 'Hug, kiss and hold the child';

- 'Tell the child how happy he/she makes you feel'.

They rated their level of warmth on a 5 point Likert scale ('1 never/almost never' to '5 always/almost always') and the mean score for the six questions was used (higher scores reflected higher levels of warmth).

Separation Anxiety

Maternal separation anxiety was assessed using six items from the Maternal Separation Anxiety Scale [148]. The six items used in LSAC assessed mothers' sadness, apprehension, guilt and concern during separation from their infants. The items were rated on a 5 point Likert scale ('1 strongly agree' to '5 strongly disagree') and the mean score for the six questions was used (higher scores reflected lower levels of separation anxiety).

3.5.5 Family structure variables

Two-parent household

The primary caregiver reported whether the child had two parents present in the household (yes or no).

Number of siblings

The number of siblings living in the household was coded as three categories: none; 1 and ≥2.

3.5.6 Home environment variables

Number of children's books

The number of children's books in the home was assessed by the following question 'about how many children's books does the child have in your home now including library books' (none; 1-10; 11-20; 21-30 and more than 30) and was coded as two categories: ≤ 20 books and ≥ 21 books.

Length of time child read to

The primary caregiver reported 'how many minutes the child was read to at a sitting' (doesn't like to be read to at all; <5 minutes; 6-10 minutes; 11-15 minutes; 16-20 minutes; 21-40 minutes; 41-60 minutes and >60 minutes) and was coded as two categories: ≤20 minutes and ≥21 minutes.

Special or extra cost activities

Special or extra cost activities were assessed by the question 'in the last 6 months has the child regularly taken part in any special or extra cost activities' (yes or no).

3.6 Developmental outcomes

A number of cognitive and socio-emotional developmental outcomes were included in the study. These developmental outcomes were chosen a priori as each is believed to play an important role in children's school readiness. These school readiness skills included measures of children's receptive vocabulary, academic literacy and numeracy proficiency, externalising and internalising behaviours, task attentiveness and emotional regulation. Descriptions of these outcomes are described below.

Receptive vocabulary

Children's receptive vocabulary at age 4-5 and at 6-7 years was directly assessed in the child's home using the Peabody Picture Vocabulary Test III (PPVT) – LSAC Australian Short Form [149]. The test involved the interviewer presenting four numbered black and white pictures to the child, stating a word to describe one of the pictures and asking the child to either point, verbally or non-verbally indicate 'yes' or 'no' as the interviewer pointed to the possible responses [150]. Raw scores were scaled according to a Rasch model to enable comparison of scores across waves [149].

Academic literacy and numeracy proficiency

Children's academic proficiency at age 6-7 years was assessed by teachers using a modified version of the Academic Rating Scale (ARS). For the purposes of the LSAC the domains measuring Literacy (9 items) and Maths (9 items) were completed [151]. Scores were Rasch modelled and transformed to the ARS [151], ranging from 1 to 5 ('1= not yet proficient' to '5= proficient'), with higher scores reflecting greater proficiency.

Externalising and internalising behaviours

Children's externalising and internalising behaviours at age 4-5 and at 6-7 years were assessed by both the parent and teacher using the Strength and Difficulties Questionnaire (SDQ). Informants used a 3 point Likert scale (0=not true, 1=somewhat true, 2=certainly true) to specify how 25 items (five sub-scales, pro-social behaviour, hyperactivity, emotional symptoms, conduct problems and peer problems of five items each) over the past six months or the current school year apply to the study child [152]. The conduct and hyperactivity sub-scales of the SDQ were summed to reflect externalising behaviours and the emotional and peer sub-scales were summed to reflect internalising behaviours [153]. The score for externalising and internalising behaviours ranged between 0-20 respectively with higher scores indicating higher risk of behavioural problems. Normative values or clinical cut off points for these broader internalising and externalising SDQ sub-scales are not yet available.

A total difficulties score was also created by summing the scores from all the scales except the prosocial scale as it measures positive behaviour. Recommended cutpoints were used to identify children scoring in the 'normal' 'borderline' and 'abnormal' range [152]. A binary variable was derived based on the raw scores, with borderline and abnormal cut-off scores used to define behavioural difficulties.

Self-regulation: task attentiveness and emotional regulation

The task attentiveness and emotional regulation measures used in this thesis were created by members of the BetterStart Child Health and Development Research Group in collaboration with the Discipline of Paediatrics, the University of Adelaide [154]. Children's self-regulation at age 4-5 and 6-7 years was defined by their ability to regulate attention, emotion and behaviour [155]. In order to assess children's self-regulatory skills, including their ability to attend and persist, and to regulate emotional reactivity, a clinical

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psychologist (Dr Alyssa Sawyer), reviewed all items and questionnaires used in the LSAC. This was done by examining the questionnaires for items or scales which asked about children's ability to regulate their attention, emotion and behaviour. Fourteen items were identified from measures at age 4-5 years and 6-7 years (six items from the SDQ [152], 8 items from the Short Temperament Scale for Children [156, 157]). Items that assessed externalizing or anti-social behaviour (e.g. bullying, lying, breaking things deliberately) were not included in the self-regulation scales. Items selected are shown in Table 3.3.

Table 3.3: A priori items selected from the Strengths and Difficulties Questionnaire and Short Temperament Scale for Children to represent self-regulation at ages 4-5 and 6-7 years

Strengths and Difficulties Questionnaire
1. Is restless, overactive, cannot stay still for long
2. Is constantly fidgeting or squirming
3. Is easily distracted, concentration wanders
4. Thinks things out before acting
5. Sees tasks through to the end, has good attention span
6. Often loses temper
Short Temperament Scale for Children
7. When this child starts a project such as a puzzle or model, he/she works on it without stopping until it is completed, even if it takes a long time
8. This child likes to complete one task or activity before going onto the next
9. This child stays with an activity (e.g. puzzle, construction, reading) for a long time
10. When a toy or game is difficult, this child quickly turns to another activity
11. If this child wants a toy or sweet while shopping, he/she will easily accept something else instead
12. When this child is angry about something, it is difficult to side-track him/her
13. When shopping together, if I do not buy what this child wants (e.g. sweets, clothing), he/she cries and yells
14. If this child is upset, it is hard to comfort him/her

These items were then reviewed independently by an expert panel, one of whom is a child psychiatrist (Professor Michael Sawyer, Discipline of Paediatrics) and three others who are experts in child development (Professor John Lynch, Dr Catherine Chittleborough, and Dr Murthy Mittinty), to assess their face validity. In order to assess the construct validity of items selected at each assessment to represent task attentiveness and emotional regulation,

exploratory factor analyses of the correlation matrix using maximum likelihood extraction

methods with oblique rotation were conducted. At each of the time-points a two factor

structure was observed, labelled task attentiveness and emotional regulation (Table 3.4).

Table 3.4: List of items identified from exploratory factor analysis to represent task attentiveness and emotional regulation at ages 4-5 and 6-7 years

Task attentiveness
1. When this child starts a project such as a puzzle or model, he/she works on it without stopping until it is completed, even if it takes a long time
2. This child likes to complete one task or activity before going onto the next
3. This child stays with an activity (e.g. puzzle, construction, reading) for a long time
4. When a toy or game is difficult, this child quickly turns to another activity
5. Sees tasks through to the end, has good attention span

Emotional regulation
1. If this child wants a toy or sweet while shopping, he/she will easily accept something else instead
2. When this child is angry about something, it is difficult to side-track him/her
3. When shopping together, if I do not buy what this child wants (e.g. sweets, clothing), he/she cries and yells
4. If this child is upset, it is hard to comfort him/her
5. Often loses temper

The factor loadings ranged from 0.40 to 0.78 for the task attentiveness factor and 0.51 to

0.71 for the emotional regulation factor. For the purpose of this thesis, we summed the

five unstandardized scores that loaded ≥0.40 for the task attentiveness factor and the five

unstandardized scores that loaded ≥0.51 for the emotional regulation factor, with high

scores representing better regulation skills. Internal consistency as measured by

Cronbach's alpha was acceptable for each age. For task attentiveness internal consistency,

as measured by Cronbach's alpha, was 0.79 at 4-5 years, and 0.78 at 6-7 years. For

emotional regulation internal consistency was 0.71 at 4-5 years and 0.72 at 6-7 years.

3.7 Analytic approach

The following section describes the methods of analysis for each specific aim. This is also

described in detail within each of the published articles in Chapters 4-6

Aim 1

The first aim of this thesis was to examine whether the total amount of time in child care

through the first three years of life was associated with children's cognitive (receptive

vocabulary) and socio-emotional development (externalising and internalising behaviours)

at age 4 to 5 years, and whether this association varied according to the primary type of

child care. As shown in Figures 3.2 and 3.3, directed acyclic graphs (DAG) were used to

demonstrate the a priori assumptions regarding the causal associations among the

exposure, outcomes and covariates [158, 159].

Figure 3.2: DAG representing the effect of time in child care on child outcomes
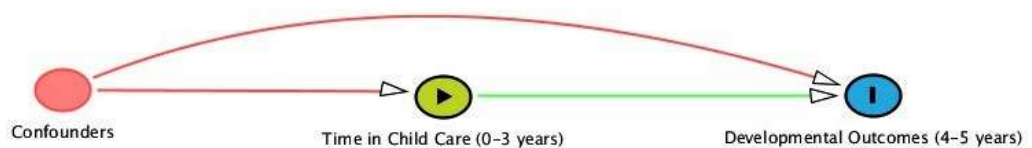
Figure 3.3: DAG representing the effect of main type of child care on child outcomes
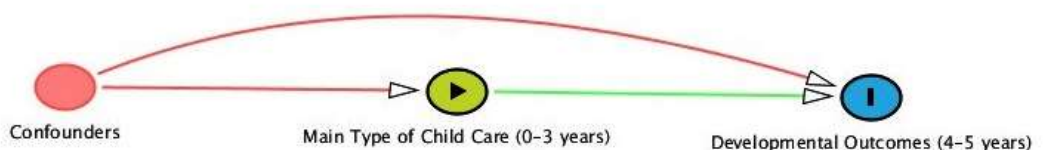
Missing Data

A common problem in longitudinal studies is missing data. There is widespread agreement that excluding cases with missing values reduces power and may yield biased estimates [160]. Traditionally researchers have used a number of methods to address missing values, including list wise deletion, and single imputation techniques, but there a number of limitations associated with the use of these methods [160-162]. Studies have shown that excluding cases with missing values on at least one variable from analyses may lead to substantial bias as it relies on the assumption that the values are missing completely at random, and this assumption rarely applies in practice [160].

To address attrition and item non-response in the LSAC, multiple imputation by chained equations was used to impute missing values for each specific aim of this thesis [163]. Imputed datasets were generated under the missing at random assumption that uses observed variables in the dataset to predict missingness and estimate parameters [164]. The variables used to predict missingness in the imputation model included the exposure, outcomes and covariates. The regression model used to impute missing values depended on the type of variable. For continuous variables (e.g. PPVT score) linear regression or predictive mean matching methods were used, for binary variables (e.g. ARIA) logistic regression was used, for ordinal variables (e.g. household income) ordinal logistic regression was used, and for variables with 2 or more categories (e.g. how much time was spent watching television, videos, DVDs) multinomial logistic regression was used. Twenty imputed data sets, using 50 cycles of regression switching were generated [163]. Within each dataset, a different value is imputed for each missing value. The advantage of multiple imputations is that, unlike other methods, it allows imputing for many patterns of missing and preserving distributions [164]. Moreover, the method used to combine the estimates from imputed data allows addressing the uncertainty due to missing values [161].

The analysis was carried out on all 20 imputed datasets and the final estimates were obtained using the rules of Rubin [165]. Following von Hippel, cases with imputed outcomes were excluded from the analyses as they do not provide any additional information to improve regression estimates [166].

Aims 2 and 3

The second and third aims of this thesis were to examine whether the quality of formal child care at age 2-3 years was associated with children's cognitive (receptive vocabulary, academic literacy and numeracy proficiency), socio-emotional development (externalising and internalising behaviours), task attentiveness and emotional regulation at age 4-5 and 6-7 years. A DAG depicting the a priori associations among the exposure, outcomes and covariates is illustrated in Figure 3.4.

Figure 3.4: DAG representing the effect of child care quality on child outcomes
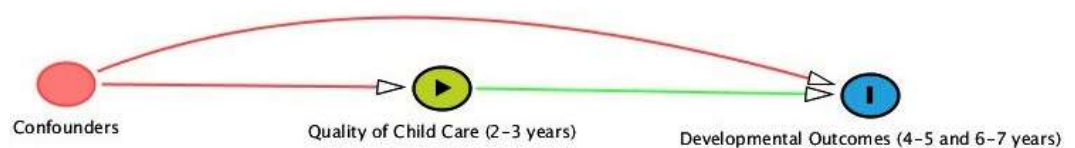
Linear regression analysis was used to examine the association between provider and program characteristics of care and factor-based domains of child care quality (activities in child care, carer-child relationship) at 2-3 years of age and children's receptive vocabulary (4-5 and 6-7 years), teacher reported literacy and math proficiency (6-7 years), task attentiveness (4-5 and 6-7 years), emotional regulation (4-5 and 6-7 years) and parent and teacher reported internalizing and externalizing behaviours (4-5 and 6-7 years).

Propensity Score Methods

The randomised controlled trial is regarded as the gold standard for establishing causation between treatment and outcome [167, 168]. Random allocation minimises the chance that treatment status is confounded by measured or unmeasured baseline covariates, hence any differences between groups can be attributed to treatment and not participants' characteristics [167]. Assignment to treatment in observational studies is not randomised therefore differences in baseline covariates must be accounted for when estimating the causal effect of treatment on outcome. When using observational data to estimate treatment effects, researchers usually control for covariates in a regression model to reduce bias [167]. In recent years, new analytic methods to address the problem of confounding variables have been developed. One such method includes propensity score matching which can be used to reduce the effects of confounding by addressing differences in covariates between the exposed and unexposed groups [167]. The goal is to estimate the likelihood (propensity score) that a case would have selected into treatment given certain characteristics [167, 168]. If a treated case and possible control have the same propensity score, then the difference between the treatment and control outcomes is an unbiased estimator of treatment effect [169]. The advantage of propensity score matching is that the exposure is not confounded by differences in covariate distributions thus bringing us closer to a randomised controlled trial [167, 168, 170]. Therefore for the second aim of this thesis, propensity score matching was used to evaluate the Average Treatment Effect on the Treated (ATT) that is the effect of experiencing higher quality child care for children who actually received it. For example, we used propensity score matching to evaluate the effect of experiencing a higher quality relationship in child care. The ATT rather than the Average Treatment Effect (ATE) was chosen in this study as it estimates the average effect of treatment for children who use child care whereas the ATE estimates the average effect

across the entire population and as all children do not use child care the ATE was not the estimate of interest.

The first step in propensity score matching involves estimating the propensity score, which is conditional upon the observed covariates. This probability is obtained by using logistic or probit regression [168]. The second step involves matching the treated cases to the untreated cases in a manner that the two groups are equivalent on all covariates included in the propensity score. There are several matching methods available for creating matched pairs of treated and untreated cases each with their own advantages and disadvantages [167]. In this study, I chose matching without replacement, meaning once an untreated case was selected to be matched to a treated case, that untreated case was no longer available as a potential match for subsequent treated cases [167]. I also chose nearest neighbour matching within a specified caliper distance where the absolute difference in the propensity score of matched cases needed to be below a pre-specified level. Therefore, an untreated case whose propensity score was closest to that of a treated case would be selected for matching [167].

In the current context, using logistic regression, the propensity score was calculated as the probability of receiving higher quality versus lower quality child care, conditional on the observed covariates. Children were classified as receiving higher quality if they scored a 1 (="low rating") on less than three (out of eight) indicators, else were classified as receiving lower quality. The probability of being in the higher versus lower group of quality was then matched using the nearest neighbour matching method with calipers set to 0.01 without replacement. This method matched the treated children to the untreated children resulting in the two groups being broadly equivalent on all covariates included in the propensity score.

Aim 4

The fourth aim of this thesis was to estimate if the effect of the quality of child care and children's receptive vocabulary and behavioural difficulties was modified by levels of income. This measure is formally known as Effect Measure Modification (EMM) [171]. In recent years, a number of researchers have argued that the presentation and discussion of EMM and interaction has been inadequate [171, 172]. There is growing concern that multiplicative statistical models are primarily used for the assessment of EMM in epidemiologic research [171, 173] and that researcher claims of no EMM / interaction may not be entirely accurate, as the presence of EMM depends on the choice of model used. Therefore, it has been recommended that both multiplicative and additive terms be presented to provide readers with sufficient information to draw conclusions about the size and statistical significance of the EMM [171].

To test for EMM in the current study, both multiplicative and additive scales outlined by Knol and VanderWeele [171] were used. Multiplicative EMM was examined through a cross-product interaction term in the regression model and additive EMM was examined using the relative excess risk due to interaction (RERI). RERI represents the risk that is in excess of what would be expected if the combination of child care quality and income was entirely additive. In the absence of additive EMM, RERI is equal to 0. In the absence of multiplicative EMM the ratio of risk equals 1.

In the following chapters (Chapters 4-6), I present the results of the four studies that comprise this thesis as manuscripts that were accepted for publication.

4 Time spent in different types of child care and children's development at school entry: an Australian longitudinal study

4.1 Preface

This chapter contains the first of four articles contributing to this thesis. This article has been published in *Archives of Disease in Childhood*. The article examines whether total time spent in child care through the first three years of life is associated with children's receptive vocabulary, externalising and internalising behaviours at age 4-5 years, and whether this association varies for different primary types of child care.

As discussed in Section 2.6, a large number of studies from the USA and the UK have found that greater time in child care, particularly centre-based care, associated with poorer socio-emotional outcomes [32, 34, 99, 174]. In contrast, Norwegian research, where government commitment to early childhood services is greater than government investment in the USA and the UK shows a very different effect of time in child care on children's development [114, 115]. Researchers have emphasised the importance of considering the regulatory context in different countries as well as the diversity of family characteristics to provide more complete estimates of how child care affects children's development [42]. This article addresses a significant gap in the literature by describing the developmental effects of the cumulative time spent in different types of child care using a nationally representative birth cohort from a country that has a different social policy context for child care than the USA, the UK or Northern Europe.

4.2 Publication: Time spent in different types of child care and children's development at school entry: an Australian longitudinal study

4.2.1 Statement of authorship

Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Time spent in different types of child care and children's development at school entry: an Australian longitudinal study. Archives of Disease in Childhood 2015; 100(3):226-232.

By signing below, the authors declare that they give consent for this paper to be presented by Angela Gialamas towards examination for the Doctor of Philosophy.

Angela Gialamas (Candidate)

Designed the study, performed the analyses, interpreted the results and drafted the manuscript.

Signed: …………………………… Date: .………06/07/2015…………

Murthy Mittinty

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015…………

Michael Sawyer

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015………

Stephen Zubrick

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015…………

John Lynch

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015…………

4.2.2 Abstract

Objective: To investigate whether the total amount of time in child care through the first 3 years of life was associated with children's receptive vocabulary, externalising and internalising problem behaviours at age 4-5 years, and whether this association varied for different types of child care.

Methods: We used data from the prospective, population-based Longitudinal Study of Australian Children (n=3208–4066, depending on outcome). Parental reports of the time spent in different types of child care were collected at face-to-face interviews at age 0-1 year and at age 2-3 years. Children's receptive vocabulary was directly assessed in the child's home, and externalising and internalising behaviours were measured by questionnaire, completed by parents and teachers at age 4-5 years.

Results: At 3 years of age, 75% of the sample spent regular time in the care of someone other than the parent. After adjustment, more time in child care was not associated with children's receptive vocabulary ability but was associated with higher levels of parent-reported (β=0.10 (95% CI 0.00 to 0.21)) and teacher-reported (β=0.31 (0.19 to 0.44)) externalising problem behaviours and lower levels of parent-reported internalising problem behaviours (β= -0.08 (-0.15 to -0.00)). Compared with children who did not attend any type of child care, children in centre-based care had higher parent-reported and teacher-reported externalising and lower internalising problem behaviours.

Conclusions: More time in centre-based child care (but not other types of care) through the first 3 years of life was associated with higher parent-reported and teacher-reported externalising problem behaviours, and lower parent-reported internalising problem behaviours but not with children's receptive vocabulary ability at school entry.

What is already known on this topic?

- Many children now spend substantial periods of time in child care during the first 3 years of their life.

- Child care during children's preschool years may be an important context for children's cognitive and socio-emotional development.

- Evidence regarding the developmental effects of the type and time spent in child care for children younger than 3 years is equivocal.

What this study adds?

- Time spent in child care during the first 3 years of life was not associated with children's receptive vocabulary at school entry.

- Time spent in child care had small effects on higher levels of parent-reported and teacher-reported externalising problems and lower parent-reported internalising problems at school entry.

- The effects were concentrated among children who experienced predominately centre-based care.

4.2.3 Introduction

Due primarily to changes in labour market conditions over recent decades in rich and middle-income countries, children are spending increasing amounts of time in child care during their first 3 years. Child care is often referred to as the care of a child, by a person other than the child's parent. This can either be formal or informal care. Formal child care refers to regulated, paid care away from the child's home including child care centres (referred to henceforth as centre-based care) and family day care (carers paid to deliver care in their home for small groups of children). Informal child care is non-regulated care in or away from the child's home and includes relative (e.g. grandparents) and non-relative care (e.g. friends) [175]. Child care fulfils many roles including supporting labour force participation and providing an opportunity to foster children's socio-emotional and cognitive development before they start school [176]. However, there has been long-standing concern that early and long exposure to child care may be harmful [3, 177].

Different types of child care environments may be an important context for child development but arguments could be mounted that time spent away from parents may or may not harm children's development depending on the amount of time spent in those environments and the context within which it occurs. Indeed, the evidence is mixed as to whether time spent in child care adversely affects children's later socio-emotional and cognitive development. In terms of socio-emotional outcomes, studies conducted in the USA revealed that more hours in child care, particularly centre-based care was associated with poorer social-behavioural outcomes [32, 34, 174]. A recent study in the UK also found that more time in centre-based care was associated with more behavioural difficulties [99]. However, studies from Norway have shown little evidence that greater time in care is associated with children's externalising problems [114, 115]. There is inconclusive evidence regarding associations between the time spent in different types of child care and children's cognitive outcomes. Some studies have found benefits of centre-

based care on children's cognitive abilities at school entry [178], however this seems not to be the case in the Australian context [48].

With an increasing number of children attending child care and the potential role child care may have in promoting the development of young children we used data from a contemporary, population-based Longitudinal Study of Australian Children (LSAC) to examine whether the total amount of time spent in all types of child care through the first 3 years of life was associated with children's receptive vocabulary and externalising and internalising problem behaviours when children were aged 4-5 years. In subsequent analyses, the influence of the main type of child care from 0 year to 3 years on children's development at 4-5 years was examined. It would have been ideal to measure the quality of child care but directly observing quality in different types of child care settings is not practical for most large population-based studies due to cost constraints. Moreover, research from the comprehensive National Institute of Child Health and Human Development study of early child care suggests that quality, quantity and type of child care have independent effects on children's development [34, 109].

4.2.4 Subjects and Methods

Study design and sample

We examined data from the LSAC, a prospective, population-based study of young children's development. Study design and sample information for LSAC are detailed elsewhere [139]. Briefly, LSAC used a two-stage cluster sampling design. The first stage selected Australian postcodes and the second stage, sampled children within these postcodes. Postcodes were randomly selected and stratified by state/territory and urban/rural status to ensure a nationally representative sample. The Medicare database, which provides medical and hospital coverage for all Australian permanent residents was then used to randomly select infants born between March 2003 and February 2004 within

each stratum. This method identified 8921 infants who were eligible to participate. Of these, 5107 infants were recruited into the study. Our analyses use the first three waves of data when children were 0-1 years, 2-3 years and 4-5 years of age. The study was approved by the Australian Institute of Family Studies Ethics Committee.

Child care measures

Detailed information concerning the time and type of child care was obtained from face-to-face interviews with the study child's primary caregiver (97% mothers) at 0-1 year and again at 2-3 years. At each time point, the primary caregiver reported whether over the past 1 month the study child had been looked after at regular times during the week by anyone other than the parent living in the home. If the response was 'yes' then the regular type of care, the number of hours each week the child attended, and for how many months the child had been attending this care was ascertained for up to three different types of child care arrangements.

The types of child care were: (1) centre-based care (2) family day care (3) nanny or relative and (4) other informal child care such as care by friends. We excluded a small proportion of children (n=218) enrolled in preschool/kindergarten, as in Australia, they are administratively classified as belonging to the education sector unlike child care services [6]. We calculated the time spent in each type of child care as reported by parents at 0-1 year and 2-3 years as: Total Time (TT) = (total hours per week x 4.3 weeks in a month) x (total months in child care). The cumulative time was calculated as the sum of the time spent at the 0-1 year and 2-3 year time period ($TT_{0-1} + TT_{2-3}$). If a child did not attend child care, a value of 0 was given. Children who did not attend any type of child care across the 0-3 year period were classified into the 'primary caregiver only' category and were used as the reference group in all analysis. Our measure of time spent in child care is similar with

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research from the US National Institute of Child Health and Human Development study that examined the developmental effects of cumulative time in child care [32].

Child outcomes

Children's receptive vocabulary at age 4-5 years was directly assessed in the child's home using the well-validated Peabody Picture Vocabulary Test III – LSAC Australian Short Form [149]. Raw scores were scaled according to a Rasch model to enable comparison of scores across waves. Children's externalising and internalising behaviours at age 4-5 years were assessed by the parent and teacher using the Strengths and Difficulties Questionnaire (SDQ) [152]. The SDQ contains five sub-scales, measuring pro-social behaviour, hyperactivity, emotional symptoms, conduct problems and peer problems of five items each. The conduct and hyperactivity sub-scales of the SDQ were summed to reflect externalising behaviours and the emotional and peer sub-scales were summed to reflect internalising behaviours [153]. Childhood externalising behaviour problems are expressed in children's outward behaviour reflecting a child's negative reaction to his or her environment [179, 180]. These externalising problems may include disruptive, hyperactive and aggressive behaviours [179]. Internalising behaviour problems primarily affect the child's internal psychological environment rather than the external environment [179, 180]. These internalising problems may include withdrawn, anxious and depressed behaviours [179]. The score for externalising and internalising behaviours ranged in between 0 and 20, respectively, with higher scores indicating higher risk of behavioural problems.

Covariates

Covariates were identified a priori, on the basis of directed acyclic graphs [158] and from research evidence to be associated with the type and time in child care and children's cognitive and socio-emotional outcomes. Covariates included; the primary caregivers country of birth, education, employment; annual household income; economic hardship

over the last year; geographical remoteness using the Accessibility and Remoteness Index of Australia (ARIA) [145]; family structure; number of siblings; child age, sex and birth weight; parental concern about the child's learning and development; number of children's books in the home; time spent reading to the child; whether the child undertook regular cost activities; the primary caregivers age, psychological distress using the Kessler 6 scale [147], and self-reported level of attachment and warmth towards their child.

Multiple imputation

To address attrition and item non-response in the present study, multiple imputation by chained equations was used to impute missing values [163]. Imputed datasets were generated under the missing at random assumption that uses observed variables in the dataset to predict missingness and estimate parameters [164]. The imputation was conducted for the full sample, however, data were analysed only for children who had observed receptive vocabulary scores (n=4066), and parent-reported (n=3646) and teacher-reported (n=3208) externalising and internalising behaviour scores [166]. The imputation model included all outcomes, exposures and covariates. Twenty imputed datasets were generated and the results of the imputed analyses were combined using Rubin's rules [165]. Results using the complete-case data were not substantively different from the imputed analysis and would not change the conclusions of this study; therefore, we report the imputed results.

Analysis

First we used multivariable linear regression to examine the overall association between the cumulative time from age 0 year to 3 years spent in all types of child care and children's receptive vocabulary and parent-reported and teacher-reported externalising and internalising behaviours at age 4-5 years. To aid interpretability of the regression coefficients we present the results for the effect of increasing the time spent in any type of

child care by 1 day per week over the first 3 years of life. Second, we examined the association between the time spent in the main type of child care from age 0 year to 3 years and receptive vocabulary and parent-reported and teacher-reported internalising and externalising behaviours at age 4-5 years. All analyses were conducted using Stata V.12.1 (Stata Corp, College Station, Texas, USA).

4.2.5 Results

As shown in Figure 4.1, the sample consisted of 4066 children with receptive vocabulary scores, 3646 and 3208 children with parent-reported and teacher-reported externalising and internalising behaviour scores at age 4-5 years, respectively.

Figure 4.1: Eligible cohort and numbers included for analyses

```
┌─────────────────────────────────┐        ┌─────────────────────────────────┐
│  Cohort recruited into LSAC in   │───────▶│         Exclusions:             │
│         2004                     │        │  Preschool (wave 2) N=218       │
│      (wave 1) N=5107             │        │                                 │
└─────────────────────────────────┘        └─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐
│        Eligible cohort           │
│           N=4889                 │
│  (Complete-cases N= 4388;        │
│   loss to follow up N=501)       │
└─────────────────────────────────┘
                │
                ▼
┌─────────────────────────────────┐
│ Impute missing values for type   │
│ and time in child care,          │
│ covariates and outcomes          │
│           N=4889                 │
└─────────────────────────────────┘
                │
                └─── Multiply Imputed Analysis Sample (imputed outcomes removed)
        ┌───────────────┼───────────────────────────┐
        ▼               ▼                           ▼
┌─────────────────┐ ┌─────────────────┐ ┌─────────────────────────┐
│ Teacher Reported│ │ Parent Reported │ │ Peabody Picture         │
│ Externalising   │ │ Externalising   │ │ Vocabulary Test Scores  │
│ and Internalising│ │ and Internalising│ │ N=4066                  │
│ Behaviour Scores│ │ Behaviour Scores│ │                         │
│ N=3208          │ │ N=3646          │ │                         │
└─────────────────┘ └─────────────────┘ └─────────────────────────┘
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As shown in Table 4.1, the majority of children had an Australian born primary caregiver (~80%) and lived in a two-parent household (~90%). About two-thirds of the primary caregivers had less than a bachelor's degree (~64%) with an average weekly household income of $A1178-1210. At 3 years of age, 75% of the total sample spent regular time in the care of someone other than the parent. Approximately, 39% experienced some centre-based care, 21% nanny or relative care, 8% family day care and 6% other types of child care. The mean number of hours per week spent in child care at 0-1 years was 17.2 h (SD: 13.6) and 20.4 h (SD: 14.3) at 2-3 years (data not shown). On average, the total number of hours spent in child care across the 3 years was 1024–1035 h (341.3–345.2 h/year) depending on outcome.

Table 4.1: Characteristics of study participants by outcome for the multiply imputed sample

	Receptive vocabulary (n= 4066)	Parent reported externalising and internalising behaviours (n=3646)	Teacher reported externalising and internalising behaviours (n=3208)
	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)
Child Factors			
Age at wave 3 (months)	57.5 (2.8)	57.4 (2.7)	57.5 (2.8)
Birth weight (grams)	3424.0 (563.8)	3429.5 (556.3)	3430.4 (557.8)
Sex			
Female	48.9% (1987)	48.2% (1758)	48.6% (1558)
Male	51.1% (2079)	51.8 (1888)	51.4% (1650)
Concerns about child's development, learning and behaviour?			
Yes a little/Don't know	5.9% (241)	6.1% (223)	6.2% (199)
No	94.1% (3825)	93.9% (3423)	93.8% (3009)
Primary Caregiver Factors			
Age (years)	31.3 (5.3)	31.4 (5.2)	31.5 (5.1)
Distress, Kessler 6 score	4.42 (0.5)	4.42 (0.5)	4.43 (0.5)
Warmth	4.5 (0.4)	4.5 (0.4)	4.5 (0.3)
Attachment	2.6 (0.8)	2.6 (0.8)	2.6 (0.8)
Country of birth			
Australia	79.6% (3238)	80.8% (2947)	80.5% (2582)
Other	20.4% (828)	19.2% (699)	19.5% (626)
Socioeconomic Position			
Annual household income ($)	1178.9 (861.3)	1194.9 (875.1)	1210.7 (885.0)
ARIA			
Highly accessible	55.1% (2242)	54.1% (1974)	55.4% (1777)
Other	44.9 (1824)	45.9% (1672)	44.6% (1431)
Primary caregiver education			
< Bachelor's degree	65.2% (2652)	64.2% (2339)	63.4% (2034)
Bachelor's degree or higher	34.8 (1414)	35.9% (1307)	36.6% (1174)
Primary caregiver work status			
Full-time work	10.9% (441)	10.9% (398)	11.1% (356)
Part-time work	31.2% (1270)	32.0% (1166)	32.5% (1042)
Not in labour force	57.9% (2355)	57.1% (2082)	56.4% (1810)
Significant economic hardship			
No significant hardship	56.9% (2315)	57.9% (2112)	59.2% (1898)
Some significant hardship	43.1% (1751)	42.1% (1534)	40.8% (1310)
Family Factors			
Two- parent household			
No	7.6% (307)	6.9% (252)	6.5 (207)
Yes	92.4% (3759)	93.1% (3394)	93.5% (3001)
Number of siblings			
0	39.3% (1597)	39.8% (1453)	40.0% (1282)
1	37.2% (1514)	37.6% (1370)	37.6% (1207)
≥ 2	23.5% (955)	22.6% (823)	22.4% (719)
Home Environment			
Children's books in the home			
≤ 20 books	15.1% (613)	13.9% (507)	13.3% (426)
≥ 21 books	84.9% (3453)	86.1% (3139)	86.7% (2782)
Minutes child usually read to at a sitting			
≤ 20 minutes	89.7% (3646)	89.8% (3273)	89.1% (2860)
≥ 21 minutes	10.3% (420)	10.2% (373)	10.9% (348)
Special or extra cost activities			
No	56.3% (2287)	54.9% (2002)	54.0% (1733)
Yes	43.7% (1779)	45.1% (1644)	46.0% (1475)

	Receptive vocabulary (n= 4066)	Parent reported externalising and internalising behaviours (n=3646)	Teacher reported externalising and internalising behaviours (n=3208)
	M (SD) or % (n)	M (SD) or % (n)	M (SD) or % (n)
Child care			
Main type of child care			
Primary caregiver only	25.5% *(1037)*	24.6% *(895)*	24.6% *(790)*
Centre-based care	38.8% *(1577)*	39.6% *(1442)*	39.5% *(1267)*
Family day care	8.1% *(328)*	8.2% *(302)*	7.7% *(247)*
Nanny or Relative	21.3% *(865)*	21.2% *(772)*	21.6% *(694)*
Other	6.3% *(259)*	6.4% *(235)*	6.5% *(210)*
Cumulative exposure to child care			
Total hours in child care (0-3 y)	1024.0 (1384.1)	1031.8 (1376.1)	1035.7 (1402.7)
Outcome			
Receptive vocabulary score	65.1 *(6.0)*	-	-
Parent-reported internalising problem score	-	2.81 *(2.4)*	-
Parent-reported externalising problem score	-	5.44 *(3.2)*	-
Teacher-reported internalising problem score	-	-	2.41 *(2.7)*
Teacher-reported externalising problem score	-	-	3.43 *(3.7)*

ARIA, Accessibility and Remoteness Index of Australia

Cumulative exposure to child care through the first 3 years of life

In unadjusted analyses, for each increase of 1 day per week in child care, parent-reported and teacher-reported externalising problem behaviours increased by 0.07 (95% CI -0.02 to 0.16) and 0.25 (0.14 to 0.36) points, respectively (Table 4.2). Parent-reported and teacher-reported internalising problem behaviours decreased by -0.07 (-0.14 to 0.00) and -0.07 (-0.15 to 0.01) points, respectively, and children's receptive vocabulary scores increased by 0.41 points (0.24 to 0.57). After adjustment, the association between the total amount of time in child care and children's receptive vocabulary strongly attenuated (β=0.04 (-0.11 to 0.21)). In contrast, after adjustment, higher levels of parent-reported and teacher-reported externalising problem behaviours and lower parent-reported internalising problem behaviours were still observed, although the effects were small (Table 4.2). Similar results were seen when examining the effects separately for children aged 0-1 year and 2-3 years (online Appendix, supplemental results Tables 4.4 - 4.5).

Table 4.2: Unadjusted and adjusted associations between increasing the quantity of child care by 1 day per week in the first 3 years of life and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported externalising and internalising problems at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT scores (n=4066)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Total time in child care	.07	-.02, .16	0.13	-.07	-.14, -.00	0.03	.25	.14, .36	<0.001	-.07	-.15, .01	0.08	.41	.24, .57	<0.001
Total time in child care + covariates[a]	.10	.00, .21	0.03	-.08	-.15, -.00	0.03	.31	.19, .44	<0.001	-.03	-.13, .05	0.42	.04	-.11, .21	0.56

a Adjusted for child age, sex, birth weight; parental concern about child's learning and development; primary caregiver education, work status; annual household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregiver age, psychological distress and level of attachment and warmth towards the child; number of children's books; minutes child usually read to; undertaking regular cost activities

Main type of child care

To determine whether the higher risk of externalising and lower risk of internalising problem behaviours observed with increasing time in child care by 1 day per week depended on the type of child care, we examined the association between main type of care and externalising and internalising problem behaviours by the four child care categories (1) centre-based care (2) family day care (3) nanny or relative and (4) other compared with children who did not attend any type of child care in the first 3 years of life. Table 4.3 shows that compared with children who did not attend any type of child care through the first 3 years of life, children in centre-based care had higher parent-reported (β= 0.45 (0.17 to 0.72)) and teacher-reported (β= 0.50 (0.17 to 0.83)) externalising problem behaviours and lower parent-reported (β= -0.43 (-0.63 to -0.22)) and teacher-reported (β= -0.36 (-0.63 to -0.08)) internalising problem behaviours at 4-5 years. There was no association between any other types of child care and children's externalising and internalising behaviours at 4-5 years. The patterns of results were similar when examining effects separately for children aged 0-1 year and 2-3 years (online Appendix, supplemental results Tables 4.6 - 4.7).

Table 4.3: Main type of child care in the first 3 years of life and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported externalising and internalising problem behaviour scores at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT scores (n=4066)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Main type of care															
Caregiver only (reference)															
Centre-based care	.45	.17, .72	<0.001	-.43	-.63, -.22	<0.001	.50	.17, .83	<0.005	-.47	-.72, -.22	<0.001	1.15	.68,1.6	<0.001
Family day care	.36	-.07, .79	0.10	-.17	-.50, .14	0.27	.59	.06, 1.1	0.02	-.32	-.71, .07	0.10	0.72	-.03, 1.4	0.06
Nanny or relative	-.13	-.45, .17	0.39	-.15	-.39, .07	0.19	-.27	-.65, .10	0.16	-.33	-.61, -.04	0.02	1.69	1.1, 2.2	<0.001
Other child care	-.24	-.72, .22	0.30	-.35	-.70, .00	0.05	-.24	-.81, .32	0.39	-.38	-.80, .03	0.07	1.37	.54, 2.2	<0.001
Main type of care + covariates[a]															
Caregiver only (reference)															
Centre-based care	.46	.17, .76	0.002	-.34	-.56, -.12	0.002	.36	.00, .71	0.04	-.36	-.63, -.08	0.01	-.05	-.53, .42	0.83
Family day care	.26	-.17, .69	0.23	-.09	-.42, .23	0.57	.42	-.11, .96	0.12	-.18	-.60, .22	0.37	-.29	-1.0, .43	0.42
Nanny or relative	-.01	-.34, .31	0.93	-.00	-.25, .25	0.98	-.33	-.74, .07	0.10	-.16	-.47, .15	0.31	.30	-.24, .85	0.27
Other child care	.10	-.35, .56	0.65	-.07	-.41, .27	0.69	-.18	-.74, .36	0.50	-.25	-.67, .17	0.25	-.13	-.89, .61	0.71

a Adjusted for time spent in main type of child care; child age, sex, birth weight; parental concern about child's learning and development; primary caregiver education, work status; annual household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregiver age, psychological distress, and level of attachment and warmth towards the child; number of children's books; minutes child usually read to; undertaking regular cost activities

4.2.6 Discussion

This study showed that more time in child care through the first 3 years of life was associated with a small increase in parent-reported and teacher-reported externalising problem behaviours, and lower parent-reported internalising problem behaviours but no effect on receptive vocabulary at school entry. These data also suggest that the effect was concentrated among children who experienced predominately centre-based care. To our knowledge, this is the first study to have examined the developmental effects of the time spent in different types of child care across multiple years using multiple informants from a contemporary, nationally representative birth cohort from a country that has a different social policy context for child care than the USA, UK or Northern Europe.

Unlike previous research from the UK [111] and USA [181] this study found no evidence of an association between the amount of time in child care and children's cognitive abilities. However, results are consistent with findings from an Australian longitudinal study that revealed time in child care was not associated with children's rate of growth in receptive vocabulary from 4 years to 8 years [182]. A possible explanation for the contradictory findings between countries may be that different cognitive domains of child development were used. For example, in our study, the number of words the child understands (receptive vocabulary) was assessed. In contrast, Loeb et al [181] examined US children's reading ability, letter and word recognition, vocabulary and comprehension. It may be that time in child care does not influence children's simple word recognition skills but does influence more complex literacy based skills that require exposure to text and reading activities.

In our study, after adjusting for time spent in the main child care arrangement, centre-based care was associated with lower levels of both parent-reported and teacher-reported internalising problems. One possible explanation for lower levels of internalising problem behaviours may be that interactions with peers before starting school may lead to lower internalising problems. Children in centre-based care have more opportunity for same-age peer interactions than children in other types of care, including parental care, that may help them develop conflict-resolution and cooperativeness skills [183] that help in reducing anxiety-based and withdrawn behaviour.

The present study also found that centre-based care was associated with higher externalising problem behaviours at 4-5 years. These results are consistent with prior studies from the USA [32, 34, 36, 40] and UK [99] but in contrast with Norwegian studies that showed quantity of child care during the first 4.5 years of life had little influence on children's externalising behaviour [114, 115]. One possible explanation for the contradictory results from studies conducted in the USA, UK and Australia compared with Norway may relate to the high level of government investment in child care [3], family-friendly policies including long-paid parental leave entitlements [184] and generally higher quality child care arrangements in Nordic countries [115].

A limitation of the present study is that we could not capture the quality of child care for all children. The LSAC used carers' reports to obtain information about the quality of child care provided to children participating in the study. Where quality information was obtained it was only for children who spent eight or more hours per week in child care and our goal in the present study was to characterise the developmental effects of child care on the whole population experiencing child care environments. A further limitation is that information concerning the time and type of child care was obtained from interviews with the child's primary caregiver at two points in time: 0-1 year and 2-3 years. We therefore

had to assume that child care arrangements were consistent over the periods being reported.

In conclusion, there was no evidence that the total amount of time in child care through the first 3 years of life was associated with children's receptive vocabulary. However, children who spent more time in child care, particularly centre-based care had higher externalising problems and lower internalising problems around the age of school entry. Although, the effects identified in this study were small, they may have important implications at the population level due to the large proportion of children who spend significant amounts of time in child care on a regular basis. For example, research has shown that the effects of extensive child care influence the child and their classroom peers with little or no exposure to such care [106]. With more children experiencing child care in their preschool years and government commitment in supporting healthy, early child development, greater public investment in family (e.g. paid parental leave) and child care policies may help reduce any negative consequences of time spent in child care.

4.2.7 Online Appendix

Supplemental results

Table 4.4: Adjusted associations between increasing the quantity of child care by 1 day per week in the first 3 years of life for children aged 0-1 years and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported internalising and externalising problem behaviour scores at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores *(n=3646)*			Parent-reported internalising behaviour scores *(n=3646)*			Teacher-reported externalising behaviour scores *(n=3208)*			Teacher-reported internalising behaviour scores *(n=3208)*			PPVT scores *(n=4066)*		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Quantity of child care	.11	-.05,.28	0.18	.06	-.06,.18	0.35	.24	.04,.43	0.01	.05	-.09,.20	0.46	-.01	-.28,.24	0.88
Child factors															
Age at wave 3 (months)	-.00	-.04,.03	0.74	-.00	-.02,.02	0.97	-.02	-.07,.01	0.21	-.01	-.05,.01	0.30	.40	.34,.46	<0.001
Birth weight (grams)	.00	-.00,.00	0.99	-.00	-.00,.00	0.10	-.00	-.00,.00	0.38	-.00	-.00,.00	0.18	.00	.00,.00	<0.005
Sex															
Male (r)															
Female	-.76	-.96,-.55	<0.001	-.04	-.19,.11	0.61	-1.8	-2.0,-1.5	<0.001	-.26	-.45,-.07	0.06	1.01	.68,1.3	<0.001
Concerns about child's development, learning and behaviour?															
Yes a little/Don't know (r)															
No	-.62	-1.0,-.20	<0.005	-.45	-.77,-.13	<0.005	-.93	-1.4,-.41	<0.001	-.38	-.78,.00	0.05	1.30	.58,2.0	<0.001
Primary caregiver factors															
Age (years)	-.04	-.06,-.02	<0.001	-.00	-.02,.00	0.33	.00	-.02,.03	0.79	.01	-.00,.03	0.07	.12	.08,.15	<0.001
Distress, Kessler 6 score	-.90	-1.1,-.69	<0.001	-.63	-.78,-.48	<0.001	-.42	-.67,-.16	<0.001	-.12	-.32,.06	0.19	.22	-.11,.55	0.19
Warmth	-.32	-.58,-.06	0.01	-.33	-.53,-.14	<0.001	.16	-.16,.48	0.32	.00	-.23,.25	0.96	-.17	-.59,.25	0.42
Maternal separation	-.06	-.19,.07	0.37	-.24	-.34,-.14	<0.001	-.00	-.16,.15	0.95	-.17	-.29,-.04	0.007	.43	.21,.65	<0.001

	Parent-reported externalising behaviour scores *(n=3646)*			Parent-reported internalising behaviour scores *(n=3646)*			Teacher-reported externalising behaviour scores *(n=3208)*			Teacher-reported internalising behaviour scores *(n=3208)*			PPVT scores *(n=4066)*		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Country of birth															
Australia (r)															
Other	-.11	-.38,.15	0.39	.22	.02,.43	0.02	-.25	-.58,.07	0.12	.07	-.17,.32	0.54	-1.6	-2.0,-1.1	<0.001
Socioeconomic position															
Household income ($)	-.00	-.00, .00	0.14	-.00	-.00,.00	0.26	-.00	-.00,.00	0.25	-.00	-.00,.00	0.59	.00	.00,.00	<0.001
ARIA															
Highly accessible (r)															
Other	-.08	-.29,.12	0.43	.07	-.08,.23	0.36	-.09	-.35,.17	0.50	-.03	-.23,.16	0.71	.10	-.25,.45	0.57
Primary caregiver education															
< Bachelor's degree (r)															
Bachelor degree or higher	-.65	-.88,-.41	<0.001	-.20	-.37,-.02	0.02	-.35	-.63,-.08	0.01	-.12	-.34,.08	0.23	1.01	.63,1.4	<0.001
Primary caregiver work status															
Full-time work (r)															
Part-time work	-.02	-.40,.35	0.89	.07	-.21,.36	0.61	-.32	-.77,.13	0.16	-.03	-.38,.31	0.85	.76	.13,1.3	0.01
Not in labour force	.08	-.29,.47	0.65	.07	-.22,.36	0.63	-.05	-.51,.41	0.82	.16	-.18,.51	0.36	.49	-.13,1.1	0.12
Significant economic hardship															
No significant hardship (r)															
Some significant hardship	.59	.37,.81	<0.001	.15	-.00,.32	0.06	.23	-.03,.49	0.09	.07	-.12,.28	0.45	-.07	-.43,.28	0.68
Family factors															
Two-parent household															
No (r)															
Yes	-.59	-1.0,-.17	<0.005	-.37	-.69,-.05	0.02	-.93	-1.4,-.40	<0.001	.06	-.34,.46	0.77	.83	.16,1.5	0.01

	Parent-reported externalising behaviour scores *(n=3646)*			Parent-reported internalising behaviour scores *(n=3646)*			Teacher-reported externalising behaviour scores *(n=3208)*			Teacher-reported internalising behaviour scores *(n=3208)*			PPVT scores *(n=4066)*		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Number of siblings															
No siblings (r)															
1	.10	-.13,.34	0.40	-.36	-.54,-.18	<0.001	-.23	-.52,.05	0.11	-.06	-.28,.15	0.55	-.93	-1.3,-.54	<0.001
≥ 2	-.55	-.84,-.26	<0.001	-.59	-.81,-.37	<0.001	-.16	-.52,.19	0.36	-.28	-.55,-.00	0.04	-2.0	-2.5,-1.5	<0.001
Home environment															
Children's books in the home															
≤ 20 books (r)															
≥ 21 books	-.51	-.82,-.19	<0.005	-.44	-.68,-.21	<0.001	-.46	-.84,-.07	0.01	-.13	-.43,.16	0.37	3.1	2.6,3.7	<0.001
Minutes child usually read to at a sitting															
≤ 20 minutes (r)															
≥ 21 minutes	-.31	-.65,.03	0.07	-.16	-.42,.09	0.21	-.31	-.71,.09	0.13	-.12	-.43,.18	0.43	.37	-.19,.94	0.20
Special or extra cost activities															
No (r)															
Yes	-.31	-.53,-.10	<0.005	-.23	-.39,-.06	0.006	-.13	-.39,.13	0.32	-.24	-.44,-.04	0.01	.68	.31,1.0	<0.001

Note. ARIA =Accessibility and Remoteness Index of Australia

Table 4.5: Adjusted associations between increasing the quantity of child care by 1 day per week in the first 3 years of life for children aged 2-3 years and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported internalising and externalising problem behaviour scores at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT scores (n=4066)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Quantity of child care	.03	-.00,.07	0.05	-.03	-.06,-.00	0.01	.10	.06,.15	<0.001	-.01	-.04,.01	0.31	.01	-.04,.07	0.52
Age at wave 3 (months)	-.00	-.04,.03	0.84	.00	-.02,.03	0.87	-.02	-.06,.02	0.33	-.01	-.05,.01	0.33	.40	.34,.46	<0.001
Birth weight (grams)	-.00	-.00,.00	0.97	-.00	-.00,.00	0.10	-.00	-.00,.00	0.34	-.00	-.00,.00	0.18	.00	.00,.00	<0.005
Sex															
Male (r)															
Female	-.76	-.96,-.56	<0.001	-.03	-.19,.11	0.64	-1.8	-2.0,-1.5	<0.001	-.26	-.45,-.07	0.006	1.01	.67,1.3	<0.001
Concerns about child's development, learning and behaviour?															
Yes a little/Don't know (r)															
No	-.61	-1.0,-.19	<0.005	-.46	-.78,-.14	<0.005	-.93	-1.4,-.42	<0.001	-.39	-.78,.00	0.05	1.30	.59,2.0	<0.001
Caregiver age (years)	-.04	-.06,-.02	<0.001	-.00	-.02,.00	0.39	.00	-.02,.02	0.94	.01	-.00,.03	0.07	.12	.08,.15	<0.001
Distress, Kessler 6 score	-.90	-1.1,-.68	<0.001	-.64	-.79,-.49	<0.001	-.39	-.64,-.14	<0.005	-.13	-.32,.06	0.17	.22	-.10,.56	0.18
Warmth	-.32	-.58,-.06	0.01	-.34	-.54,-.14	<0.001	.17	-.14,.49	0.29	.00	-.24,.24	0.99	-.16	-.59,.25	0.43
Maternal separation	-.06	-.19,.07	0.37	-.22	-.32,-.12	<0.001	-.01	-.17,.14	0.87	-.15	-.28,-.03	0.01	.42	.20,.64	<0.001
Country of birth															
Australia (r)															
Other	-.11	-.38,.15	0.41	.23	.02,.43	0.02	-.23	-.55,.09	0.16	.08	-.16,.32	0.52	-1.6	-2.0,-1.7	<0.001
Household income ($)	-.00	-.00,.00	0.14	-.00	-.00,.00	0.40	-.00	-.00,.00	0.23	-.00	-.00,.00	0.70	.00	.00,.00	<0.001
ARIA															
Highly accessible (r)															
Other	-.07	-.28,.14	0.51	.06	-.09,.22	0.43	-.05	-.31,.20	0.67	-.04	-.24,.15	0.68	.10	-.24,.45	0.55

	Parent-reported externalising behaviour scores *(n=3646)*			Parent-reported internalising behaviour scores *(n=3646)*			Teacher-reported externalising behaviour scores *(n=3208)*			Teacher-reported internalising behaviour scores *(n=3208)*			PPVT scores *(n=4066)*		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Primary caregiver education															
< Bachelor's degree (r)															
Bachelor degree or higher	-.65	-.88,-.42	<0.001	-.19	-.37,-.02	0.02	-.37	-.65,-.09	0.009	-.12	-.34,.08	0.24	1.01	.62,1.40	<0.001
Primary caregiver work status															
Full-time work (r)															
Part-time work	-.02	-.39,.34	0.87	-.03	-.31,.24	0.81	-.24	-.69,.20	0.28	-.10	-.44,.23	0.54	.81	.20,1.42	0.009
Not in labour force	.09	-.27,.45	0.62	-.08	-.36,.19	0.53	.06	-.38,.51	0.77	.05	-.28,.39	0.74	.57	-.03,1.18	0.06
Significant economic hardship															
No significant hardship (r)															
Some significant hardship	.58	.36,.80	<0.001	.16	.00,.33	0.04	.21	-.05,.47	0.12	.08	-.12,.28	0.43	-.07	-.44,.28	0.66
Two-parent household															
No (r)															
Yes	-.58	-1.0,-.16	0.006	-.43	-.75,-.11	0.008	-.90	-1.4,-.37	<0.001	.02	-.38,.42	0.91	.86	.19,1.53	0.01
Number of siblings															
0 (r)															
1	.09	-.13,.33	0.41	-.36	-.54,-.18	<0.001	-.24	-.53,.04	0.09	-.06	-.28,.15	0.55	-.93	-1.3,-.54	<0.001
≥ 2	-.54	-.83,-.25	<0.001	-.61	-.83,-.39	<0.001	-.12	-.47,.23	0.51	-.29	-.56,-.02	0.03	-2.0	-2.5,-1.5	<0.001
Children's books in the home															
≤ 20 books (r)															
≥ 21 books	-.52	-.83,-.20	<0.001	-.45	-.69,-.21	<0.001	-.49	-.88,-.10	0.01	-.13	-.43,.16	0.36	3.19	2.6,3.7	<0.001
Minutes child usually read to at a sitting															
≤ 20 minutes (r)															
≥ 21 minutes	-.30	-.64,.03	0.08	-.17	-.43,.08	0.19	-.30	-.70,.10	0.14	-.12	-.43,.18	0.43	.37	-.19,.94	0.19

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT scores (n=4066)		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Special or extra cost activities															
No (r)															
Yes	-.31	-.52,-.09	<0.005	-.23	-.40,-.07	<0.005	-.11	-.37,.14	0.38	-.24	-.45,-.04	0.01	.69	.32,1.0	<0.001

Note. ARIA =Accessibility and Remoteness Index of Australia

Table 4.6: Adjusted associations between main type of child care for children aged 0-1 years and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported internalising and externalising problem behaviour scores at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT scores (n=4066)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Main type of care + covariates[a]															
Caregiver only (r)															
Centre-based care	.19	-.19, .57	0.32	-.33	-.62, -.04	0.02	.55	.09, 1.0	0.02	-.45	-.80,-.09	0.01	.18	-.45, .82	0.56
Family day care	.46	-.11, 1.0	0.11	.14	-.29, .57	0.51	.72	.01, 1.4	0.05	-.21	-.75, .33	0.44	-.41	-1.3, .54	0.39
Nanny or relative	-.08	-.40, .22	0.58	.07	-.16, .31	0.54	-.27	-.65,.10	0.16	-.12	-.41, .16	0.39	.15	-.36, .67	0.55
Other child care	-.24	-.83, .33	0.40	-.21	-.65, .22	0.34	-.33	-1.0,.39	0.37	-.62	-1.1,-.06	0.03	-.03	-1.0, .95	0.95

a Adjusted for time spent in main type of child care at 0-1 years; child age, sex, birth weight; parental concern about child's learning and development; primary caregiver education, work status; annual household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregiver age, country of birth, psychological distress, level of attachment and warmth towards the child; number of children's books; minutes child usually read to; undertaking regular cost activities

Table 4.7: Adjusted associations between main type of child care for children aged 2-3 years and children's receptive vocabulary scores (PPVT), parent-reported and teacher-reported internalising and externalising problem behaviour scores at 4-5 years using the multiply imputed sample

	Parent-reported externalising behaviour scores (n=3646)			Parent-reported internalising behaviour scores (n=3646)			Teacher-reported externalising behaviour scores (n=3208)			Teacher-reported internalising behaviour scores (n=3208)			PPVT Scores (n=4066)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Main type of care + covariates[a]															
Caregiver only (r)															
Centre-based care	.52	.24, .80	<0.001	-.28	-.49, -.06	<0.005	.52	.18, .86	<0.005	-.29	-.56,-.03	0.03	-.06	-.52, .40	0.79
Family day care	.29	-.13, .73	0.17	-.02	-.35, .29	0.86	.59	.06, 1.1	0.03	-.09	-.50, .31	0.63	-.24	-.97, .48	0.50
Nanny/Relative	.03	-.31, .37	0.85	.09	-.17, .35	0.50	-.07	-.49,.34	0.73	-.04	-.37, .27	0.78	.30	-.27, .87	0.30
Other child care	.11	-.34, .58	0.62	-.09	-.44, .26	0.61	.10	-.46,.66	0.72	-.14	-.58, .29	0.51	-.39	-1.1, .38	0.31

a Adjusted for time spent in main type of child care at 2-3 years; child age, sex, birth weight; parental concern about child's learning and development; primary caregiver education, work status; annual household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregiver age, country of birth, psychological distress, level of attachment and warmth towards the child; number of children's books; minutes child usually read to; undertaking regular cost activities

End of published article

5 Child care quality and children's cognitive and socio-emotional development

5.1 Preface

This chapter contains the second and third articles contributing to this thesis. The first, published in *Early Child Development and Care*, examines whether the quality of formal child care at age 2-3 years is associated with children's children's cognitive (receptive vocabulary; academic literacy and numeracy proficiency) and socio-emotional development (internalising and externalising behaviours) at age 4-5 and 6-7 years. The second, published in *The Journal of Pediatrics*, examines whether the quality of formal child care at age 2-3 years is associated with children's children's task attentiveness and emotional regulation at age 4-5 and 6-7 years.

The data for these two publications are a subset of those in Chapter 4. Although all types of child care were the focus of the previous chapter, only formal child care arrangements were considered here, since provider and program characteristics of care, such as the number of years worked in child care settings and hours spent in professional development were not collected from informal child care providers, and the purpose was to investigate the developmental effects of both structural and process qualities of child care. Furthermore, the LSAC obtained information about the quality of child care for children who spent ≥8 hours in care, thus analyses were restricted to children aged 2-3 years as very few infants spent this amount of time in formal child care on a regular, weekly basis.

The aim of this chapter is to contribute to the limited evidence regarding the developmental effects of the quality of formal child care within the Australian context.

5.2 Publication: Child care quality and children's cognitive and socio-emotional development: an Australian longitudinal study

5.2.1 Statement of authorship

Gialamas A, Mittinty MN, Sawyer MG, Zubrick SR, Lynch J. Child care quality and children's cognitive and socio-emotional development. Early Child Development and Care 2014; 184(7):1-21.

By signing below, the authors declare that they give consent for this paper to be presented by Angela Gialamas towards examination for the Doctor of Philosophy.

Angela Gialamas (Candidate)

Designed the study, performed the analyses, interpreted the results and drafted the manuscript.

Signed: …………………………… Date: .………06/07/2015………

Murthy Mittinty

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015………

Michael Sawyer

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

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Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

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John Lynch

Contributed to the design of the study and interpretation of the results, and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………… Date: …………06/07/2015…………

5.2.2 Abstract

There is growing evidence that high quality non-parental child care can contribute to children's learning, development and successful transition to school. Research examining the quality of child care and the effect on children's development is not well documented outside the USA. We used data from the Longitudinal Study of Australian Children to examine the association between domain-specific aspects of child care quality at ages two to three and children's cognitive (receptive vocabulary, literacy, math proficiency) and socio-emotional development (internalising, externalising behaviours) at ages four to five and six to seven (n=772-1136, depending on outcome). After extensive controls for parent, family and child background characteristics, higher quality relationships were associated with higher receptive vocabulary, literacy and math scores and lower internalising and externalising problem behaviour scores at four to five and these effects although weaker, were still evident at age six to seven. Activities in child care and provider/program characteristics of care were not associated with children's developmental outcomes.

5.2.3 Introduction

Over recent decades, for a variety of demographic, social and economic reasons, increasing numbers of children have experienced non-parental child care during their preschool years. Child care for young children is usually provided in two settings: 1) formal, regulated care that takes place outside children's homes, such as centre and family day care or 2) informal non-regulated care, such as that provided by relatives (grandparents) and non-relatives (friends) either in children's homes or in other settings. In 2008, the first evaluation of early childhood services across twenty five OECD countries estimated that 25% of 0-3 year olds spent some time in child care. Participation rates were shown to differ considerably between countries with approximately 40% of American children in care compared to 28% of Australian children [3].

Child care during children's preschool years is an important component of early child health and development policies in many rich countries. In 2009, the Australian Government endorsed a National Quality Agenda committing more than $18 billion to improve the quality, affordability and accessibility of child care [185]. The policy set standards for the structural components of child care, including a requirement for qualified staff and minimum staff to children ratios. It also established a new quality rating system and quality standards to be implemented by a national body, the Australian Children's Education and Care Quality Authority [185].

These major reforms are an important step towards recognising that quality child care may contribute to children's learning and development. However, most evidence regarding child care quality has come from the USA with little evidence as to whether these findings apply in Australia, where the social and labour market context is different. The aim of the present study was to examine the association between quality of non-parental child care at age two to three and children's cognitive and socio-emotional functioning at school entry (ages four to five) and at ages six to seven, using data drawn from a large, nationally representative cohort of Australian children.

What is child care quality and how is it assessed?

Child care quality is considered to be a multidimensional construct that includes both structural and process characteristics of care. Structural quality refers to provider and program characteristics of child care such as staff qualifications and staff-to-child ratios. Process quality refers to practices that directly affect children's experiences, including the quality of relationships and interactions between carers and children [80, 81, 186]. Qualified staff, small group size, positive and responsive carer-child relationships and interactions have all been suggested as aspects of quality that promote children's learning emotionally, socially and cognitively [28, 81, 83, 109].

Direct observation is frequently used to assess the quality of child care. Observers rate quality utilizing instruments such as the Early Childhood Environment Rating Scale-Revised (ECERS-R) [86] and the Observational Record of the Caregiving Environment (ORCE) [33, 34, 84]. It should be noted that results from these two instruments are not readily comparable as the ECERS-R was designed to measure overall classroom quality whereas the ORCE focused on a particular child's experience. A problem with using direct observation to assess the quality of child care is that it requires substantial time and resources. As such, it is often not practical to use this approach in large-scale longitudinal studies. For this reason, the Longitudinal Study of Australian Children (LSAC) utilized carers' reports to obtain information about the nature of child care provided to children participating in the study. Carers' reports of child care quality have begun to appear in the literature [43, 89-91]. One study aimed to investigate whether accurate information on child care quality could be obtained without direct observation [89]. Findings revealed a high level of agreement between carer-report and direct observation of child care quality with self-report classifying over 89% of the care in terms of 'poor' 'mediocre' or 'developmentally appropriate' compared to the ECERS-R. This suggests reasonable validity of carer-report in assessing child care quality [89].

Child care quality and children's development

To date, the United States National Institute of Child Health and Development (NICHD) Study of early child care has been the main source of evidence regarding the effects of child care and children's development. The NICHD study has comprehensively assessed the cognitive and socio-emotional development of children aged 6, 15, 24, 36 and 54 months, who were receiving any type of non-parental care for more than 10 hours per week [85].

Findings from the NICHD study showed positive cognitive and socio-emotional benefits for children enrolled in centres that provide a cognitively stimulating experience, have smaller group sizes and have carers who were more sensitive and responsive to children's needs [35, 37, 109, 125]. A cross-sectional Australian study using carer self-report data from LSAC also found that the more time non-parental carers spent in active engagement in play was associated with improved child social competence at ages two to three years [43]. However, this study did not control for important parental and background confounding influences of the association between child care and child outcomes. Evidence of the enduring impact of early quality care was observed in a recent analysis of the NICHD cohort which demonstrated that higher quality child care predicted better cognitive-academic outcomes and lower externalising behaviours at age fifteen [37].

Australian context

As there is considerable variation in child care provisions across countries, it is important to know whether the same effects of child care quality seen in the USA would exist in different countries [42, 187]. In terms of the regulatory environment, Australia is one of few countries with a national quality improvement and accreditation system funded by the government to promote high quality care for centre and family day care services [128]. As the quality improvement and accreditation system is attached to government funding, over 98% of services are accredited or registered in the system [130]. By way of contrast, less than 10% of child care centres in the USA are nationally accredited [129] with recent reviews indicating that many states do not meet the licensing laws or are exempt from them [100]. The differential compliance with standards may result in wider variations in quality, indicating the need for studies in different countries.

The present study

The aim of the present study was to examine whether the quality of child care for children aged two to three years was associated with children's cognitive and socio-emotional development at ages four to five and at six to seven, using data from a nationally representative LSAC. The study had two objectives. First, as no direct measurement of child care quality was available in LSAC, we quantified child care quality using questionnaire data from non-parental carers, using a priori theoretical domains derived from the literature, and confirmed with factor analysis. The second objective of the study was to examine whether domains of child care quality were associated with children's later cognitive and socio-emotional development after adjusting for a wide range of potential confounding factors.

5.2.4 Methods

Study design, setting and sampling

This study used data from the infant cohort of the LSAC, a prospective cohort study which commenced in 2004. LSAC is funded by the Australian Government Department of Families, Community Services and Indigenous Affairs and is a nationally representative, population-based study [138]. Detailed study design and sampling framework has been described elsewhere [139]. Briefly, the sampling framework used a two-stage clustered sampling. The first stage selected Australian postcodes and the second, sampled children within postcodes [139]. Postcodes were randomly selected and stratified by state/territory and urban/rural status to ensure a nationally representative sample. The Medicare database, which provides medical and hospital coverage for all Australian permanent residents was then used to randomly select infants born March 2003-February 2004 within each stratum. At wave 1, 5107 infants aged zero to one years were recruited into the study (response rate 57.2% of an eligible 8921 infants) and were reassessed at two to three years

(n=4606), four to five years (n=4386) and six to seven years of age (n=4242). The study was approved by the Australian Institute of Family Studies Ethics Committee.

Participants

For the present study, the sample consisted of children aged two to three years attending formal, centre-based or family day care (Figure 5.1). Most Australian centres and family day care facilities operate under the same regulatory environment incorporating national regulations and quality assessment. Data were obtained from face-to-face interviews and questionnaires with the child's primary caregiver and questionnaires from non-parental carers. At the parent interview, when children were aged two to three years, the primary caregiver (97% mothers) identified whether in the past month the study child was 'looked after at regular times during the week by anyone other than the primary or secondary caregiver'. If the child spent eight or more hours per week in non-parental care, a questionnaire was posted to the main non-parental carer (if more than one child care arrangement was used, it was posted to the child care setting attended for the most number of hours). As shown in Figure 5.1, the prevalence of formal, non-parental child care among children aged two to three years was 40.8%. There were 1859 children aged two to three years in formal care for ≥8 hours per week and whose primary caregiver consented for a questionnaire to be posted to the study child's main carer. A total of 1282 questionnaires were returned (69% response rate).

Figure 5.1: Data flow of recruitment into LSAC and identification of children in centre or family day care at age two to three and their cognitive and socio-emotional outcomes at ages four to five and six to seven

```
┌────────────────────────────┐         ┌────────────────────────────┐
│  Cohort recruited n=5107   │────────>│  Lost to follow up n=501   │
└────────────────────────────┘         └────────────────────────────┘
              │
              v
┌────────────────────────────┐
│  Cohort n=4606 at wave 2   │
└────────────────────────────┘
              │                        ┌────────────────────────────┐
              v                        │  Exclusions:               │
┌────────────────────────────┐         │  Children not in centre or │
│ Cohort in child care n=3244│────────>│  family day care n=1081    │
│        at wave 2           │         │  <8 hours/week in centre or│
└────────────────────────────┘         │  family day care n=284     │
              │                        │  Centre or family day care │
              v                        │  ≥8 hours but parent refused│
┌────────────────────────────┐         │  to send questionnaire n=20│
│ Non-parental carers eligible│        └────────────────────────────┘
│ to receive a questionnaire │
│         n=1859             │
└────────────────────────────┘
              │                        ┌────────────────────────────┐
              v                        │ Incomplete child care      │
┌────────────────────────────┐         │ quality ≥ 1 indicator      │
│ Non-parental carer         │────────>│ missing n=327              │
│ questionnaires received    │         └────────────────────────────┘
│       n=1282               │
└────────────────────────────┘
              │
              v
┌────────────────────────────┐
│ Children with complete     │
│ child care quality         │
│ information n=955          │
└────────────────────────────┘
              │
              v
┌────────────────────────────┐
│ Children with complete     │
│ child care quality and     │
│ covariates n=745           │
└────────────────────────────┘
              │
              v
┌────────────────────────────┐
│ Imputed Analysis Sample    │
│        n=1282              │
└────────────────────────────┘
         │            │
         v            v
┌──────────────────┐ ┌──────────────────┐
│ PPVT 4-5 years   │ │ PPVT 6-7 years   │
│    n=1136        │ │    n=1136        │
└──────────────────┘ └──────────────────┘
┌──────────────────┐ ┌──────────────────┐
│ ARS Literacy 6-7 │ │ ARS Math 6-7     │
│ years n=970      │ │ years n=951      │
└──────────────────┘ └──────────────────┘
┌──────────────────┐ ┌──────────────────┐
│Parent-reported   │ │Parent-reported   │
│internalising &   │ │internalising &   │
│externalising     │ │externalising     │
│behaviours 4-5    │ │behaviours 6-7    │
│years n=1056      │ │years n=1056      │
└──────────────────┘ └──────────────────┘
┌──────────────────┐ ┌──────────────────┐
│Teacher-reported  │ │Teacher-reported  │
│internalising &   │ │internalising &   │
│externalising     │ │externalising     │
│behaviours 4-5    │ │behaviours 6-7    │
│years n=772       │ │years n=772       │
└──────────────────┘ └──────────────────┘
```

Defining child care quality from questionnaires

Two types of questionnaires were developed by the LSAC consortium to capture information about the non-parental child care environment: a centre based questionnaire and a home-based questionnaire sent to carers who provided care in their home (family day care). The present study used common indicators from the centre and home-based carer questionnaires to generate three a priori domains of child care quality. For this purpose, domains of child care quality were identified on the basis of a conceptual framework that considered (1) Australian child care standards for centre-based care [128] (2) aspects of quality captured by direct observational methods and (3) previous research on the key components of quality, as described above.

Information on 57 potential indicators of child care quality was selected from the questionnaires. Indicators that were not asked of all non-parental carers were excluded. A final list of 31 indicators that were judged to capture meaningful aspects of the quality of care with research evidence to support their inclusion was used [33, 43, 87]. Of the 31 indicators, 5 indicators described provider and program characteristics of care, 11 indicators described activities in child care and 15 indicators described the carer-child relationship, using the closeness and conflict scales from the short version of the Student Teacher Relationship Scale (STRS) [92]. Online appendix A provides details of the complete list of 31 indicators (see Section 3.4, Table 3.1).

In order to assess our a priori conceptualization of the 31 indicators to represent child care quality, exploratory factor analysis of the correlation matrix using a maximum likelihood extraction method with oblique rotation was conducted. Exploratory analysis was conducted rather than confirmatory analysis, because the structure of child care quality measured with these indicators had not been previously assessed. This approach was also used to establish whether indicators clustered together meaningfully into one or more

factors. The number of factors identified was based on eigenvalues >1.50, detecting a

break-point in the scree plot and interpretability. Indicators were considered to load on a

factor if they had an absolute correlation of ≥0.47 with that factor [140].

Exploratory factor analysis revealed two domain-specific aspects of child care quality: one

factor describing activities in child care and a second factor describing the carer-child

relationship. The activities in child care domain is the sum of (1) singing, telling stories

and reading books, (2) participating in active outdoor play, (3) pretend play and (4)

teaching good health practices. Activities that did not strongly load with the factor

(correlation <0.47) were not retained and included: the amount of time spent sitting and

playing with the children; providing individual attention in routine care, supervising

children's play, organizing space, equipment, toys, food and drink, managing problem

behaviours, minutes per day reading books or singing songs to the children and time spent

watching television. The carer-child relationship domain is the sum of (1) sharing an

affectionate, warm relationship, (2) in tune with child's feelings, (3) child values

relationship, (4) spontaneously shares information, (5) openly shares feelings and

experiences, (6) child's feelings towards me can be unpredictable (reverse-coded), (7) child

drains my energy (reverse-coded) and (8) this child and I struggle with each other (reverse-

coded). Relationship indicators that did not strongly load with the factor (correlation

<0.47) were not retained and included: if upset this child will seek comfort from me, this

child is uncomfortable with physical affection or touch from me, when I praise this child,

he/she beams with pride, child easily becomes angry with me, child remains angry or

resistant after being disciplined, when this child is in a bad mood I know we're in for a

long and difficult day, child is manipulative with me. The two factors accounted for 75%

of the total variance. The Kaiser-Meyer-Olkin measure used to assess the strength of the

linear association among the 31 indicators in the correlation matrix was 0.78.

We chose to sum the four unstandardized scores that loaded ≥0.47 for the activities in child care domain and the eight unstandardized scores that loaded ≥0.47 for the carer-child relationship domain. The domain score could range from 4 to 8 for activities in child care, with a maximum score of 8 indicating that the child participated in all four activities 'very much/quite a lot'. A higher score was considered to reflect higher quality care because spending quite a lot/very much of the day in activities that foster learning and interaction were thought to have a positive effect on children's cognitive and socio-emotional development. To investigate whether the quality of activities in child care was associated with children's developmental outcomes, we used each score as a category in the regression analyses as the score had a narrow range of variation (mean score 7.19; median score 8; interquartile range, 7-8) with 55.2% of all participants achieving the maximum score of 8.

The domain score for the carer-child relationship could range from 8 to 16, with a maximum score indicating that all relationship indicators 'applied somewhat/definitely applied' with the exception for reverse-coded indicators (child's feelings can be unpredictable, child drains my energy, child and I always seem to be struggling with each other), where 'definitely does not apply/not really/ neutral/not sure' indicated a more positive relationship. A higher score was considered to reflect higher quality child care because research shows when children have positive, warm relationships they can use their carer as a secure base and source for learning and social relationships [141, 142]. The carer-child relationship score was negatively skewed (mean score 14.9; median score 16; interquartile range, 15-16) with 55.1% of all participants achieving the maximum score of 16. To investigate whether the quality of the carer-child relationship was associated with children's development, we used both continuous and dichotomised scores. Children were classified as receiving higher quality if they scored a 1(= 'low rating') on less than three (out of eight) indicators, else were classified as receiving lower quality.

Indicators used to define provider and program characteristics of child care did not significantly load onto any factor. This is not surprising, given the heterogeneity of the items, so the five individual indicators were retained for later regression analyses because of a priori theoretical evidence [142, 143], and because it represents a domain of child care quality that regulating agencies and governments use to define child care quality (e.g. carer qualifications and numbers of children in care).

Child outcomes
Receptive vocabulary

Children's receptive vocabulary at ages four to five and at six to seven years was directly assessed in the child's home using the Peabody Picture Vocabulary Test III (PPVT) – LSAC Australian Short Form [149]. The test involved the interviewer presenting four numbered black and white pictures to the child, stating a word to describe one of the pictures and asking the child to either point, verbally or non-verbally indicate 'yes' or 'no' as the interviewer pointed to the possible responses [150]. Raw scores were scaled according to a Rasch model to enable comparison of scores across waves [149].

Academic proficiency

Children's academic proficiency at age six to seven years was assessed by teachers using a modified version of the Academic Rating Scale (ARS). The ARS was adapted for the LSAC study and only the domains assessing language, literacy and mathematical thinking were used [151]. There are nine items that teachers use to rate children's language, literacy and mathematical thinking according to a five-point Likert scale (1=not proficient to 5=proficient). Scores were scaled according to a Rasch model and transformed to the ARS rating scale [151]. Scores could range from 1 to 5 with higher scores indicating greater proficiency.

Internalising and externalising behaviours

Children's internalising and externalising behaviours at school entry (age four to five) and at six to seven years were assessed by both the parent and teacher, using the Strength and Difficulties Questionnaire (SDQ). Informants used a three-point Likert scale (0=not true, 1=somewhat true, 2=certainly true) to specify how 25 items (five sub-scales, prosocial behaviour, hyperactivity, emotional symptoms, conduct problems and peer problems of five items each) over the past six months or the current school year apply to the study child [152]. In the present study, the conduct and hyperactivity sub-scales of the SDQ were summed to reflect externalising behaviours and the emotional and peer sub-scales were summed to reflect internalising behaviours [153]. The score for externalising and internalising behaviours ranged between 0 and 20, respectively, with higher scores indicating higher risk of behavioural problems. Normative values or clinical cut-off points for these broader internalising and externalising SDQ sub-scales are not yet available.

Confounding factors

Confounding factors were identified a priori using a directed acyclic graph [158] as being associated theoretically or empirically with child care quality and children's cognitive or socio-emotional development. These covariates included indicators of socioeconomic position and characteristics of the child, parent, family and home environment and total time spent in non-parental child care. Covariates were measured at baseline at the parent interview (zero to one year) with the exception of variables representing time spent in child care and the home environment that were measured when children were two to three years of age.

Socioeconomic position

Indicators of socioeconomic position included the primary caregiver's education, annual household income, the primary caregivers work status, whether the family experienced one or more indicator of economic hardship (e.g. not been able to pay gas, electricity or telephone bills on time) over the last 12 months and geographic remoteness using the Accessibility and Remoteness Index of Australia (ARIA) [145].

Child factors

Child factors included sex, age, birth weight and whether the primary caregiver had any concerns about the child's development, learning and behaviour.

Parent factors

Parent factors included the primary caregiver's age and psychological wellbeing. The primary caregiver reported their psychological distress by completing the Kessler K6 scale with higher scores indicating less distress [147].

Family factors

The primary caregiver reported the number of siblings living in the household and whether the child lived in a two-parent household.

Home environment factors

Three questions were used to define the home environment including: the number of children's books in the home, how many minutes the child was read to at a sitting and whether the child undertook regular, special or extra cost activities in the last six months.

Child care factors

The total time spent in non-parental child care was reported by the primary caregiver as hours per week.

Analytic approach

Linear regression analysis was used to examine the association between individual provider and program characteristics of care and factor-based domains of child care quality (activities in child care, carer-child relationship) at two to three years of age and children's receptive vocabulary (four to five and six to seven years), teacher reported literacy and math proficiency (six to seven years) and parent- and teacher-reported internalising and externalising behaviours (four to five and six to seven years). All analyses were conducted using Stata version 12.1 (Stata Corp, College Station, TX, USA).

Multiple imputation

Of the 1859 children in formal child care for eight or more hours per week and whose primary care giver consented to contact the main non-parental carer, 1282 questionnaires were returned and were eligible to be included in the analysis. As not all children had complete exposure, covariate and outcome information, the nature of the missing responses was investigated and there was evidence to suggest that they were not missing completely at random. The missing responses were assumed to be missing at random and multiple imputation was used to address the possibility of bias due to missing values [162].

The imputation model included all 31 indicators of child care quality, all 17 covariates, main type of child care and scores for all eight outcomes. Multiple imputation by chained equations was used in Stata to impute missing data for all indicators of child care quality, covariates and outcomes. We generated 20 imputed datasets, using 50 cycles of regression switching [163]. After imputation, children with imputed outcomes were excluded from the analysis as they do not provide any additional information to improve the regression estimate [166]. Analysis was performed on each of the imputed datasets and the '*mi estimate*' command was used to combine the 20 imputed datasets using Rubin's rules [165]. Results using the imputed data are reported because they are subject to fewer

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assumptions than a complete-case analysis that requires the data to be missing completely at random.

Propensity score analysis

Domain-specific propensity score matching was utilised as sensitivity analyses. For example, we used propensity score matching to evaluate the Average Treatment Effect on the Treated (ATT), that is, the effect of experiencing a higher quality relationship for children who actually received it. Using logistic regression, the propensity score was calculated as the probability of receiving higher quality (children scored 1 = 'low rating' on less than three out of eight carer-child relationship indicators, treated group) vs. lower quality care (children who scored a 'low rating' on greater or equal to three indicators, untreated group). The probability of being in the higher vs. lower group of quality was then matched using the nearest neighbour matching method with calipers set to 0.01 without replacement. This method matched the treated children to the untreated children resulting in the two groups being as equivalent as possible on all 17 covariates included in the propensity score. After matching the total bias was reduced so that standardised differences were generally < 10%. This suggests that covariates were reasonably balanced between the lower and higher quality groups; however some residual differences in covariate balance remained. A comparison of different matching algorithms showed similar results. Propensity score analyses were conducted using the Stata module '*psmatch2*'.

5.2.5 Results

Characteristics of the study participants using the complete-case sample are shown in Table 5.1 (see online Appendix for results using the multiply imputed sample, supplemental results Table 5.3). As the number of children included in the analysis differed depending on outcome, characteristics of study participants with receptive vocabulary scores at ages four to five and six to seven years are reported here as an example. Table 5.1 shows that of the 726 children with a receptive vocabulary score, 626 (86.2%) spent time in centre-based care and 100 (13.8%) spent time in a family day care setting. Children spent approximately 23.7 hours (standard deviation (SD): 11.4) per week in child care. The majority of children lived in a two-parent household (92.6% vs. 7.4%), with a higher percentage of primary caregivers with less than a bachelor degree (58.7% vs. 41.3%) and an annual combined household income of $41,549 – $77,999 (42.7%). The characteristics of study participants and mean scores for quality and child outcome measures were similar across all outcomes (Table 5.1).

Table 5.1: Characteristics of the study participants by outcome using the complete-case sample

Characteristic	Receptive vocabulary (n=726)	Literacy proficiency (n=612)	Maths proficiency (n=602)	Parent-reported internalising and externalising behaviour (n=683)	Teacher-reported internalising and externalising behaviour (n=505)
Child Factors					
Age at wave 3 (months), mean (SD)	57.7 (2.7)	57.7 (2.8)	57.7 (2.8)	57.7 (2.7)	57.7 (2.8)
Age at wave 4 (months), mean (SD)	82.1 (3.4)	81.9 (3.3)	81.9 (3.3)	82.1 (3.5)	81.9 (3.4)
Sex					
Male	380 (52.3)	321 (52.5)	314 (52.2)	368 (53.9)	407 (52.7)
Female	346 (47.7)	291 (47.5)	288 (47.8)	315 (46.1)	365 (47.3)
Concerns about child's development, learning and behaviour?					
Yes a little/don't know	42 (5.8)	32 (5.2)	31 (5.2)	41 (6.0)	44 (5.7)
No	684 (94.2)	580 (94.8)	571 (94.8)	642 (94.0)	728 (94.3)
Birth weight					
≤2500 grams	33 (4.6)	30 (4.9)	30 (5.0)	31 (4.5)	31 (4.0)
≥2501 grams	693 (95.4)	582 (95.1)	572 (95.0)	652 (95.5)	741 (96.0)
Parent Factors					
Primary caregiver age (years), mean (SD)	31.9 (4.9)	31.9 (4.8)	31.9 (4.8)	32.0 (4.8)	32.1 (4.8)
Primary caregiver Kessler 6 score, mean (SD)	4.40 (0.5)	4.40 (0.5)	4.39 (0.5)	4.41 (0.5)	4.43 (0.5)
Socioeconomic Position					
Accessibility and Remoteness Index of Australia (ARIA)					
Highly accessible	409 (56.3)	344 (56.2)	341 (56.6)	383 (56.1)	447 (57.9)
Other	317 (43.7)	268 (43.8)	261 (43.4)	300 (43.9)	325 (42.1)
Primary caregiver education					
< Bachelor's degree	426 (58.7)	352 (57.5)	347 (57.6)	394 (57.7)	281 (55.6)
Bachelor's degree or higher	300 (41.3)	260 (42.5)	255 (42.4)	289 (42.3)	224 (44.4)

Characteristic	Receptive vocabulary (n=726)	Literacy proficiency (n=612)	Maths proficiency (n=602)	Parent-reported internalising and externalising behaviour (n=683)	Teacher-reported internalising and externalising behaviour (n=505)
Significant economic hardship					
No significant hardship	418 *(57.6)*	347 *(56.7)*	342 *(56.8)*	399 *(58.4)*	297 *(58.8)*
Some significant hardship	308 *(42.4)*	265 *(43.3)*	260 *(43.2)*	284 *(41.6)*	208 *(41.2)*
Primary caregiver work status					
Full-time work	114 *(15.7)*	102 *(16.7)*	100 *(16.6)*	113 *(16.5)*	89 *(17.6)*
Part-time work	274 *(37.7)*	225 *(36.8)*	223 *(37.0)*	262 *(38.4)*	187 *(37.0)*
Not in labour force	338 *(46.6)*	285 *(46.6)*	279 *(46.4)*	308 *(45.1)*	229 *(45.4)*
Household income					
≤ $41,548	159 *(21.9)*	129 *(21.1)*	126 *(20.9)*	140 *(20.5)*	102 *(20.2)*
$41,549 – $77,999	310 *(42.7)*	262 *(42.8)*	259 *(43.0)*	293 *(42.9)*	211 *(41.8)*
≥ $78,000	257 *(35.4)*	221 *(36.1)*	217 *(36.1)*	250 *(36.6)*	192 *(38.0)*
Family Factors					
Two-parent household					
No	54 *(7.4)*	44 *(7.2)*	43 *(7.1)*	51 *(7.5)*	32 *(6.3)*
Yes	672 *(92.6)*	568 *(92.8)*	559 *(92.9)*	632 *(92.5)*	473 *(93.7)*
Number of siblings					
0	299 *(41.2)*	253 *(41.3)*	248 *(41.2)*	284 *(41.6)*	210 *(41.6)*
1	304 *(41.9)*	258 *(42.2)*	254 *(42.2)*	283 *(41.4)*	215 *(42.6)*
≥ 2	123 *(16.9)*	101 *(16.5)*	100 *(16.6)*	116 *(17.0)*	80 *(15.8)*
Home Environment					
Number of children's books in the home					
≤ 20 books	74 *(10.2)*	64 *(10.5)*	110 *(11.6)*	70 *(10.3)*	48 *(9.5)*
≥ 21 books	652 *(89.8)*	548 *(89.5)*	841 *(88.4)*	613 *(89.8)*	457 *(90.5)*
How many minutes child usually read to at a sitting					
≤ 20 minutes	651 *(89.7)*	550 *(89.9)*	852 *(89.6)*	610 *(89.3)*	454 *(89.9)*
≥ 21 minutes	75 *(10.3)*	62 *(10.1)*	99 *(10.4)*	73 *(10.7)*	51 *(10.1)*

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Characteristic	Receptive vocabulary (n=726)	Literacy proficiency (n=612)	Maths proficiency (n=602)	Parent-reported internalising and externalising behaviour (n=683)	Teacher-reported internalising and externalising behaviour (n=505)
Special or extra cost activities					
No	362 *(49.9)*	303 *(49.5)*	499 *(52.5)*	337 *(49.3)*	240 *(47.5)*
Yes	364 *(50.1)*	309 *(50.5)*	452 *(47.5)*	346 *(50.7)*	265 *(52.5)*
Child care Factors					
Child care quality					
Carer-child relationship score, mean (SD)	14.9 *(1.5)*	14.9 *(1.6)*	15.0 *(1.5)*	14.9 *(1.6)*	14.9 *(1.6)*
Activities score, mean (SD)	7.16 *(1.1)*	7.16 *(1.1)*	7.16 *(1.1)*	7.17 *(1.1)*	7.17 *(1.1)*
Type of main non-parental child care					
Centre care	626 *(86.2)*	531 *(86.8)*	794 *(83.5)*	587 *(85.9)*	442 *(87.5)*
Family day care	100 *(13.8)*	81 *(13.2)*	157 *(16.5)*	96 *(14.1)*	63 *(12.5)*
Total hours per week in child care	23.7 *(11.4)*	23.5 *(11.3)*	23.6 *(11.9)*	23.9 *(11.4)*	23.1 *(11.2)*
Outcome					
PPVT score 4-5 years, mean (SD)	66.25 *(5.8)*	-	-	-	-
PPVT score 6-7 years, mean (SD)	75.03 *(4.9)*	-	-	-	-
Literacy score, mean (SD)	-	3.46 *(0.7)*	-	-	-
Maths score, mean (SD)	-	-	3.40 *(0.7)*	-	-
Parent-reported internalising score 4-5, mean (SD)	-	-	-	2.61 *(2.2)*	-
Parent-reported externalising score 4-5, mean (SD)	-	-	-	5.63 *(3.3)*	-
Parent-reported internalising score 6-7, mean (SD)	-	-	-	2.98 *(2.7)*	-
Parent-reported externalising score 6-7, mean (SD)	-	-	-	5.29 *(3.4)*	-
Teacher-reported internalising score 4-5, mean (SD)	-	-	-	-	2.06 *(2.3)*
Teacher-reported externalising score 4-5, mean (SD)	-	-	-	-	3.79 *(4.0)*
Teacher-reported internalising score 6-7, mean (SD)	-	-	-	-	2.31 *(2.6)*
Teacher-reported externalising score 6-7, mean (SD)	-	-	-	-	4.14 *(4.0)*

In multi-variable regression analyses using multiply imputed data, the sample consisted of 1136 children with receptive vocabulary scores at ages four to five and six to seven, 970 and 951 children with teacher-reported literacy and math proficiency scores at ages six to seven, 1056 and 772 children with parent- and teacher-reported internalising and externalising behaviour scores at ages four to five and six to seven respectively. Table 5.2 shows the regression coefficients for the quality of the carer-child relationship at two to three years of age and children's receptive vocabulary at four to five and at six to seven and teacher-reported literacy and math proficiency at ages six to seven. After adjusting for confounding, children who were rated as experiencing higher quality relationships had higher receptive vocabulary scores (β 0.63; *95% CI* 0.42, 0.83; effect size 0.11) at four to five years. Although the magnitude of the association slightly reduced by age six to seven years the effect remained (β 0.41; *95%* CI 0.23, 0.59; effect size 0.08). There was also a positive association between the carer-child relationship and teacher-reported children's literacy (β 0.08; *95% CI* 0.05, 0.10; effect size 0.11) and math proficiency (β 0.05; *95 CI* 0.02, 0.08; effect size 0.07) at ages six to seven years.

Table 5.2 also presents the regression coefficients for the quality of the carer-child relationship at two to three years of age and children's parent- and teacher-reported internalising and externalising behaviour at ages four to five and six to seven years. After adjustment for confounding, ratings of a higher quality carer-child relationship was associated with lower parent- and teacher-reported internalising and externalising behaviour scores at four to five years and the association persisted to six to seven years. With the exception of parent-reported internalising behaviour scores, there was evidence to suggest that the protective effects of quality strengthened, albeit slightly, over time. Results of complete-case analyses were similar.

Table 5.2: Quality of carer-child relationship at 2-3 years of age and children's receptive vocabulary (PPVT score), teacher-reported literacy and math proficiency (ARS score), parent-reported and teacher-reported internalising and externalising behaviour scores using multiply imputed data

Outcome	Age of Child	Unadjusted			Adjusted [a]		
		β	95% CI	P	β	95% CI	P
PPVT Score	4-5 years	0.81	0.60, 1.03	<0.001	0.63	0.42, 0.83	<0.001
PPVT Score	6-7 years	0.49	0.31, 0.68	<0.001	0.41	0.23, 0.59	<0.001
ARS literacy score	6-7 years	0.10	0.07, 0.13	<0.001	0.08	0.05, 0.10	<0.001
ARS maths score	6-7 years	0.07	0.03, 0.10	<0.001	0.05	0.02, 0.08	<0.001
Parent-reported internalising score	4-5 years	-0.17	-0.26, -0.08	<0.001	-0.12	-0.21, -0.02	<0.01
Parent-reported externalising score	4-5 years	-0.39	-0.52, -0.26	<0.001	-0.30	-0.42, -0.17	<0.001
Parent-reported internalising score	6-7 years	-0.23	-0.33, -0.12	<0.001	-0.17	-0.28, -0.07	<0.001
Parent-reported externalising score	6-7 years	-0.37	-0.51, -0.24	<0.001	-0.26	-0.40, -0.13	<0.001
Teacher-reported internalising score	4-5 years	-0.37	-0.49, -0.26	<0.001	-0.35	-0.47, -0.23	<0.001
Teacher-reported externalising score	4-5 years	-0.71	-0.90, -0.53	<0.001	-0.63	-0.81, -0.45	<0.001
Teacher reported internalising score	6-7 years	-0.32	-0.44, -0.19	<0.001	-0.30	-0.43, -0.17	<0.001
Teacher-reported externalising score	6-7 years	-0.52	-0.70, -0.34	<0.001	-0.42	-0.60, -0.25	<0.001

a Adjusted for total time spent in child care (hours/week); child age, sex, birth weight, parental concern about child's learning and development; primary caregiver education, work status; household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregiver age, Kessler 6 score; number of children's books; minutes child usually read to; special or extra cost activities

Multivariable regression analyses were also conducted using a dichotomised carer-child relationship score that categorised children as experiencing either 'higher' or 'lower' quality. These analyses are presented because they better parallel the sensitivity analyses using propensity scores. The substantive findings remain unchanged in these analyses. A higher quality carer-child relationship was associated with higher cognitive and lower internalising and externalising problem behaviour scores at each time point. More specifically, compared to children rated as experiencing a lower quality relationship a higher quality carer-child relationship resulted in a 2.45 point increase (*95% CI* 1.55, 3.35)

in receptive vocabulary at four to five years. By age six to seven years, the effect on children's receptive vocabulary had almost halved (*β* 1.44 *95% CI* 0.66, 2.23). In addition, a higher quality carer-child relationship resulted in a 0.30 point (*95% CI* 0.17, 0.43) and 0.22 point (*95% CI* 0.22, 0.35) increase in teacher-reported literacy and math proficiency at age six to seven years, respectively. A higher quality carer-child relationship was associated with a lower risk of parent-reported internalising (*β* -0.47 *95% CI* -0.87, -0.06) and externalising behaviours (*β* -1.18 *95% CI* -1.73, -0.62) at four to five years. The protective effect of higher quality relationships persisted to age six to seven (internalising score *β* -0.58 *95% CI* -1.04, -0.12; externalising score *β* -0.92 *95% CI* -1.51, -0.34).

Children experiencing a higher quality carer-child relationship also had lower rates of teacher-reported internalising (*β* -1.64 *95% CI* -2.16, -1.11) and externalising behaviours (*β* -2.54 *95% CI* -3.32, -1.76) at four to five years that continued to age six to seven (internalising *β* -1.29 *95% CI* -1.84, -0.74 and externalising *β* -1.46 *95% CI* -2.12, -0.81).

Teacher ratings of children's internalising and externalising behaviours were two times larger in magnitude compared to parent reports.   Results from the propensity score analysis showed similar effect sizes as the regression analyses (online Appendix, supplemental results Table 5.4).

There was no evidence to suggest that activities in child care or provider and program characteristics of care (carers' highest educational qualification, professional development, work experience, currently working towards a qualification that would expand their skills and knowledge in child care or early childhood education and number of children in the group) were associated with any outcomes (online Appendix, supplemental results Tables 5.5 - 5.10).

5.2.6 Discussion

This study showed that after adjustment for a wide range of potential confounding factors, children experiencing a higher quality carer-child relationship, that is care characterised by warmth and affection had higher receptive vocabulary, literacy and math scores and lower internalising and externalising behaviour scores at four to five years and these effects although weaker, remained evident at age six to seven years. These results were supported by sensitivity checks using propensity score matching. The effect size was small and ranged from 0.06 to 0.11 SD units for cognitive outcomes and 0.05 to 0.15 SD units for socio-emotional outcomes. There was no evidence to suggest that activities in child care or provider and program characteristics of care were associated with children's developmental outcomes.

Domains of child care quality and children's cognitive and socio-emotional development

To our knowledge, this is the first Australian study that has used a national cohort to investigate the effects of child care quality on children's developmental outcomes at school entry and their continued influence after two years of formal schooling. Directly comparing our study findings to prior research is challenging due to the different approaches used to assess child care quality and that most studies reported a rating averaged over quality domains. However, there are at least three previous studies that examined domain-specific associations between developmental outcomes and quality of care [35, 38, 127]. One of these studies, the Cost, Quality and Child Outcomes in Child Care Centers Study, utilised the closeness factor of the STRS as one measure of child care quality. Findings showed that teachers who rated their relationship with the child as closer (e.g. sharing a warm and affectionate relationship) had higher language and math scores and were rated as having lower problem behaviours through second grade [38]. Our findings that higher quality carer-child relationships predicted children's later development

are also theoretically consistent with past research that emphasises infants and toddlers need for secure attachments and positive interactions with their carer for their healthy development [188, 189].

Our analyses showed that spending more time in various educational activities such as singing, telling stories and reading books was not associated with children's cognitive and socio-emotional outcomes. We expected that spending more time in activities that fostered learning and interaction would be positively associated with children's cognitive and socio-emotional outcomes. Although it is not entirely clear why this domain was not associated with outcomes in our study, it does not mean that activities in child care are not important for children's development. A possible interpretation for the lack of association may be that the questions used by LSAC could not adequately capture the elements of play and interaction that facilitate healthy development. The narrow range of variation in the score may have also decreased the ability to observe effects on outcomes. On the other hand, this finding may indicate that activities in child care at age two to three plays a smaller role in facilitating children's later cognitive and socio-emotional functioning, whereas establishing warm and positive connections is particularly important for this age group.

Provider and program characteristics of care – that is, the carer's highest educational qualification, professional development, work experience, currently working towards a qualification that would expand their skills and knowledge in child care or early childhood education and group size were also not associated with children's cognitive and socio-emotional outcomes. There is inconsistent evidence regarding the importance of structural quality in predicting cognitive and socio-emotional skills. Some studies have shown that carers with more training are more likely to demonstrate positive, responsive and sensitive interactions [143, 190] but other studies have only found weak associations between

specific aspects of structural quality with children's developmental outcomes [28, 127]. In exploratory analyses, we found that carer attributes, as described above, were not associated with carers' perception of their relationship with children. However, relationship quality incrementally improved with smaller numbers of children in care (β 0.06 *95% CI* -0.19, 0.33 11-20 children; β 0.22 *95% CI* -0.09, 0.54 6-10 children and β 0.49 *95% CI* 0.16, 0.83 ≤5 children). The Australian Government is implementing a policy, including a requirement for qualified staff and minimum staff to children ratios. The results from the present study suggest that characteristics of the carer including qualifications do not strongly influence the quality of the carer-child relationship or children's development. However, smaller numbers of children in care appear to promote higher quality relationships that may reflect improved opportunity for carers to develop sensitive and positive relationships that in turn go on to influence children's cognitive and socio-emotional skills.

Policy implications

As the policy context for quality differs between countries, local evidence of whether the quality of child care can contribute to children's healthy development is imperative. Previous researchers have emphasised the importance of considering the regulatory context in different countries as well as the diversity of family characteristics to provide more complete estimates of how child care quality affects children's development [42]. Although the components of what constitutes high quality care transcend national borders, translating findings from other countries has potential limitations because of differences in family welfare systems, policies and practices [44, 130, 191]. The Australian Government has recently invested substantial resources to improve the quality of centre-based and family day care. However, the quality of child care and the impact on children's learning and development within the Australian context is not well documented.

Limitations

The present findings should be interpreted within the context of the study limitations. Our domains of child care quality were based on carer-report that may have resulted in an overestimation of quality. In comparison, major child care studies including the NICHD study used more objective measures of child care quality, encompassing observation and quantification of key aspects of care using the ORCE [33, 34, 84]. However, no single measure is currently accepted as a gold standard and the domains of carer-reported quality used here are consistent with domains derived from direct observations. Encouragingly, recent studies have also revealed a high level of agreement between carer-report and direct observation of child care quality [89]. Ongoing work in developing and assessing the validity of instruments in defining child care quality is needed. Additionally, the quality of the relationships as reported by carers may be inextricably linked with a child's temperament or behaviour. It is possible that the quality of the relationship reflected the child's actual behaviour rather than a measure of relationship quality with the carer, and hence child care quality. However, the quality of the carer-child relationship is considered essential to providing a quality child care experience and has been associated with children's developing cognitive and socio-emotional functioning [38, 192].

Conclusion

This study showed that children experiencing a higher quality carer-child relationship in child care achieved higher receptive vocabulary, literacy and math scores and lower internalising and externalising behaviour scores at school entry, and these effects although weaker, were still evident at ages six to seven after two years of formal schooling. These effects were evident after extensive controls for parental, family and child background characteristics. Activities in child care and provider and program characteristics of care, at least as measured in this study, were not associated with children's later cognitive and socio-emotional outcomes.

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5.2.7 Online Appendix

Supplemental results

Table 5.3: Characteristics of the study participants by outcome using the multiply imputed sample

Characteristic	Receptive vocabulary (n=1136)	Literacy proficiency (n=970)	Maths proficiency (n=951)	Parent-reported internalising and externalising behaviour (n=1056)	Teacher-reported internalising and externalising behaviour (n=772)
Child Factors					
Age at wave 3 (months), mean (SD)	57.7 *(2.7)*	57.7 *(2.8)*	57.7 *(2.8)*	57.7 *(2.7)*	57.7 *(2.8)*
Age at wave 4 (months), mean (SD)	82.0 *(3.4)*	81.9 *(3.4)*	81.9 *(3.4)*	82.0 *(3.5)*	81.9 *(3.4)*
Sex					
Male	592 *(52.1)*	510 *(52.6)*	498 *(52.4)*	564 *(53.4)*	407 *(52.7)*
Female	544 *(47.9)*	460 *(47.4)*	453 *(47.6)*	492 *(46.6)*	365 *(47.3)*
Concerns about child's development, learning and behaviour?					
Yes a little/don't know	66 *(5.8)*	53 *(5.5)*	51 *(5.4)*	65 *(6.2)*	44 *(5.7)*
No	1070 *(94.2)*	917 *(94.5)*	900 *(94.6)*	991 *(93.8)*	728 *(94.3)*
Birth weight					
≤2500 grams	49 *(4.3)*	43 *(4.4)*	43 *(4.5)*	45 *(4.3)*	31 *(4.0)*
≥2501 grams	1087 *(95.7)*	927 *(95.6)*	908 *(95.5)*	1011 (95.7	741 *(96.0)*
Parent Factors					
Primary caregiver age (years), mean (SD)	31.8 *(5.0)*	31.9 *(4.9)*	31.9 *(4.9)*	31.9 *(5.0)*	32.1 *(4.8)*
Primary caregiver Kessler 6 score, mean (SD)	4.41 *(0.5)*	4.41 *(0.5)*	4.41 *(0.5)*	4.41 *(0.5)*	4.43 *(0.5)*
Socioeconomic Position					
Accessibility and Remoteness Index of Australia (ARIA)					
Highly accessible	637 *(56.1)*	550 *(56.7)*	542 *(57.0)*	590 *(55.9)*	447 *(57.9)*
Other	499 *(43.9)*	420 *(43.3)*	409 *(43.0)*	466 *(44.1)*	325 *(42.1)*

Characteristic	Receptive vocabulary (n=1136)	Literacy proficiency (n=970)	Maths proficiency (n=951)	Parent-reported internalising and externalising behaviour (n=1056)	Teacher-reported internalising and externalising behaviour (n=772)
Primary caregiver education					
< Bachelor degree	681 *(60.0)*	573 *(59.1)*	561 *(59.0)*	628 *(59.5)*	443 *(57.4)*
Bachelor degree or higher	455 *(40.0)*	397 *(40.9)*	390 *(41.0)*	428 *(40.5)*	329 *(42.6)*
Significant economic hardship					
No significant hardship	640 *(56.3)*	544 *(56.1)*	535 *(56.3)*	603 *(57.1)*	446 *(57.8)*
Some significant hardship	496 *(43.7)*	426 *(43.9)*	416 *(43.7)*	453 *(42.9)*	326 *(42.2)*
Primary caregiver work status					
Full-time work	182 *(16.0)*	161 *(16.6)*	159 *(16.7)*	172 *(16.3)*	134 *(17.4)*
Part-time work	436 *(38.4)*	372 *(38.4)*	363 *(38.2)*	413 *(39.1)*	304 *(39.4)*
Not in labour force	518 *(45.6)*	437 *(45.1)*	429 *(45.1)*	471 *(44.6)*	334 *(43.3)*
Household income					
≤ $41,548	261 *(23.0)*	214 *(22.1)*	210 *(22.1)*	235 *(22.3)*	162 *(21.0)*
$41,549 – $77,999	478 *(42.0)*	417 *(43.0)*	409 *(43.0)*	448 *(42.4)*	333 *(43.1)*
≥ $78,000	397 *(35.0)*	339 *(34.9)*	332 *(34.9)*	373 *(35.3)*	277 *(35.9)*
Family Factors					
Two-parent household					
No	82 *(7.2)*	66 *(6.8)*	64 *(6.7)*	78 *(7.4)*	46 *(6.0)*
Yes	1054 *(92.8)*	904 *(93.2)*	887 *(93.3)*	978 *(92.6)*	726 *(94.0)*
Number of siblings					
0	461 *(40.6)*	395 *(40.7)*	386 *(40.6)*	430 *(40.7)*	315 *(40.8)*
1	477 *(42.0)*	411 *(42.4)*	403 *(42.4)*	443 *(42.0)*	330 *(42.8)*
≥ 2	198 *(17.4)*	164 *(16.9)*	162 *(17.0)*	183 *(17.3)*	127 *(16.5)*
Home Environment					
Number of children's books in the home					
≤ 20 books	128 *(11.3)*	114 *(11.7)*	110 *(11.6)*	114 *(10.8)*	76 *(9.8)*
≥ 21 books	1008 *(88.7)*	856 *(88.3)*	841 *(88.4)*	942 *(89.2)*	696 *(90.2)*

Characteristic	Receptive vocabulary (n=1136)	Literacy proficiency (n=970)	Maths proficiency (n=951)	Parent-reported internalising and externalising behaviour (n=1056)	Teacher-reported internalising and externalising behaviour (n=772)
How many minutes child usually read to at a sitting					
≤ 20 minutes	1015 *(89.4)*	869 *(89.6)*	852 *(89.6)*	940 *(89.0)*	689 *(89.3)*
≥ 21 minutes	121 *(10.7)*	101 *(10.4)*	99 *(10.4)*	116 *(11.0)*	83 *(10.7)*
Special or extra cost activities					
No	600 *(52.8)*	511 *(52.7)*	499 *(52.5)*	551 *(52.2)*	395 *(51.2)*
Yes	536 *(47.2)*	459 *(47.3)*	452 *(47.5)*	505 *(47.8)*	377 *(48.8)*
Child Care Quality					
Carer-child relationship score, mean (SD)	15.0 *(1.5)*	15.0 *(1.5)*	15.0 *(1.5)*	14.9 *(1.5)*	15.0 *(1.5)*
Activities score, mean (SD)	7.17 *(1.1)*	7.17 *(1.1)*	7.16 *(1.1)*	7.17 *(1.1)*	7.16 *(1.1)*
Type of main non-parental child care					
Centre care	936 *(82.4)*	808 *(83.3)*	794 *(83.5)*	863 *(81.7)*	649 *(84.1)*
Family day care	200 *(17.6)*	162 *(16.7)*	157 *(16.5)*	193 *(18.3)*	123 *(15.9)*
Total hours per week in child care	23.9 *(11.9)*	23.5 *(11.8)*	23.6 *(11.9)*	23.9 *(11.9)*	23.3 *(11.9)*
Outcome					
PPVT score 4-5 years, mean (SD)	65.8 *(5.7)*	-	-	-	-
PPVT score 6-7 years, mean (SD)	74.9 *(4.8)*	-	-	-	-
Literacy score, mean (SD)	-	3.43 *(0.7)*	-	-	-
Maths score, mean (SD)	-	-	3.37 *(0.7)*	-	-
Parent-reported internalising score 4-5, mean (SD)	-	-	-	2.65 *(2.3)*	-
Parent-reported externalising score 4-5, mean (SD)	-	-	-	5.75 *(3.3)*	-
Parent-reported internalising score 6-7, mean (SD)	-	-	-	3.00 *(2.7)*	-
Parent-reported externalising score 6-7, mean (SD)	-	-	-	5.36 *(3.4)*	-
Teacher-reported internalising score 4-5, mean (SD)	-	-	-	-	2.17 *(2.5)*
Teacher-reported externalising score 4-5, mean (SD)	-	-	-	-	3.89 *(4.1)*
Teacher-reported internalising score 6-7, mean (SD)	-	-	-	-	2.39 *(2.7)*
Teacher-reported externalising score 6-7, mean (SD)	-	-	-	-	4.21 *(3.9)*

Table 5.4: Propensity score analysis using nearest neighbour matching with caliper <0.01 showing the average treatment effect on the treated (ATT) (treated: higher quality carer-child relationship) at 2-3 years of age on children's receptive vocabulary (PPVT score) at age 4-5 and 6-7 years, academic literacy and math proficiency (ARS score) at age 6-7 years and internalising and externalising behaviour scores at age 4-5 and 6-7 years

Outcome	Age of child	ATT	95% CI
PPVT score	4-5 years	2.55	1.18, 3.91
PPVT score	6-7 years	1.59	0.54, 2.63
ARS literacy score	6-7 years	0.21	0.02, 0.41
ARS maths score	6-7 years	0.30	0.30, 0.50
Parent-reported internalising score	4-5 years	-0.48	-1.02, 0.05
Parent-reported externalising score	4-5 years	-0.86	-1.66, -0.06
Parent-reported internalising score	6-7 years	-0.64	-1.26, -0.01
Parent-reported externalising score	6-7 years	-0.92	-1.76, -0.09
Teacher-reported internalising score	4-5 years	-1.66	-2.40, -0.92
Teacher-reported externalising score	4-5 years	-2.61	-3.76, -1.46
Teacher-reported internalising score	6-7 years	-1.16	-1.98, -0.34
Teacher-reported externalising score	6-7 years	-1.79	-2.89, -0.69

Table 5.5: Activities in child care at 2-3 years of age and children's receptive vocabulary (PPVT score) and teacher-reported literacy and maths proficiency (ARS score) using multiply imputed data, unadjusted model

	PPVT score 4-5 years (n=1136)			PPVT score 6-7 years (n=1136)			ARS literacy score 6-7 years (n=970)			ARS maths score 6-7 years (n=951)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Activities in child care												
4 (r)												
5	2.47	0.29, 4.65	0.03	1.24	-0.60, 3.10	0.18	0.13	-0.18, 0.44	0.41	0.12	-0.19, 0.44	0.45
6	1.02	-0.89, 2.94	0.29	0.34	-1.28, 1.98	0.67	0.18	-0.08, 0.46	0.18	0.14	-0.14, 0.43	0.31
7	1.21	-0.60, 3.03	0.19	0.61	-0.93, 2.15	0.43	0.06	-0.20, 0.32	0.64	0.02	-0.25, 0.29	0.88
8	1.36	-0.37, 3.10	0.12	0.87	-0.59, 2.35	0.24	0.13	-0.11, 0.39	0.28	0.08	-0.17, 0.34	0.52

Table 5.6: Activities in child care at 2-3 years of age and parent-reported and teacher-reported internalising and externalising behaviour scores at ages 4-5 years using multiply imputed data, unadjusted model

	Parent-reported internalising behaviour scores (n=1056)			Parent-reported externalising behaviour scores (n=1056)			Teacher-reported internalising behaviour scores (n=772)			Teacher-reported externalising behaviour scores (n=772)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Activities in child care												
4 (r)												
5	-0.97	-1.89, -0.04	0.04	-0.40	-1.71, 0.89	0.54	0.22	-0.97, 1.41	0.71	0.61	-1.28, 2.50	0.52
6	-0.02	-0.83, 0.78	0.94	0.22	-0.92, 1.37	0.70	0.15	-0.92, 1.23	0.77	0.37	-1.34, 2.09	0.66
7	-0.63	-1.40, 0.13	0.10	0.16	-0.93, 1.25	0.77	0.11	-0.91, 1.14	0.82	0.50	-1.13, 2.14	0.54
8	-0.76	-1.49, -0.03	0.05	-0.18	-1.22, 0.86	0.73	0.02	-0.95, 1.01	0.95	0.30	-1.26, 1.87	0.70

Table 5.7: Activities in child care at 2-3 years of age and parent-reported and teacher-reported internalising and externalising behaviour scores at ages 6-7 years using multiply imputed data, unadjusted model

	Parent-reported internalising behaviour scores (n=1056)			Parent-reported externalising behaviour scores (n=1056)			Teacher-reported internalising behaviour scores (n=772)			Teacher-reported externalising behaviour scores (n=772)		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Activities in child care												
4 (r)												
5	0.05	-1.01, 1.25	0.92	0.38	-0.98, 1.75	0.58	0.52	-0.74, 1.79	0.41	-0.06	-1.90, 1.76	0.94
6	0.23	-0.70, 1.17	0.62	0.25	-0.94, 1.45	0.68	0.06	-1.08, 1.21	0.91	-0.42	-2.09, 1.23	0.61
7	0.02	-0.86, 0.92	0.95	0.32	-0.82, 1.47	0.58	0.77	-0.33, 1.87	0.17	0.45	-1.14, 2.05	0.57
8	-0.16	-1.01, 0.69	0.71	0.14	-0.94, 1.23	0.79	0.72	-0.32, 1.77	0.17	0.28	-1.23, 1.80	0.71

Table 5.8: Provider and program characteristics of care and children's receptive vocabulary (PPVT score) and teacher-reported literacy and maths proficiency (ARS score) using multiply imputed data, unadjusted models

	PPVT score 4-5 years (n=1136)			PPVT score 6-7 years (n=1136)			ARS literacy score 6-7 years (n=970)			ARS maths score 6-7 years (n=951)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Number children, including the study child, usually present in the same room												
≥ 21 children (r)												
11-20 children	-0.44	-1.47, 0.58	0.40	-0.71	-1.59, 0.15	0.10	-0.08	-0.23, 0.06	0.26	-0.11	-0.26, 0.03	0.14
6-10 children	-1.08	-2.32, 0.15	0.09	-0.81	-1.87, 0.23	0.12	-0.17	-0.34,-0.00	0.05	-0.30	-0.48, -0.12	0.001
≤ 5 children	-1.08	-2.36, 0.19	0.10	-1.08	-2.16, 0.00	0.05	-0.14	-0.33, 0.04	0.12	-0.21	-0.40, -0.02	0.03
In last 12 months, hours spent on professional development activities												
≤ 6 hours (r)												
7-12 hours	0.07	-1.00, 1.15	0.89	-0.19	-1.11, 0.72	0.67	0.15	0.00, 0.31	0.04	0.20	0.04, 0.36	0.01
13-18 hours	-0.07	-1.18, 1.02	0.89	-0.41	-1.36, 0.52	0.38	-0.02	-0.18, 0.13	0.73	-0.04	-0.20, 0.12	0.62
19-24 hours	0.30	-0.89, 1.49	0.61	-0.17	-1.18, 0.82	0.72	0.05	-0.11, 0.21	0.56	0.01	-0.16, 0.18	0.88
≥ 25 hours	-0.19	-1.18, 0.78	0.69	-0.51	-1.33, 0.30	0.21	0.02	-0.11, 0.16	0.70	-0.01	-0.16, 0.12	0.81
Number years worked for ≥ 10 hours per week in child care settings, early education programs or school settings												
≤ 8 years (r)												
≥ 9 years	0.32	-0.36, 1.00	0.36	-0.15	-0.74, 0.42	0.59	-0.05	-0.15, 0.04	0.28	-0.02	-0.12, 0.07	0.59
Highest educational qualification												
≤ secondary education (r)												
Advanced diploma/certificate	-0.13	-1.22, 0.95	0.80	-0.90	-1.83, 0.02	0.06	0.04	-0.11, 0.19	0.62	-0.00	-0.16, 0.16	0.99
≥ Bachelor degree	0.84	-0.42, 2.11	0.19	-1.00	-2.08, 0.08	0.07	0.06	-0.11, 0.24	0.50	-0.00	-0.19, 0.18	0.98
Studying for a qualification that will expand skills/knowledge in child care or early childhood education												
Yes (r)												
No	-0.18	-0.94, 0.58	0.64	-0.20	-0.85, 0.43	0.52	-0.06	-0.17, 0.04	0.24	-0.09	-0.20, 0.01	0.09

Table 5.9: Provider and program characteristics of care and parent-reported and teacher-reported internalising and externalising behaviour scores at age 4-5 years using multiply imputed data, unadjusted models

	Parent-reported internalising behaviour scores (n=1056)			Parent-reported externalising behaviour scores (n=1056)			Teacher-reported internalising behaviour scores (n=772)			Teacher-reported externalising behaviour scores (n=772)		
	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*	β	95% CI	*P*
Number children, including the study child, usually present in the same room												
≥ 21 children (r)												
11-20 children	0.17	-0.26, 0.60	0.43	0.17	-0.43, 0.78	0.57	0.34	-0.22, 0.91	0.24	0.25	-0.66, 1.17	0.58
6-10 children	0.30	-0.21, 0.83	0.24	0.15	-0.58, 0.89	0.68	0.23	-0.44, 0.91	0.49	-0.23	-1.32, 0.85	0.67
≤ 5 children	0.46	-0.07, 1.00	0.09	-0.02	-0.78, 0.73	0.94	0.39	-0.32, 1.11	0.27	0.16	-0.98, 1.32	0.77
In last 12 months, hours spent on professional development activities												
≤ 6 hours (r)												
7-12 hours	-0.57	-1.03, -0.10	0.02	-0.40	-1.04, 0.23	0.21	-0.24	-0.82, 0.33	0.41	-0.82	-1.75, 0.09	0.08
13-18 hours	-0.50	-0.97, -0.03	0.04	-0.23	-0.88, 0.42	0.48	0.54	-0.06, 1.15	0.08	-0.38	-1.35, 0.57	0.43
19-24 hours	-0.37	-0.87, 0.11	0.13	-0.44	-1.15, 0.26	0.21	-0.16	-0.80, 0.48	0.62	-0.59	-1.62, 0.44	0.26
≥ 25 hours	-0.04	-0.46, 0.37	0.83	0.05	-0.52, 0.63	0.85	0.07	-0.45, 0.59	0.78	-0.39	-1.23, 0.43	0.34
Number years worked for ≥ 10 hours per week in child care settings, early education programs or school settings												
≤ 8 years (r)												
≥ 9 years	-0.15	-0.44, 0.13	0.29	-0.06	-0.47, 0.35	0.77	0.11	-0.26, 0.49	0.56	-0.00	-0.59, 0.57	0.97
Highest educational qualification												
≤ secondary education (r)												
Advanced diploma/certificate	-0.10	-0.56, 0.36	0.67	0.19	-0.45, 0.85	0.55	-0.14	-0.75, 0.45	0.62	0.42	-0.53, 1.37	0.38
≥ Bachelor degree	-0.29	-0.84, 0.25	0.28	-0.26	-1.03, 0.50	0.50	-0.04	-0.74, 0.64	0.88	0.22	-0.87, 1.32	0.69
Studying for a qualification that will expand skills/knowledge in child care or early childhood education												
Yes (r)												
No	0.22	-0.09, 0.55	0.16	0.54	0.08, 1.00	0.02	0.36	-0.05, 0.79	0.09	-0.02	-0.70, 0.65	0.95

Table 5.10: Provider and program characteristics of care and parent-reported and teacher-reported internalising and externalising behaviour scores at age 6-7 years using multiply imputed data, unadjusted models

	Parent-reported internalising behaviour scores (n=1056)			Parent-reported externalising behaviour scores (n=1056)			Teacher-reported internalising behaviour scores (n=772)			Teacher-reported externalising behaviour scores (n=772)		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Number children, including the study child, usually present in the same room												
≥ 21 children (r)												
11-20 children	-0.03	-0.53, 0.46	0.88	0.09	-0.54, 0.73	0.76	-0.21	-0.83, 0.40	0.49	-0.08	-0.96, 0.80	0.85
6-10 children	0.39	-0.20, 0.99	0.19	0.21	-0.55, 0.98	0.58	-0.04	-0.77, 0.69	0.91	0.16	-0.88, 1.22	0.75
≤ 5 children	0.59	-0.02, 1.20	0.06	0.40	-0.39, 1.20	0.31	-0.10	-0.87, 0.67	0.79	0.36	-0.75, 1.49	0.52
In last 12 months, hours spent on professional development activities												
≤ 6 hours (r)												
7-12 hours	-0.49	-1.02, 0.03	0.07	-0.94	-1.62, -0.27	0.05	0.09	-0.53, 0.71	0.77	-0.95	-1.84, -0.06	0.04
13-18 hours	-0.30	-0.85, 0.24	0.28	-0.47	-1.17, 0.21	0.18	0.04	-0.59, 0.69	0.88	-0.72	-1.65, 0.19	0.12
19-24 hours	-0.52	-1.09, 0.05	0.08	-0.65	-1.41, 0.08	0.08	-0.09	-0.78, 0.59	0.79	-0.13	-1.13, 0.86	0.79
≥ 25 hours	-0.30	-0.78, 0.17	0.21	-0.29	-0.90, 0.31	0.34	0.14	-0.41, 0.70	0.61	-0.14	-0.95, 0.65	0.72
Number years worked for ≥ 10 hours per week in child care settings, early education programs or school settings												
≤ 8 years (r)												
≥ 9 years	0.18	-0.16, 0.53	0.29	0.18	-0.24, 0.61	0.39	0.10	-0.28, 0.50	0.58	0.17	-0.39, 0.74	0.54
Highest educational qualification												
≤ secondary education (r)												
Advanced diploma/certificate	-0.01	-0.55, 0.52	0.95	0.04	-0.63, 0.73	0.89	-0.24	-0.89, 0.40	0.45	0.11	-0.83, 1.06	0.81
≥ Bachelor degree	-0.13	-0.76, 0.49	0.66	-0.48	-1.29, 0.32	0.24	-0.35	-1.10, 0.40	0.36	-0.03	-1.12, 1.05	0.95
Studying for a qualification that will expand skills/knowledge in child care or early childhood education												
Yes (r)												
No	0.19	-0.17, 0.56	0.30	0.35	-0.13, 0.83	0.15	0.16	-0.29, 0.62	0.48	0.17	-0.48, 0.83	0.60

End of article

5.3 Publication: Quality of child care influences children's attentiveness and emotional regulation at school entry

5.3.1 Statement of authorship

Gialamas A, Sawyer ACP, Mittinty MN, Zubrick SR, Sawyer MG, Lynch J. Quality of child care influences children's attentiveness and emotional regulation at school entry. The Journal of Pediatrics 2014; 165(4):813-819.

By signing below, the authors declare that they give consent for this paper to be presented by Angela Gialamas towards examination for the Doctor of Philosophy.

Angela Gialamas (Candidate)

Designed the study, led the development of the child care quality measures, performed the analyses, interpreted the results and drafted the manuscript.

Signed: …………………………… Date: …………06/07/2015………

Alyssa Sawyer

Contributed to the development of the self-regulation measures, interpreted the results and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

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Murthy Mittinty

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John Lynch

Designed the study, contributed to the development of the child care quality and self-regulation measures, interpreted the results and reviewed the manuscript. I give consent for Angela Gialamas to present this paper towards examination for the Doctor of Philosophy.

Signed: …………………………. Date: …………06/07/2015………

5.3.2 Abstract

Objective: To examine the association between domain-specific qualities of formal child care at age 2-3 years and children's task attentiveness and emotional regulation at age 4-5 and 6-7 years.

Study Design: We used data from the Longitudinal Study of Australian Children (n=1038). Three domain-specific aspects of child care quality were assessed: provider and program characteristics of care, activities in child care and carer-child relationship. Two self-regulatory abilities were considered: task attentiveness and emotional regulation. Associations between domain-specific qualities of child care and self-regulation were investigated in linear regression analyses adjusted for confounding, with imputation for missing data.

Results: There was no association between any provider or program characteristics of care and children's task attentiveness and emotional regulation. The quality of activities in child care were only associated with higher levels of emotional regulation at 4-5 years (β=0.24; 95% CI, 0.03-0.44) and 6-7 years (β=0.26; 95% CI, 0.04-0.48). Higher quality carer-child relationships were associated with higher levels of task attentiveness (β=0.20; 95% CI, 0.05-0.36) and emotional regulation at age 4-5 years (β=0.19; 95% CI, 0.04-0.34) that persisted to age 6-7 years (β=0.26; 95% CI, 0.10-0.42) (β=0.31; 95% CI, 0.16-0.47).

Conclusion: Among children using formal child care, those who experienced higher quality relationships were better able to regulate their attention and emotions as they started school. Higher emotional regulation was also observed for children engaged in more activities in child care. Beneficial effects were stable over time.

5.3.3 Introduction

High quality care and education have been identified as one of the most effective means of developing children's cognitive and socio-emotional capabilities [118, 193]. Early childhood interventions designed for at-risk children, such as Early Head Start, provide evidence that quality non-parental child care is associated with improved cognitive and socio-emotional outcomes [119, 122]. The effects of domain-specific aspects of child care quality on children's ability to attend to and persist with tasks and to regulate their emotions as they start school have not been widely investigated, however.

Children need certain skills as they start school, including the ability to attend to and persist with tasks and regulate their emotions; we conceptualize these skills as dimensions underlying 'self-regulation'. Children who display high levels of self-regulatory behaviour are considered better ready to be engaged in school [1, 12]. The first 5 years of life is a significant period for the development of self-regulation [194], influenced by the relationships and interactions shared with important adults in a child's life [1]. The family home and non-parental child care environments are the key caregiving settings in early life, where children learn how to relate to others and to regulate their emotions and behaviors.

In 2008, an estimated 28% of Australian children aged 0-3 years spent time in non-parental care. This prevalence was even higher in America, with approximately 40% of children this age in child care [3]. In many high-income countries, child care policy for children ≤ 3 years has focused primarily on supporting the labour force participation of mothers, with only recent policy consideration given to the possible effects of the quality of this care on children's later health and well-being. With significant numbers of children aged 0-3 years attending formal child care, the relationships formed and the interactions shared with non-parental carers (i.e. child care providers) may be important influences on children's developing capacity for self-regulation.

Child care presents many challenges for children, including following directions from non-parental carers who may have different rules, routines and expectations from parents, and fewer opportunities for one-to-one interactions [195]. Consistent, positive interactions with familiar caregivers, particularly in the first 3 years of life, have been shown to generate secure attachment that influences children's self-regulation ability [196, 197]; however, little is known about the effects of the quality of the carer-child relationship, quality of activities and provider and program characteristics of formal child care on children's self-regulatory abilities. The aim of the present study was to examine the association between domain-specific aspects of child care quality at age 2-3 years and children's task attentiveness and emotional regulation at age 4-5 and 6-7 years.

5.3.4 Methods

This study used data from the birth cohort of the Longitudinal Study of Australian Children (LSAC), a nationally representative cohort study which commenced in 2004 [138]. Details of the study design and sampling framework are available elsewhere [139]. In brief, the sampling framework used 2-stage clustered sampling. The first stage selected Australian postcodes, and the second stage, sampled children within these postcodes [139]. Postcodes were selected at random and stratified by state/territory and urban/rural status to ensure a nationally representative sample. The Medicare database, which provides medical and hospital coverage for all Australian permanent residents, was then used to randomly select infants born between March 2003 and February 2004 within each stratum. At baseline, 5107 infants aged 0-1 years were recruited into the study. These participants were reassessed at age 2-3 years (n=4606), 4-5 years (n=4386) and 6-7 years (n=4242). The study was approved by the Australian Institute of Family Studies Ethics Committee.

For the present study, the sample included children aged 2-3 years attending centre-based or family day care (i.e. carers paid to deliver care in their home for small groups of children) (Figure 5.2). Data were obtained from face-to-face interviews and questionnaires with the child's primary caregiver (97% mothers) and questionnaires from child care providers. At the parent interview, the primary caregiver identified whether in the past month the study child was "looked after at regular times during the week by anyone other than the parent living in the home". If the child spent ≥8 hours per week in non-parental care, then a questionnaire was given to the main non-parental caregiver. The study group comprised 1859 children aged 2-3 years in child care for ≥8 hours per week whose primary caregiver consented for a questionnaire to be given to the non-parental caregiver. A total of 1282 questionnaires were returned, for a response rate of 69%.

Figure 5.2: Data flow of recruitment into LSAC and identification of children in formal child care at age 2-3 years and their task attentiveness and emotional regulation at age 4-5 and 6-7 years

Cohort recruited at wave 1
N=5107

Lost to follow-up
N=501

Cohort at wave 2
N=4606

Cohort in childcare at wave 2
N=3244

Exclusions: Children not in centre or family day care *N=1081;* <8 hours/week in child care *N=284*; Children in child care for ≥8 hours/week but parent refused to send questionnaire *N=20*

Non-parental carers eligible to receive a questionnaire
N=1859

Non-parental carer questionnaires received
N=1282

Incomplete child care quality ≥ 1 indicator missing *N=327*

Complete child care quality data
N=955

Complete child care quality, covariates and outcome data
N=770

Imputed Analysis Sample
N=1038

Domain-Specific Qualities of Child Care

Details of the child care quality measures have been reported elsewhere [198]. In brief, LSAC used non-parental caregivers' reports to obtain information about the nature of child care provided to the children participating in the study. Two types of questionnaires were developed by the LSAC consortium: a centre-based questionnaire and a home-based questionnaire sent to family day carers. Three domains of child care quality were developed a priori on the basis of a conceptual framework that considered Australian child care standards, aspects of quality captured by direct observational methods and previous research on key components of quality. The 3 domains represented provider and program characteristics of care (n=5), activities in child care (n=11), and the carer-child relationship using the closeness and conflict scales from the short (15-item) version of the Student-Teacher Relationship Scale [92] (n=15 items) (online Appendix, see Section 3.4, Table 3.1). To explore our a priori conceptualization of the 31 indicators representing child care quality, we performed exploratory factor analysis of the correlation matrix using a maximum likelihood extraction method with oblique rotation. The analysis generated 2 factors, a factor describing the carer-child relationship and a second factor describing activities in child care. The number of factors identified was based on eigenvalues >1.50, detecting a breakpoint in the scree plot and interpretability. Indicators were considered to load on a factor if they had an absolute correlation of ≥0.47 with that factor [140].

Four of the 11 indicators describing the quality of activities in child care had a factor loading of ≥0.47: singing, telling stories and reading books; participating in active outdoor play; participating in pretend play; and teaching good health practices. Eight of the 15 indicators describing the quality of the carer-child relationship had a factor loading of ≥0.47: sharing an affectionate, warm relationship; in tune with child's feelings; child values relationship; spontaneously shares information; openly shares feelings and experiences; child's feelings towards me can be unpredictable (reverse-scored); child

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drains my energy (reverse-scored); and the child and I struggle with each other (reverse-scored). Indicators used to assess provider/program characteristics - carers' highest educational qualification, professional development, work experience, working towards a qualification that would expand their skills and knowledge in child care and number of children in the group did not significantly load onto any factor. However, the individual indicators were retained for later regression analyses because of a priori theoretical evidence, [142] and it is an aspect of child care quality that regulatory agencies and governments use to define quality.

We created 2 factor-based domains that summed the 4 non-standardized scores for the quality of activities in child care domain and the 8 non-standardized scores for the quality of the carer-child relationship domain. The quality of activities in child care domain score could range from 4 to 8, with a maximum score of 8 indicating that the child participated in all 4 activities "very much/quite a lot". A higher score was considered to reflect higher-quality care. The quality of activities in child care score was negatively skewed (mean, 7.1; median, 8 [IQR, 7-8]), with 54.8% of all participants achieving the maximum score of 8.

The domain score for the quality of the carer-child relationship could range from 8 to 16, with a maximum score indicating that all relationship indicators "applied somewhat/definitely applied" with the exception for reverse-scored indicators (child's feelings can be unpredictable, child drains my energy, child and I always seem to be struggling with each other) where "definitely does not apply/not really/ neutral/not sure" indicated a more positive relationship. A higher score was considered to reflect higher-quality child care. The quality of the carer-child relationship score was negatively skewed (mean score, 14.9; median, 16 [IQR, 15-16]), with 55.2% of all participants achieving the maximum score of 16.

Self-Regulation: Task Attentiveness and Emotional Regulation

We measured two self-regulatory behaviors, task attentiveness and emotional regulation using parent-rated questionnaires [116, 156, 157] (online Appendix, see Section 3.6, Table 3.3). To assess the construct validity of items selected at each assessment to represent task attentiveness and emotional regulation, we performed exploratory factor analyses of the correlation matrix using maximum likelihood extraction methods with oblique rotation. At each time point a 2-factor structure was observed, labelled task attentiveness and emotional regulation. Five items that loaded >0.40 were summed to create a task attentiveness factor, and 5 items that loaded >0.50 were summed to create an emotional regulation factor, with high scores representing better regulation skills (online Appendix, see Section 3.6, Table 3.4). Example items included "often loses temper" for emotional regulation and "sees tasks through to the end, has good attention span" for task attentiveness.

For task attentiveness, internal consistency, as measured by the Cronbach's α, was 0.79 at 4-5 years and 0.78 at 6-7 years. For emotional regulation, internal consistency was 0.71 at 4-5 years and 0.72 at 6-7 years. The mean task attentiveness score for the sample was 17.4 ± 3.8 (range, 5-27) for children aged 4-5 years and 17.9 ± 4.03 (range, 5-27) for those aged 6-7 years. The mean emotional regulation score for the sample was 19.6 ± 3.8 (range, 5-27) for children aged 4-5 years and 20.5 ± 3.97 (range, 7-27) for those aged 6-7 years.

Confounders

An extensive range of confounding factors was identified a priori, using a directed acyclic graph [158], as being theoretically or shown in previous research to be associated with both child care quality and children's self-regulation. Covariates were measured at baseline at the parent interview (age 0-1 year) with the exception of variables representing the home environment and time spent in any non-parental child care that were measured at age 2-3 years. Covariates included hours per week spent in child care; the primary

caregiver's, education and employment; annual household income; indicators of economic hardship over the previous year; geographic remoteness using the Accessibility and Remoteness Index of Australia [145]; whether the child lived in a 2-parent household; number of siblings; child's age, sex and birth weight; parental concerns about the child's learning and development; number of children's books in the home; time spent reading to the child; whether the child undertook regular special or extra cost activities in the previous 6 months; and primary caregiver's age, psychological distress using the Kessler 6 score [147], and self-reported level of warmth toward the child.

Analyses

Multiple linear regression analysis was used to examine the associations between factor-based domains of child care quality (i.e. activities in child care, carer-child relationship) and individual provider/program characteristics of care at age 2-3 years and children's task attentiveness and emotional regulation at age 4-5 and 6-7 years.

Missing Data

For the 1859 children aged 2-3 years in formal child care for ≥8 hours per week and whose primary caregiver consented to contact the main non-parental carer, 1282 questionnaires were returned and were eligible to be included in the analysis. Multiple imputation by chained equations was used to address the possibility of bias due to missing values [163]. The imputation was conducted for the full sample; however, data were analysed only for those children with recorded task attentiveness and emotional regulation scores (n=1038) [166]. The imputation model included all 31 indicators of child care quality, all 18 covariates, type of non-parental child care, and scores for self-regulation outcomes. Imputed datasets were generated under the missing at random assumption that uses observed variables in the dataset to predict missingness and estimate measurements [164]. Twenty imputed datasets were generated, and the results of the imputed analyses were

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combined using the rules of Rubin [165]. Results using the complete-case data were not substantively different from the imputed analysis; however, we report the imputed results, because they are subject to fewer assumptions than a complete-case analysis that assumes the data is missing completely at random. All analyses were performed with Stata version 12.1 (Stata-Corp, College Station, Texas).

5.3.5 Results

Of the 1038 children spending ≥8 hours per week in child care, 847 (81%) spent time in centre-based care and 191 (18%) spent time in family day care (Table 5.11). The mean number of hours per week in child care was 24.0 ± 11.9 hours (IQR, 15-31 hours). The majority of children lived in a 2-parent household (92.5% vs 7.5%), had a primary caregiver with less than a bachelor's degree (59.4% vs 40.6%) and an annual household income of $41 549-$77 999 (41.4%).

Table 5.12 presents the associations between provider and program characteristics of child care, including the carers' highest educational qualification, professional development, work experience, working toward a qualification that would expand their skills and knowledge in child care, number of children in the group, and children's task attentiveness and emotional regulation at age 4-5 and 6-7 years. There was no evidence to suggest that provider or program characteristics of child care were associated with children's later task attentiveness and emotional regulation.

Table 5.13 presents the association between the quality of activities in child care and children's task attentiveness and emotional regulation at age 4-5 and 6-7 years. The quality of activities in child care at age 2-3 years was associated with greater emotional regulation both before and after adjustment. More specifically, after adjustment for covariates, the quality of activities was associated with a 0.23 point (95% CI, 0 .00-0.42) increase in emotional regulation at age 4-5 years and a 0.26 point (95% CI, 0 .04-0 .47)

increase at age 6-7 years. Adjustment for covariates and the quality of the carer-child relationship attenuated the association between the quality of activities in child care and children's emotional regulation at age 4-5 and 6-7 years; however, the effect remained. There was no association between the quality of activities in child care and task attentiveness at age 4-5 and 6-7 years.

In unadjusted and adjusted analyses, ratings of a higher-quality carer-child relationship at age 2-3 years were associated with higher levels of task attentiveness at 4-5 years and 6-7 years and higher emotional regulation at ages 4-5 and 6-7 years (Table 5.13). The benefit of a higher-quality carer-child relationship for children's task attentiveness and emotional regulation at age 4-5 and 6-7 years remained unaltered even after adjusting for covariates and the quality of activities in child care.

Table 5.11: Characteristics of the study participants

	Complete Case Sample[a] (n=770)	Imputed Sample[b] (n=1038)
Age at wave 3 (months), mean (SD)	57.7 (2.7)	57.6 (2.7)
Age at wave 4 (months), mean (SD)	82.1 (3.4)	82.0 (3.5)
Sex, n (%)		
Female	363 (47.1)	485 (46.7)
Male	407 (52.9)	553 (53.3)
Do you have concerns about your child's development, learning and behaviour, n (%)		
No	724 (94.0)	973 (93.7)
Yes a little/don't know	46 (6.0)	65 (6.3)
Birth weight, n (%)		
<=2500 grams	32 (4.2)	45 (4.3)
>=2501 grams	738 (95.8)	993 (95.7)
Primary caregiver age, years, mean (SD)	32.1 (4.8)	31.9 (4.9)
Primary caregiver Kessler 6 score, mean (SD)	4.41 (0.5)	4.41 (0.5)
Primary caregiver warmth, mean (SD)	4.52 (0.3)	4.52 (0.3)
Two-parent household, n (%)		
Yes	713 (92.6)	960 (92.5)
No	57 (7.4)	78 (7.5)
Number of siblings, n (%)		
0	324 (42.1)	421 (40.6)
1	315 (40.9)	437 (42.1)
≥ 2	131 (17.0)	180 (17.3)
Primary caregiver education, n (%)		
Less than bachelor's degree	437 (56.8)	617 (59.4)
Bachelor's degree or higher	333 (43.3)	421 (40.6)
Primary caregiver work status, n (%)		
Full-time employment	124 (16.1)	169 (16.3)
Part-time employment	306 (39.7)	408 (39.3)
Not working	340 (44.2)	461 (44.4)
Household income, n (%)		
≤ $41,548	160 (20.8)	236 (22.7)
$41,549 – $77,999	328 (42.6)	430 (41.4)
≥ $78,000	282 (36.6)	372 (35.8)
Significant economic hardship, n (%)		
No significant hardship	452 (58.7)	595 (57.3)
Some significant hardship	318 (41.3)	443 (42.7)
ARIA, n (%)		
Highly accessible	436 (56.6)	575 (55.4)
Other	334 (43.4)	463 (44.6)
Number of children's books, n (%)		
≤ 20 books	70 (9.1)	107 (10.3)
≥ 21 books	700 (90.9)	931 (89.7)
How long child is usually read to, n (%)		
≤ 20 minutes	686 (89.1)	924 (89.0)
≥ 21 minutes	84 (10.9)	114 (11.0)

	Complete Case Sample[a] (n=770)	Imputed Sample[b] (n=1038)
Child taken part in any special activities, n (%)		
No	374 *(48.6)*	541 *(52.1)*
Yes	396 *(51.4)*	497 *(47.9)*
Quality of activities in child care, mean (SD)	7.1 *(1.1)*	7.1 *(1.1)*
Quality carer-child relationship, mean (SD)	14.9 *(1.5)*	14.9 *(1.5)*
Main type of child care, n (%)		
Centre care	669 *(86.8)*	847 *(81.6)*
Family day care	101 *(13.2)*	191 *(18.4)*
Total hours per week in child care, mean (SD)	24.0 *(11.8)*	24.0 *(11.9)*
Provider's highest educational qualification, n (%)		
Secondary education or less	71 *(9.2)*	117 *(11.3)*
Advanced diploma/certificate	555 *(72.1)*	729 *(70.2)*
Bachelor's degree or greater	144 *(18.7)*	192 *(18.5)*
Hours spent on professional development, n (%)		
≤ 6	169 *(21.9)*	229 *(22.1)*
7-12	139 *(18.1)*	194 *(18.7)*
13-18	135 *(17.5)*	179 *(17.2)*
19-24	120 *(15.6)*	142 *(13.7)*
>24	207 *(26.9)*	294 *(28.3)*
Studying for a qualification that will expand skills/knowledge in child care or early childhood, n (%)		
No	551 *(71.6)*	749 *(72.2)*
Yes	219 *(28.4)*	289 *(27.8)*
Years worked ≥10 h/week in child care settings, early education programs or school, n (%)		
≤ 8	404 *(52.5)*	545 *(52.5)*
≥ 9	366 *(47.5)*	493 *(47.5)*
Number children, present in the same room, n (%)		
≥21	112 *(14.5)*	138 *(13.3)*
11-20	442 *(57.4)*	561 *(54.1)*
6-10	131 *(17.0)*	174 *(16.7)*
≤5	85 *(11.0)*	165 *(15.9)*
Task attentiveness age 4-5, mean (SD)	17.4 *(3.8)*	17.4 *(3.8)*
Task attentiveness age 6-7, mean (SD)	17.9 *(4.0)*	17.9 *(4.0)*
Emotional regulation age 4-5, mean (SD)	19.7 *(3.9)*	19.6 *(3.8)*
Emotional regulation age 6-7, mean (SD)	20.6 *(3.9)*	20.5 *(3.9)*

ARIA, Accessibility and Remoteness Index of Australia

[a] Complete case sample includes respondents with complete data on the outcome, exposure and covariates

[b] Imputed sample includes data imputed on child exposure and covariates

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Table 5.12: Provider and program characteristics of formal child care and task attentiveness and emotional regulation scores at age 4-5 and 6-7 years using the imputed sample (n=1038)

	Task attentiveness 4-5 years			Task attentiveness 6-7 years			Emotional regulation 4-5 years			Emotional regulation 6-7 years		
	β	95%CI	P	β	95%CI	P	β	95%CI	P	β	95%CI	P
Highest educational qualification												
≤ secondary education (reference)												
Advanced diploma/certificate	-.51	-1.28, .25	0.19	-.82	-1.62, -.01	0.05	-.40	-1.17, .35	0.29	.04	-.74, .83	0.91
≥Bachelor degree	-.50	-1.41, .39	0.27	-.61	-1.55, .33	0.20	-.28	-1.17, .60	0.53	.45	-.47, 1.38	0.34
In last 12 months, hours spent on professional development activities												
≤ 6 hours (reference)												
7-12 hours	.41	-.34, 1.17	0.28	.74	-.04, 1.52	0.06	.49	-.24, 1.24	0.19	.72	-.05, 1.51	0.07
13-18 hours	.48	-.28, 1.26	0.21	.39	-.41, 1.20	0.33	.50	-.26, 1.27	0.19	.34	-.46, 1.15	0.39
19-24 hours	.33	-.48, 1.15	0.42	.52	-.34, 1.38	0.23	.58	-.22, 1.40	0.15	.77	-.07, 1.62	0.07
≥25 hours	.09	-.58, .78	0.77	.21	-.50, .92	0.55	.33	-.34, 1.00	0.33	.31	-.38, 1.02	0.37
Studying for a qualification that will expand skills/knowledge in child care												
No (reference)												
Yes	-.01	-.55, .52	0.95	.14	-.42, .71	0.61	.24	-.27, .77	0.35	.18	-.36, .73	0.51
Years worked for ≥ 10 hours/week in child care, early education programs												
≤ 8 years (reference)												
≥ 9 years	.12	-.35, .60	0.61	-.28	-.78, .21	0.25	.12	-.35, .59	0.61	-.07	-.57, .41	0.75
Number children in the same room												
≥21 children (reference)												
11-20 children	-.10	-.83, .61	0.76	.04	-.71, .79	0.91	-.34	-1.06, .36	0.33	-.11	-.85, .62	0.76
6-10 children	-.52	-1.40, .35	0.24	-.02	-.93, .89	0.96	-.42	-1.28, .43	0.33	-.36	-1.26, .53	0.43
≤5 children	-.03	-.92, .86	0.94	.12	-.79, 1.05	0.78	.08	-.80, .97	0.85	.03	-.87, .95	0.93

Table 5.13: Quality of activities and quality of carer-child relationships in formal child care at 2-3 years of age and children's task attentiveness and emotional regulation scores at age 4-5 and 6-7 years using the imputed sample (n=1038)

	Task attentiveness 4-5 years			Task attentiveness 6-7 years			Emotional regulation 4-5 years			Emotional regulation 6-7 years		
	β	95% CI	P	β	95% CI	P	β	95% CI	P	β	95% CI	P
Quality of activities	.03	-.17, .25	0.71	.02	-.19, .24	0.82	.28	.08, .49	0.007	.30	.08, .51	0.007
Quality of activities + covariates[a]	-.00	-.22, .20	0.94	-.02	-.24, .19	0.80	.23	.02, .44	0.02	.26	.04, .47	0.01
Quality of activities + covariates[a] + quality of carer-child relationship	-.04	-.25, .17	0.70	-.06	-.29, .15	0.54	.21	.00, .42	0.04	.21	-.00, .43	0.05
Quality of carer-child relationship	.28	.13, .43	<0.001	.31	.16, .47	<0.001	.24	.09, .39	<0.001	.39	.23, .54	<0.001
Quality of carer-child relationship + covariates[a]	.20	.05, .36	0.009	.26	.10, .42	<0.001	.19	.04, .34	0.01	.27	.24, .30	<0.001
Quality of carer-child relationship + covariates[a] + quality of activities	.21	.05, .36	0.008	.26	.10, .42	<0.001	.17	.02, .32	0.02	.29	.13, .45	<0.001

[a] Adjusted for total time spent in child care (hours/week); child age, sex, birth weight, parental concern about child's learning and development; primary caregiver education, work status; household income; economic hardship; ARIA; two-parent household; number of siblings; primary caregivers age, Kessler 6 score, self-reported level of warmth towards the child; number of children's books, minutes child usually read to and special or extra cost activities

5.3.6 Discussion

After taking into account a wide range of confounders, carer ratings of a higher quality relationship in child care - that is, care characterized by warmth and predictability - remained associated with greater task attentiveness and emotional regulation in the early years of schooling. The quality of activities in child care, including children spending more time with carers (singing, telling stories and reading books), was associated with higher levels of emotional regulation, but not of task attentiveness. The beneficial effects persisted from age 4-5 to age 6-7 years. In contrast, provider and program characteristics of care were not associated with children's self-regulation.

Our results are consistent with findings reported by Sylva et al., who found an association between high quality pre-school at age 3 years and higher levels of self-regulation at age 11 years [199]. Those authors used the Early Childhood Environment Rating Scale-Revised, which comprises 43 items across a number of child care quality domains. Our analyses focusing on specific domains of child care quality extend those of Sylva et al., highlighting the particular importance of higher quality relationships in formal child care contributing to young children's task attentiveness and emotional regulation as they start school.

There is substantial evidence that the relationships children share with important adults in early life affect later development. Most of this evidence has highlighted the importance of the parent-infant relationship in fostering the child's developing socio-emotional and self-regulation capacities [99, 200]. However, it makes sense that relationships and interactions shared with non-parental carers, such as child care providers, also may contribute to children's later functioning. For example, a US study of centre-based child care found that children whose carers rated their relationship with the child as closer (e.g., sharing a warm relationship), had fewer problem behaviors through second-grade [38].

This finding, along with our data, support past research and theory emphasizing the importance of positive relationships and interactions for children's healthy development [197, 201].

There is inconsistent evidence regarding the importance of provider characteristics, including educational qualifications, and program features, such as number of children in a group, in predicting socio-emotional skills. Our results study suggest that provider and program characteristics of care, at least in the Australian child care setting, do not strongly influence children's development. This may be because carer characteristics, such as educational qualifications, support skills that influence carer behavior, which then go on to influence children's development.

Our findings should be interpreted within the context of the study limitations. One limitation is that the domains of child care quality were based on carer self-reports, which might have resulted in an overestimation of child care quality. Direct observation is frequently used to assess the quality of child care; however, a problem with using direct observation is that it requires substantial time and resources, which is not practical for large-scale studies investigating diverse aspects of child health and development. Encouragingly, recent research revealed a high level of agreement between carer-reports and direct observations of child care quality [89]. Another limitation is our use of parent report measures to assess the children's self-regulation, which are subject to measurement error. However, we were interested in examining the children's ability to regulate attention, emotion and behavior in their everyday lives rather than their capacity to regulate as measured by objective assessments of children's regulatory capabilities [202].

Conclusions

Our study adds to the literature by demonstrating a relatively small but enduring effect of the quality of the carer-child relationship and activities in formal child care on children's task attentiveness and emotional regulation as they start school. There is increasing policy focus on improving the quality of child care to facilitate children's learning and development before they start school. Randomized controlled trials of high quality child care have provided evidence of developmental benefits; however, these trials had important limitations, targeting disadvantaged populations and using multi-faceted interventions that combined high quality child care with other interventions (e.g. home visiting), thereby making inferences about the specific components of child care impossible. Trials investigating the developmental effect of child care for children in the general population under age 3 years are lacking. With increasing focus from parents, clinicians, and governments on the potential contributions of child care on children's development, our study may have important implications for interventions and practice. Targeting the quality of the carer-child relationship in formal child care to support children's self-regulatory abilities may have implications for school readiness and later academic achievement as well.

End of article

6 Social inequalities in child care quality and their effects on children's development at school entry: findings from the Longitudinal Study of Australian Children

6.1 Preface

This chapter contains the final of a series of four articles contributing to this thesis. This article has been published in the *Journal of Epidemiology & Community Health* and examines whether higher quality child care was associated with better developmental outcomes at school entry for children from lower than higher income families.

In Chapter 5, the association between three domains of child care quality (carer-child relationships; activities; provider and program characteristics) and children's development were examined. These studies revealed that only one domain, the quality of the carer-child relationship, was associated with children's development. Consequently, the focus of this article is to determine whether the quality of the carer-child relationship is associated with better developmental outcomes for children from lower compared to higher income families. As no Australian study has investigated whether higher quality child care can function as a protective factor for children who may be at risk of poorer development this article addresses an important research gap and may have important policy and practice implications.

6.2 Publication: Social inequalities in child care quality and their effects on children's development at school entry: findings from the Longitudinal Study of Australian Children

6.2.1 Statement of authorship

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By signing below, the authors declare that they give consent for this paper to be presented by Angela Gialamas towards examination for the Doctor of Philosophy.

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Designed the study, contributed to the statistical framework, performed the analyses, interpreted the data, and drafted the manuscript.

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6.2.2 Abstract

Objective: Higher quality child care in the years before school may help narrow developmental gaps between the richest and poorest children in our societies, but specific evidence is limited and inconsistent. We address this issue by examining whether higher quality child care is associated with better developmental outcomes at school entry for children from lower than higher income families.

Methods: The sample from the Longitudinal Study of Australian Children included children attending child care from 2-3 years (n=980-1187, depending on outcome). Child care quality was measured using carers assessment of their relationship with the child. Children's receptive vocabulary was directly assessed in the child's home, and behavioural difficulties were measured by teachers and parents at 4-5 years. We assessed additive and multiplicative income-related effect measure modification of the quality of carer-child relationship on developmental outcomes.

Results: After adjusting for confounding, there was some evidence of effect measure modification on the additive and multiplicative scales of child care quality by income. Children experiencing higher quality relationships and lower income had almost the same risk of poorer receptive vocabulary as children in higher quality relationships and higher incomes (relative excess risk due to interaction = 0.18; 95% CI: -0.20, 0.52), ratio of relative risks = 1.11 (95% CI: 1.04, 1.17)). These patterns were similar for teacher and parent-reported behavioural difficulties.

Conclusions: The effects of higher quality child care, in terms of quality relationships with carers, on children's cognitive and behavioural development at school entry were stronger among children from lower income families. This provides some evidence that higher quality relationships in child care may be especially important in helping reduce developmental gaps for children from lower income families.

What is already known on this subject?

- Research suggests that children's experiences before starting school are crucial foundations for learning and behaviour across the life course.

- The child care setting is a key caregiving environment where children learn and build healthy relationships prior to commencing school.

- High quality child care is positively associated with children's learning and development, yet questions remain as to whether higher quality child care can function as a protective factor for lower income children who may be at risk of poorer development.

What this study adds?

- Higher quality child care, in terms of relationships with carers, was more strongly associated with better receptive vocabulary and fewer behavioural difficulties, among children from lower than higher income families.

- Higher quality relationships in child care are equity enhancing for developmental outcomes at school entry.

- These findings support the concept that higher quality child care may help reduce school readiness gaps for children from lower income families.

6.2.3 Introduction

Family income experienced before age 5 has been associated with children's cognitive ability, behaviour and school readiness [203], such that children from lower income families are more likely to start school with poorer cognitive skills and more socio-emotional problems than their more affluent peers [19].

Access to high quality child care may have an important role in promoting the development of young children and supporting children's better school readiness [77, 204]. Child care exposes children to educational resources and may help them learn skills and behaviours they require in school. Child care quality is a multidimensional construct characterised by domains including the quality of the relationship between the carer and child, availability of age-appropriate activities and the level of education of carers [127]. Higher quality child care is positively associated with children's cognitive and socio-emotional skills at school entry [33, 198]. Higher quality child care may be particularly beneficial for lower income children who may be more likely to experience less cognitively stimulating home environments and caregiving than children from higher income families [21]. However, the evidence (mainly from the USA) is mixed as to whether higher quality child care is more important for children from lower income backgrounds [39, 74, 127, 205].

Equitable access to high quality child care is an important policy issue for many countries because it is central to issues around workforce participation, especially for women, and promoting optimal child development. An associated policy issue is reducing disparities between the most and least advantaged socioeconomic groups [206]. In the USA, most public resources for child care are targeted to children living in poverty [65]. In contrast, the Australian government assists with the costs of child care for most families with no explicit targeted support for low income children [66]. In Australia child care centres and

family day care services operate under a national quality improvement and accreditation system funded by the federal government to promote high quality care [128]. Despite these policy commitments, children from low income families remain more likely to experience poorer quality care than those from high income families [63], yet it is they who are believed to gain the most [77].

Our previous research showed that of the three domains (higher quality relationships, activities and child care provider characteristics) of child care quality we hypothesised would be associated with children's development, only one domain (the quality of carer-child relationships) was associated with children's development [198]. The purpose of the current study was to examine whether the effect of higher-quality child care, in terms of the carer-child relationship, on children's receptive vocabulary and behavioural difficulties at school entry was modified by family income, that is, whether higher quality relationships between carer and child were more important for better outcomes among children from lower than higher income families. This is a hypothesis of effect measure modification (EMM) – that the effect of an exposure (i.e., potentially manipulable) differs according to another characteristic (in this case income), although we recognise that these two factors can still have joint effects [207].

6.2.4 Methods

Study Design

Data from the infant cohort of the Longitudinal Study of Australian Children (LSAC) was used in the present study. Sampling design, recruitment and data collection for LSAC have been reported elsewhere [139]. The study was approved by the Australian Institute of Family Studies Ethics Committee. Briefly, LSAC used a two-stage cluster sampling design. First, Australian postcodes were randomly sampled within strata for state/territory and urban/rural status to ensure that the sample was nationally representative. Second,

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children born between March 2003 and February 2004 within each postcode were randomly selected using Australia's national Medicare database in which >90% of infants are enrolled. This method identified 8921 infants who were eligible to participate. Of these, 5107 infants were recruited into the study (response rate 57.2%). Our analyses use the first three waves of data when children were 0-1 (n=5107), 2-3 (n=4606) and 4-5 years (n=4386). The LSAC sample, like many such cohorts internationally, recruited somewhat more socioeconomically advantaged participants, but it can be considered broadly representative of the Australian population of children [139].

Sample

For the present study, the sample included children aged 2-3 years attending formal child care. Formal child care refers to regulated, paid care away from the child's home and included care in a child care centre or family day care. At the face-to-face interview, the primary caregiver identified whether in the past month the study child was 'looked after at regular times during the week by anyone other than the parent living in the home'. If the child spent eight or more hours/week in child care, a questionnaire was posted to the main child care provider to capture information about the child care environment. There were 1859 (40% of the wave 2 sample) children in child care for at least 8 h/week and whose primary caregiver consented for a questionnaire to be posted. This proportion is similar to national reports which show 54% children aged 2-3 years attending formal child care [7]. A total of 1282 questionnaires were returned (69% response rate).

Measures

Child care quality

The quality of the carer-child relationship was derived using factor analysis from child care provider questionnaire data [198]. The quality of the carer-child relationship measured the perceived degree to which a child care provider experienced affection, warmth and open

communication with the child. The domain score for the quality of the carer-child relationship ranged from 8-16 where a higher score reflected higher quality child care. The carer-child relationship score was left skewed (mean score=14.9; median=16; IQR=15-16) with 55% of all participants achieving the maximum score of 16. Both continuous and dichotomised scores were examined in the analyses. Children were classified as receiving higher quality if they scored a 1(='low rating') on less than three (of eight) indicators, else were classified as receiving lower quality. Further information concerning the measurement of relationship quality is provided in Supplemental Table 1 (online Appendix, see Section 3.4, Table 3.1).

Socioeconomic Position

In this study, annual household income was used as the indicator of socioeconomic position because it is the most relevant indicator for the ability to pay for higher quality child care. The income distribution was categorized as ≤$41 599/year (<799/week = lower income) and ≥$41,600/year (≥$799/week = higher income). We chose these cut-points as they aligned with national household income data for 'low income' groups, where the bottom 20% of Australians received less than $769/week, 40% received between $770–$1362/week, and 40% received over $1363/week [146].

Developmental Outcomes

Children's receptive vocabulary at 4-5 years was directly assessed in the child's home using the Peabody Picture Vocabulary Test III (PPVT)–LSAC Australian Short Form [149]. For estimating the risk of poorer development, we used the continuous PPVT score to construct a binary variable, with a score below the median used to define lower receptive vocabulary. While this dichotomisation is arbitrary, we based this decision on the density of the PPVT score that showed a mixture of distributions. Dichotomising the

PPVT score at the median was considered to provide a meaningful representation of the variable (online Appendix, supplemental results Figure 6.2).

Children's behavioural difficulties at 4-5 years were assessed by using the Strengths and Difficulties Questionnaire (SDQ), which was completed by primary caregivers and teachers.

Informants used a 3-point Likert scale to specify how 25 items for five sub-scales, prosocial, hyperactivity, emotional symptoms, conduct problems and peer problems of five items apply to the child [152]. A total difficulties score was created by summing the scores from all the scales except the prosocial scale as it measures positive behaviour. Recommended cut-points were used to identify children scoring in the 'normal' 'borderline'' and 'abnormal' range [152]. We derived a binary variable based on the raw scores, with borderline and abnormal cutoff scores used to define behavioural difficulties.

Confounders

Confounding factors were identified a priori using a directed acyclic graph [158] as being common causes of child care quality and children's development. Confounders were measured at baseline (0-1 year) with the exception of variables representing the home environment that were measured when children were aged 2-3 years. These factors included child age, sex, birthweight; parental concern about the child's learning and development; primary caregivers age, highest educational qualification, work status, psychological distress using the Kessler 6 [147]; geographic remoteness using the Accessibility and Remoteness Index of Australia [145]; whether the family experienced economic hardship over the last year; whether the child lived in a two-parent household; number of siblings; number of children's books in the home; time spent reading to the child; and whether the child undertook other activities that required additional payment that were not part of his/her normal care, including swimming lessons or music class.

Multiple Imputation

Of the 1282 children, 836 (65.2%) had missing data in one or more variables of interest (exposure, outcome or covariate) leaving 446 children with complete information. The response rate for each variable ranged from 74.1% to 100%. To address attrition and item non-response, multiple imputation by chained equations was used to impute missing values [163]. Imputed datasets were generated under the missing at random assumption that uses observed variables in the dataset to predict missingness and estimate parameters [164]. In accordance with best practice [162], the variables used to predict missingness in the imputation model included the exposure, outcomes, confounders and auxiliary predictors (e.g. not part of the estimation model) of missingness such as the type and time spent in child care. The imputation was conducted for the full study sample (n=1282), however data were analysed only for children who had observed outcomes for receptive vocabulary (n=1187) and parent-reported (n=1092) and teacher-reported (n=980) SDQ scores (online Appendix, supplemental results Figure 6.3). There were no systematic differences between children with and without imputed outcomes. Twenty imputed datasets were generated and the results of the imputed analyses were combined using Rubin's rules [208]. All analyses were conducted using Stata V.12.1.

Analysis

To examine differences in the quality of the carer-child relationship and poorer receptive vocabulary and behavioural difficulties we computed the absolute and relative slope differences within strata of income [209]. These summary measures can be interpreted as the absolute and relative differences in receptive vocabulary and behavioural difficulties between the lowest and highest classes of relationship quality [210, 211]. If the absolute difference in the slope is 0 or the ratio of the slopes is 1.0 the proportion of children with poorer development is equal over levels of relationship quality. The computational process

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of constructing the absolute and relative slope differences is provided in supplemental

Table 2 (online Appendix, supplemental results Table 6.5).

Effect Measure Modification

Our a priori expectation was that higher quality relationships in child care would be more

strongly associated with better outcomes for children from lower than higher income

backgrounds. In other words, we were interested in estimating the causal effect of the

quality of the carer-child relationship (CCQ, 1=lower-quality, 0=higher quality) and

children's receptive vocabulary (Y, 1= <median, 0= ≥median) and behavioural difficulties

(Y, 1= problems, 0= no problems) within the levels of income (1=lower income, 0=higher

income). This measure is formally known as EMM [171]. The formula for estimating

EMM can be written as:

$$\mu\big(E(Y_{ccq=1}|Income = i), E(Y_{ccq=0}|Income = i)\big)$$

where μ is the risk ratio (RR) that varies across strata of income (i =0,1). For estimating

risk we used the log link in generalised linear regression models, adjusting for all

confounders. We can decompose the joint effect of CCQ and income into a component

that is due to CCQ alone, or the effect due to income alone or, the effect due to their

interaction.

Most research to date has tested for effect modification by including a product term

between the exposure and potential effect modifier [39, 74]. However, using a regression

analysis with product terms of both exposures do not discriminate between which variable

is the exposure of interest (in this case child care quality) and which variable is the effect

modifier (income) [212]. In this study, we draw on recent advances on modelling effect

modifiers [171, 212]. We used both multiplicative and additive scales and present the

analyses with a single common reference group for each stratum as outlined by Knol and

VanderWeele [171]. Currently, the statistical methods available to test for EMM only

support the use of binary variables hence we dichotomised the variables (child care quality; income; developmental outcomes) of interest. Sensitivity analyses were conducted to explore the effects of different dichotomisation of carer-child relationship and receptive vocabulary.

It has been recommended that both multiplicative and additive EMM terms be presented to provide readers with sufficient information to draw conclusions about the size and statistical significance of the EMM [171]. Multiplicative EMM was examined through a cross-product interaction term in the regression model and additive EMM was examined using the relative excess risk due to interaction (RERI). RERI represents the risk that is in excess of what would be expected if the combination of relationship quality and income was entirely additive. In the absence of additive EMM, RERI is equal to 0. In the absence of multiplicative EMM the ratio of risk equals 1. The 95% CIs for the receptive vocabulary outcome was calculated using non-parametric bootstrap [213]. As the data for behavioural difficulties was skewed we used the following correction to obtain 95% CIs:

$\mu \pm Z_{(1-\alpha/2)} \left(\sqrt{\sigma^2/m} \right)$ where μ is the mean of the multiplicative EMM from m=500

bootstrap replicates, σ^2 is the variance, and Z is standard normal value corresponding to a given level of significance, usually (α=) 0.05.

6.2.5 Results

Table 6.1 describes the characteristics of the study participants. The majority of children lived in a family with an annual household income ≥$41,600 (~76%). A total of 509 (43%) children had a receptive vocabulary score below the median, 160 (15%) and 162 (16%) children had parent-reported and teacher-reported behavioural difficulties, respectively.

Table 6.1: Summary characteristics of study participants using the multiply imputed sample

	Receptive vocabulary (n= 1187)	Parent-reported difficulties (n=1092)	Teacher-reported difficulties (n=980)
Child age, mean (SD)	57.7 (2.7)	57.7 (2.7)	57.7 (2.7)
Birth weight (grams)			
<=2500	54 *(4.5)*	50 *(4.6)*	43 *(4.4)*
>=2501	1133 *(95.5)*	1042 *(95.4)*	937 *(95.6)*
Sex			
Female	570 *(48.0)*	510 *(46.7)*	461 *(47.0)*
Male	617 *(52.0)*	582 *(53.3)*	519 *(53.0)*
Concerns about child's learning and development			
Yes a little/don't know	71 *(6.0)*	69 *(6.3)*	65 *(6.6)*
No	1116 *(94.0)*	1023 *(93.7)*	915 *(93.4)*
Caregiver age (years), mean (SD)	31.7 *(5.1)*	31.9 *(5.1)*	31.9 *(5.0)*
Kessler 6 score, mean (SD)	4.41 (.55)	4.41 (.55)	4.42 (.55)
Annual household income			
≤$41 599	282 *(23.8)*	250 *(22.9)*	224 *(22.9)*
≥$41,600	905 *(76.2)*	842 *(77.1)*	756 *(77.1)*
Remoteness Index (ARIA)			
Highly accessible	670 *(56.4)*	612 *(56.0)*	556 *(56.7)*
Other	517 *(43.6)*	480 *(44.0)*	424 *(43.3)*
Primary caregiver education			
< Bachelor's degree	725 *(61.1)*	655 *(60.0)*	582 *(59.4)*
Bachelor's degree or higher	462 *(38.9)*	437 *(40.0)*	398 *(40.6)*
Primary caregiver work status			
Full-time work	186 *(15.7)*	173 *(15.8)*	158 *(16.1)*
Part-time work	448 *(37.7)*	424 *(38.8)*	381 *(38.9)*
Not in labour force	553 *(46.6)*	495 *(45.3)*	441 *(45.0)*
Economic hardship			
No significant hardship	665 *(56.0)*	620 *(56.8)*	570 *(58.2)*
Some significant hardship	522 *(44.0)*	472 *(43.2)*	410 *(41.8)*
Two-parent household			
No	91 *(7.7)*	84 *(7.7)*	66 *(6.7)*
Yes	1096 *(92.3)*	1008 *(92.3)*	914 *(93.3)*
Number of siblings			
0	483 *(40.7)*	443 *(40.6)*	398 *(40.6)*
1	488 *(41.1)*	454 *(41.6)*	406 *(41.4)*
≥ 2	216 *(18.2)*	195 *(17.9)*	176 *(18.0)*
Children's books in the home			
≤ 20 books	145 *(12.2)*	125 *(11.5)*	107 *(10.9)*
≥ 21 books	1042 *(87.8)*	967 *(88.5)*	873 *(89.1)*
Minutes child usually read to			
≤ 20 minutes	1061 *(89.4)*	973 *(89.1)*	874 *(89.2)*
≥ 21 minutes	126 *(10.6)*	119 *(10.9)*	106 *(10.8)*
Regular cost activities			
No	639 *(53.8)*	580 *(53.1)*	515 *(52.6)*
Yes	548 *(46.2)*	512 *(46.9)*	465 *(47.5)*

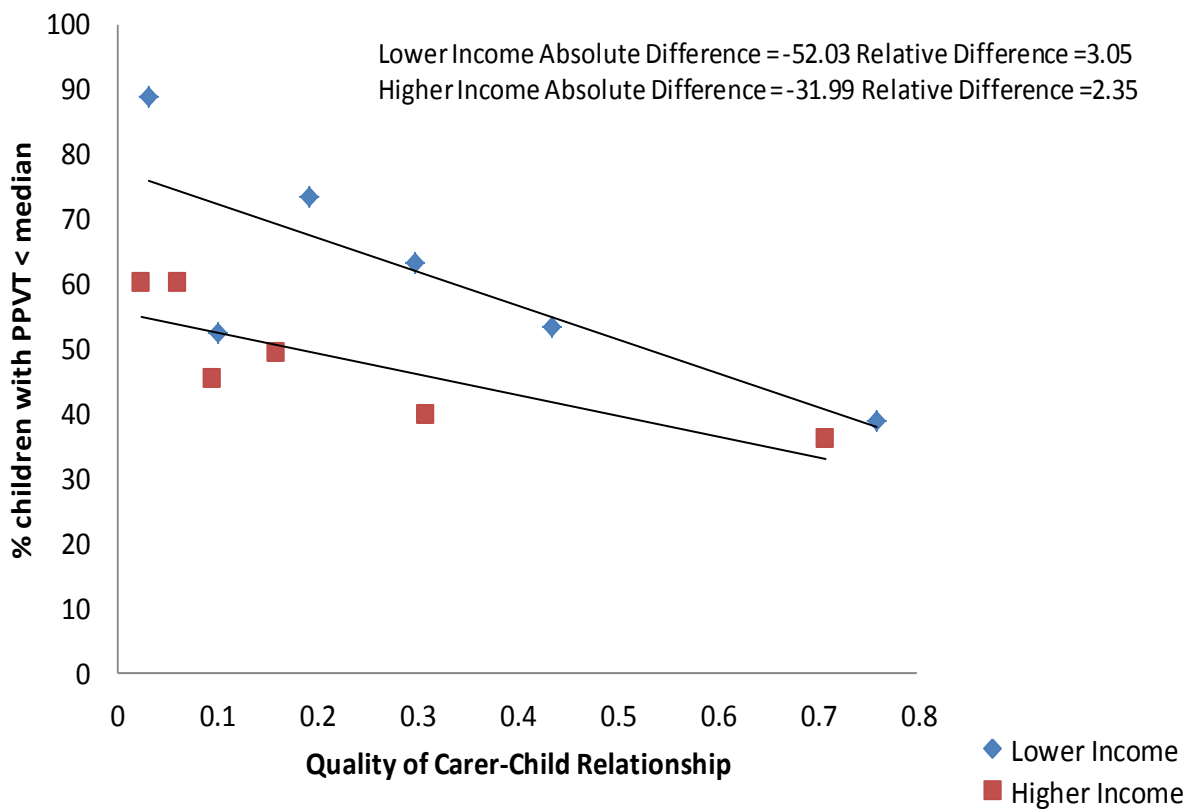|	Receptive vocabulary (n= 1187)	Parent-reported difficulties (n=1092)	Teacher-reported difficulties (n=980)
Quality of carer-child relationship			
Higher quality	1011 *(85.2)*	923 *(84.5)*	825 *(84.2)*
Lower quality	176 *(14.8)*	169 *(15.5)*	155 *(15.8)*
PPVT score			
PPVT ≥ median	678 *(57.1)*	-	-
PPVT < median	509 *(42.9)*	-	-
Parent-reported difficulties			
No Problems	-	932 *(85.4)*	-
Problems	-	160 *(14.7)*	-
Teacher-reported difficulties			
No Problems	-	-	818 *(83.5)*
Problems	-	-	162 *(16.5)*

Data are presented as N (%) except as noted

PPVT = Peabody Picture Vocabulary Test

As a first step in estimating the potential effect of the quality of the carer-child relationship on children's development by income group we considered the absolute and relative slope differences within strata of income. As shown in Figure 1 the gap in receptive vocabulary between the lower and higher-income groups experiencing the highest-quality of care was negligible (39% vs 36%, respectively). However, 89% of children in the lower income group experiencing the lowest quality of carer-child relationship had a receptive vocabulary score < median versus 60% of children in the higher income group and lowest quality child care. For the lower income group, the absolute difference in average PPVT (proportion of children with a receptive vocabulary score < median) between children at the lowest and at the highest quality carer-child relationships was -52.3. In comparison for the higher income group the absolute difference in average PPVT between children experiencing the lowest quality of carer-child relationship and children experiencing the highest quality of care was -31.9. Results on a relative scale suggests a similar effect, with children in the lower income group experiencing the lowest quality relationship in childcare 3.05 times more likely to have a receptive vocabulary score < median than those experiencing a higher-quality relationship whereas children in the higher income group

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experiencing the lowest quality carer-child relationship were 2.35 times more likely to

have a receptive vocabulary score < median than those experiencing higher quality

relationships (Figure 6.1). The pattern of results was similar for parent-reported and

teacher-reported behavioral difficulties (online Appendix, supplemental results Figures 6.4

– 6.5). For example, in the lower income group the difference in prevalence of parent-

reported difficulties between children experiencing the lowest and highest quality of

relationships in child care was -26.46.

Figure 6.1: Absolute and relative slope differences in the quality of the carer-child relationship and proportion of children with a receptive vocabulary score < median by income group

Lower Income Absolute Difference =-52.03 Relative Difference =3.05
Higher Income Absolute Difference =-31.99 Relative Difference =2.35

The second step in our analyses was to formally assess for EMM. That is, examine whether the effect of higher quality relationships in child care on children's receptive vocabulary and behavioral difficulties was moderated by income level, adjusting for confounding. As shown in Table 6.2, compared with children who experienced higher quality relationships and higher income, children with higher quality relationships and lower income had a negligible risk of a receptive vocabulary score < median (RR=1.05 (95% CI 0.86, 1.27). Similarly, children experiencing higher quality relationships and lower income had no increased risk of teacher-reported behavioural difficulties (RR=0.99 (0.61, 1.57) and had a slightly higher increased risk of parent-reported (RR=1.20 (0.79, 1.84) behavioural difficulties (Tables 6.3 – 6.4).

There were some indications for effect modification on both additive and multiplicative scales for each outcome (Tables 6.2 – 6.4). For example, as shown in Table 6.2, the RERI calculated as $1.56 - 1.05 - 1.33 + 1 = 0.18$ (-0.20, 0.52) was greater than 0, suggesting some indications of EMM on the additive scale such that the effect of lower-quality carer-child relationships with lower income was larger than the estimated effect of lower quality carer-child relationships with higher income. The measure of multiplicative EMM, the ratio of RRs in strata of income, calculated as $(1.56 \times 1) / (1.05 \times 1.33)$ was 1.11 (CI 1.04, 1.17). This means there were some indications that the estimated effect of lower quality carer-child relationships on the RR scale with lower income was larger than the estimated effect of lower quality relationships with higher income. Similar results were obtained using different cut-off points for dichotomising the quality of carer-child relationship and receptive vocabulary scores (online Appendix, supplemental results Table 6.6).

Table 6.2: Receptive vocabulary (PPVT): effect measure modification of the quality of carer-child relationship by income group

	Higher quality carer-child relationship		Lower quality carer-child relationship		RR (95% CI) for lower vs. higher quality of carer-child relationship within strata of income
	N <median/≥median PPVT	RR (95% CI)	N <median/≥median PPVT	RR (95% CI)	
Higher Income	305/493	1.0	58/49	1.33 (1.09, 1.62) *p=0.004*	1.33 (1.09, 1.62) *p=0.004*
Lower Income	97/116	1.05 (0.86, 1.27) *p=0.60*	49/20	1.56 (1.27, 1.91) *p=<0.001*	1.46 (1.18, 1.82) *p=<0.001*

Measure for effect measure modification on an additive scale: RERI= 0.18 (-0.20, 0.52) p=0.39
Measure for effect measure modification on a multiplicative scale: Ratio of RRs= 1.11 (1.04, 1.17) p=<0.001
RRs are adjusted for child age, sex, birth weight, parental concern about child's learning and development; primary caregiver education, work status; economic hardship; geographic remoteness [ARIA]; two-parent household; number of siblings; primary caregiver age, Kessler 6 score; number of children's books; minutes child usually read to; regular cost activities

Table 6.3: Parent-reported behavioural difficulties (SDQ): effect measure modification of the quality of carer-child relationship by income group

	Higher quality carer-child relationship		Lower quality carer-child relationship		RR (95% CI) for lower vs. higher quality of carer-child relationship within strata of income
	N Problems/ No Problems	RR (95% CI)	N Problems/ No Problems	RR (95% CI)	
Higher Income	85/651	1.0	18/88	1.26 (0.79, 2.01) *p=0.31*	1.26 (0.79, 2.01) *p=0.31*
Lower Income	34/153	1.20 (0.79, 1.84) *p=0.002*	23/40	2.15 (1.32, 3.51) p=*0.002*	1.64 (1.04, 2.58) *p=0.03*

Measure for effect measure modification on an additive scale: RERI= 0.69 (-0.43, 1.55) p=0.26
Measure for effect measure modification on a multiplicative scale: Ratio of RRs= 1.45[*] (estimates from Table 6.3=1.42) (1.40, 1.49) p=0.002
RRs are adjusted for child age, sex, birth weight, parental concern about child's learning and development; primary caregiver education, work status; economic hardship; geographic remoteness [ARIA]; two-parent household; number of siblings; primary caregiver age, Kessler 6 score; number of children's books; minutes child usually read to; regular cost activities
[*] mean value from non-parametric bootstrap

Table 6.4: Teacher-reported behavioural difficulties (SDQ): effect measure modification of the quality of carer-child relationship by income group

	Higher quality carer-child relationship		Lower quality carer-child relationship		RR (95% CI) for lower vs. higher quality of carer-child relationship within strata of income
	N Problems/ No Problems	RR (95% CI)	N Problems/ No Problems	RR (95% CI)	
Higher Income	81/580	1.0	26/69	2.07 (1.39, 3.09) *p=<0.001*	2.07 (1.39, 3.09) *p=<0.001*
Lower Income	27/137	0.99 (0.61,1.57) p=*0.95*	28/32	2.35 (1.47, 3.74) *p=<0.001*	2.40 (1.52, 3.78) *p=<0.001*

Measure for effect measure modification on an additive scale: RERI= 0.29 (-0.74, 1.44) *p=0.53*
Measure for effect measure modification on a multiplicative scale: Ratio of RRs= 1.26[*] (estimates from Table 6.4=1.15) (1.23-1.30) *p=<0.001*
RRs are adjusted for child age, sex, birth weight, parental concern about child's learning and development; primary caregiver education, work status; economic hardship; geographic remoteness [ARIA]; two-parent household; number of siblings; primary caregiver age, Kessler 6 score; number of children's books; minutes child usually read to; regular cost activities
[*] mean value from non-parametric bootstrap

6.2.6 Discussion

In this large, nationally representative cohort of Australian children we found that the gap in developmental outcomes at ages 4-5 between lower and higher income groups experiencing the highest quality of care was small, highlighting the positive contribution higher quality relationships in child care has for children from lower income backgrounds. After adjusting for an extensive range of confounding factors, the EMM analyses between the quality of the carer-child relationship and income provided some evidence that higher quality relationships acted as a protective factor for lower income children.

These results are encouraging but, it is important to consider the measurement of child care quality when interpreting these findings. Our measure utilised carers self-report of their perceived relationship with the child that may have resulted in an over-estimation of quality. For example, in our study 55% of children achieved the maximum quality score. However, the high quality reported by carers may reflect the regulatory context of child care in Australia [128], which strives for universal access to high quality care. For instance, a recent Australian study examining two sources of child care quality, the Early Childhood Environment Rating Scale-Revised, a well-established direct observational method and Australia's nationally administered Quality Improvement and Accreditation System found that centres provided quality of a good to high standard [214]. Although there were no nationally consistent Australian child care regulations when the present study commenced in 2004, the quality assurance and accreditation system managed by the National Child Care Accreditation Council was designed to operate in conjunction with state and territory licensing regulations, with most services (98%) complying with the standards [128]. Yet, even in a country that sees most formal child care services operating under a regulatory environment, inequalities in the quality of relationships in child care remain. The explicit targeting of additional support for children from lower income

families has been overlooked in the Australian context [215], however; results from this study suggest that attention to universal high quality child care, especially for disadvantaged children may require policy attention.

Our finding that higher quality relationships among lower income children buffered the effect of poorer developmental outcomes at school entry is consistent with a longitudinal study of child care from the USA. Dearing et al. [74] used a global measure of child care quality that summed a number of quality domains including carer sensitivity and responsiveness to a child, and found higher quality care protective of school readiness among children from lower income families. As this US study was not nationally representative with participating families having higher incomes, more education and less likely to be of a minority group than the general population, the present study using a more representative sample of children both strengthens this finding and extends it to Australia where the child care system and regulatory context is quite different. Furthermore, our results provide specific information regarding the mechanism through which child care may protect or put children at risk which can then be used for interventions, such as those targeting carer-child relationships to enhance the quality of child care programs and in turn improve the developmental outcomes of children.

The present findings should be interpreted within the context of the study limitations. As noted earlier, our measure of child care quality was based on carer-report that may have resulted in an overestimation of quality. However, no single measure is currently accepted as a gold standard. Furthermore, the quality of the relationships as reported by carers may be linked with attributes of the child such as the child's temperament or behaviour. It is possible that the quality of the relationship reflected the child's actual behaviour rather than a measure of relationship quality with the carer, and hence childcare quality. However, the development of relationships between children and adults is complex and not

easily divided into child and adult characteristics. Relationships are determined not only by child characteristics (e.g. temperament, gender) but from a combination of factors including adult characteristics and attributes of the social environment (e.g. number of children in the room, rules) [216]. Research regarding whether attributes of the child such as temperament contributes to teachers perceptions of the quality of their relationship with children is contradictory [216, 217]. Therefore it is difficult to say whether characteristics of the child influence relationship quality and in turn developmental outcomes. It would be difficult to imagine what kind of research could ever disentangle this other than longitudinal direct observation. Strengths of the present study include its use of multiple informants' reports to assess children's development, the use of a large, nationally representative sample of children and the ability to adjust for a large number of confounders. Furthermore, to our knowledge, this is the first study to have investigated the joint effect as well as the moderation effect of child care quality and income on children's development thus advancing existing research in this area.

Conclusion

High quality child care during children's preschool years may have an important role in helping close developmental gaps for children from more socioeconomically disadvantaged backgrounds [77, 206]. Our results showed that when quality of relationships in child care was high, there was little difference in developmental outcomes between children from lower and higher income groups. This provides some support for the concept that high quality child care may be equity enhancing by eliminating developmental gaps between children from low income and high income backgrounds.

6.2.7 Online Appendix

Supplemental results

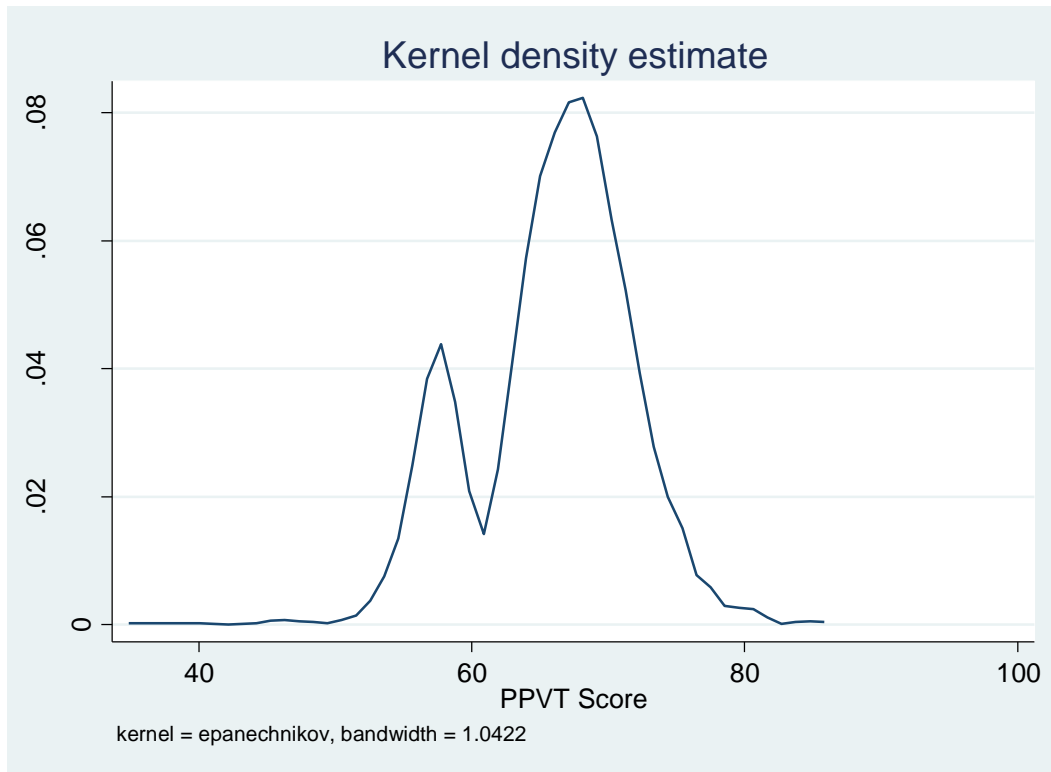**Figure 6.2: Density plot of measured receptive vocabulary (PPVT score) for children aged 4-5 years**

Kernel density estimate

kernel = epanechnikov, bandwidth = 1.0422

Figure 6.3: Eligible cohort and numbers included for the analyses

Cohort recruited into LSAC in 2004 (wave 1) N=5107	→	Lost to follow-up: N=501

Cohort in 2006 (wave 2) N=4606	→	Cohort in 2006 not in childcare: N=1362

Cohort in childcare 2006 (wave 2) N=3244	→	Exclusions: Children not in centre or family day care N=1081 <8 hours/week in centre or family day care N=284 Centre or family day care ≥8 hours/week but parent refused to send questionnaire N=20

Non-parental carers eligible to receive questionnaire N=1859	→	Non-responders to childcare questionnaire N=577

Non-parental carer questionnaires received
N=1282

Children with complete childcare quality information
N=955

Children with complete quality, covariates, outcomes
N=446

Impute missing values for childcare quality, covariates, and outcomes
N=1282

Study Sample

Multiply Imputed Analysis Sample (imputed outcomes removed)

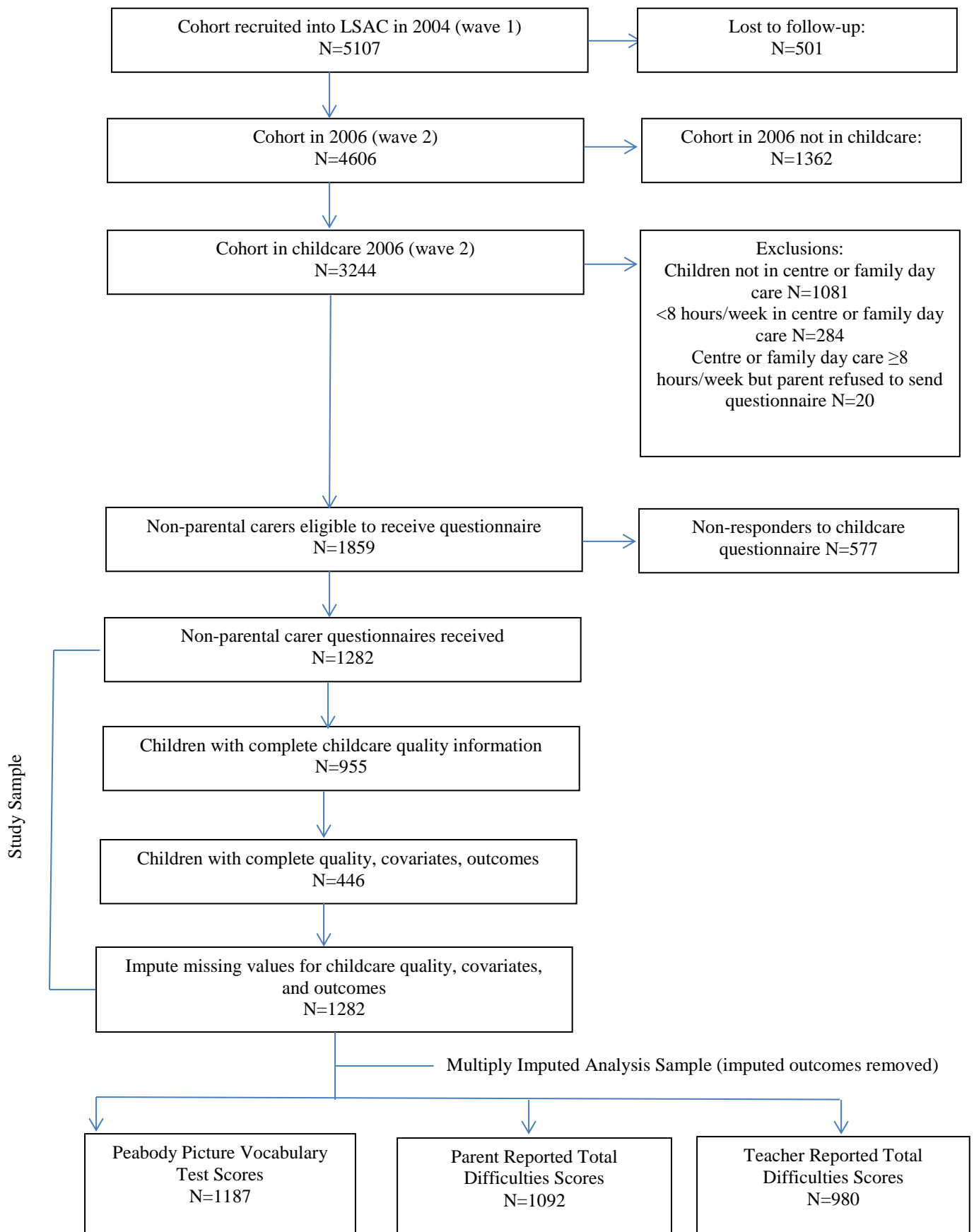| Peabody Picture Vocabulary Test Scores N=1187	Parent Reported Total Difficulties Scores N=1092	Teacher Reported Total Difficulties Scores N=980

Table 6.5: Computational process of constructing the absolute and relative slope differences to examine inequalities in the quality of the carer-child relationship and poorer receptive vocabulary and behavioural difficulties by income group

1. Compute the proportion of total children (t_i) for the ordered (lowest to highest) classes of quality (i= 11, 12,…16).

2. Compute the cumulative proportion of children for each class of quality (c_i) and then give a score based on the midpoint of its range in the cumulative distribution in the children $(i.e.\ x_i = c_{i-1} + t_i/2)$.

3. Compute the proportion of children with a receptive vocabulary score below the median and the proportion of children with parent and teacher reported behavioural difficulties within each class of quality for i^{th} class (r_i).

4. The values of r_i for each developmental outcome are then plotted against the values of x_i and a regression line is fitted to the data. Thus the value of the slope coefficient (B1) of the regression line is the absolute difference.

5. The relative difference is calculated as:

$Relative Diff = \beta_0 / (\beta_0 - \beta_1)$ where β_0 is the intercept and β_1 is the slope coefficient of regression between relationship quality and the outcome.

Figure 6.4: Absolute and relative slope differences in the quality of the carer-child relationship and proportion of children with parent-reported behavioural difficulties by income group
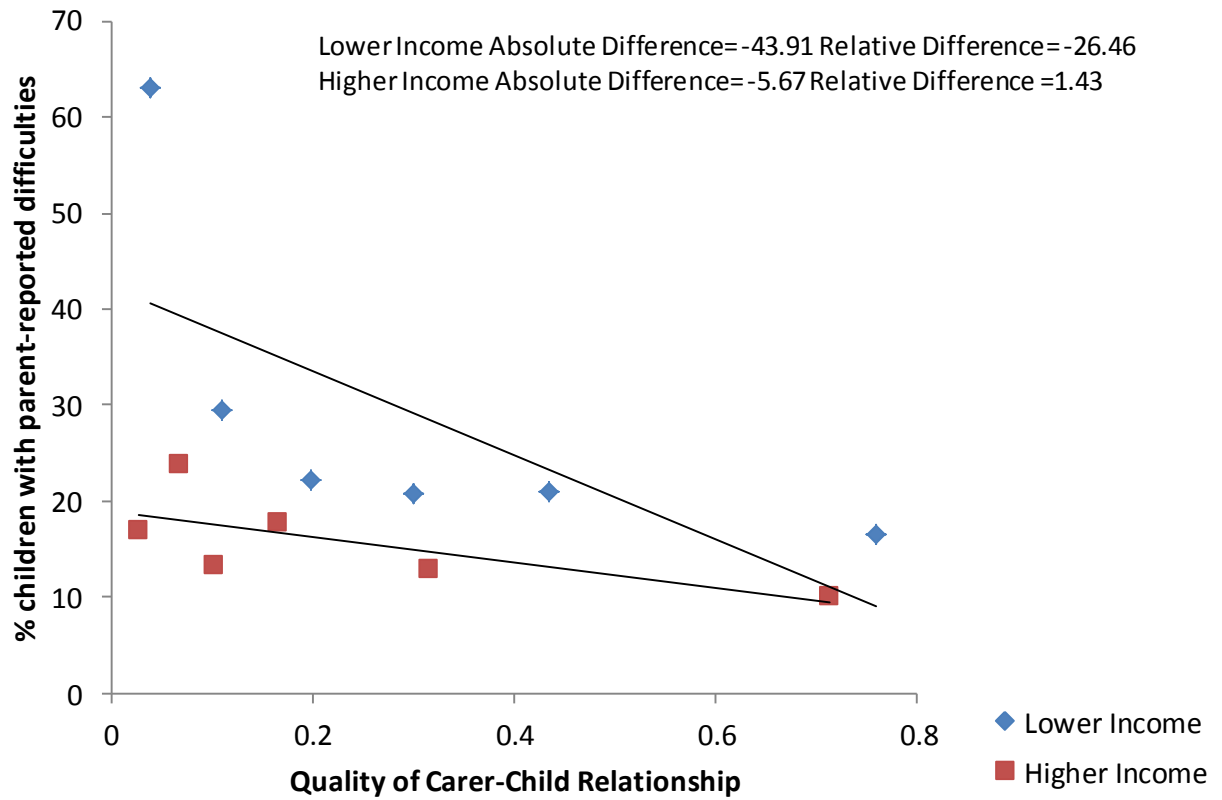
*Due to small numbers in the lowest quality of carer-child relationship, we combined scores 8-11 into a single category for the analysis

Figure 6.5: Absolute and relative slope differences in the quality of the carer-child relationship and proportion of children with teacher-reported behavioural difficulties by income group
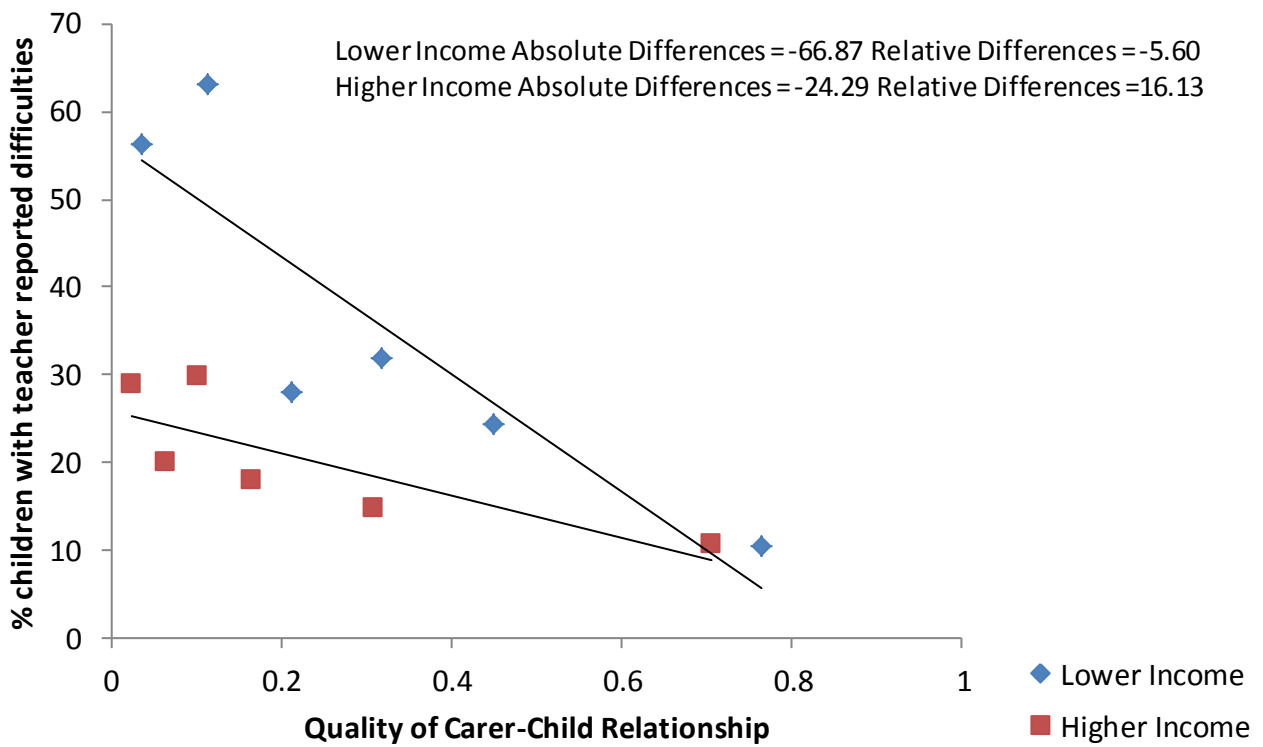
*Due to small numbers in the lowest quality of carer-child relationship, we combined scores 8-11 into a single category for the analysis

Table 6.6: Sensitivity analyses to explore the effects of possible misclassification of quality carer-child relationship and receptive vocabulary status on relative risk estimates

Scenario 1: Effect of potential exposure misclassification

Newly defined quality carer-child relationship score:

1= Lower-quality carer-child relationship score, ≤15

0= Higher-quality carer-child relationship score, ≥16

Receptive vocabulary score:

1= < median

0 = ≥ median

Adjusted association between receptive vocabulary and quality of carer-child relationship by income group

Quality of child care	β	95% CI	P
Higher income and higher quality relationship (r)			
Lower income and lower-quality relationship	1.47	1.20, 1.79	<0.001
Lower income and higher-quality relationship	1.00	0.79, 1.28	0.93
Higher income and lower-quality relationship	1.21	1.03, 1.42	0.01

Scenario 2: Effect of potential exposure misclassification

Newly defined quality carer-child relationship score:

1= Lower-quality carer-child relationship score, ≤12

0= Higher-quality carer-child relationship score, ≥13

Receptive vocabulary score:

1= < median

0 = ≥ median

Adjusted association between receptive vocabulary and quality of carer-child relationship

by income group

Quality of childcare	β	95% CI	P
Higher income and higher quality relationship (r)			
Lower income and lower-quality relationship	1.59	1.26, 2.01	<0.001
Lower income and higher-quality relationship	1.08	0.91, 1.30	0.34
Higher income and lower-quality relationship	1.45	1.18, 1.79	<0.001

Scenario 3: Potential for outcome (PPVT score) misclassification

Quality carer-child relationship score:

1= Lower-quality carer-child relationship score, ≤13

0= Higher-quality carer-child relationship score, ≥14

Newly defined receptive vocabulary score:

1 = PPVT score in lowest 30%

0 = Other

Adjusted association between receptive vocabulary and quality of carer-child relationship

by income group

Quality of childcare	β	95% CI	P
Higher income and higher quality relationship (r)			
Lower income and lower-quality relationship	1.37	1.20, 1.57	<0.001
Lower income and higher-quality relationship	1.03	0.90, 1.17	0.65
Higher income and lower-quality relationship	1.29	1.14, 1.47	<0.001

Scenario 4: Potential for outcome (PPVT score) misclassification

Quality carer-child relationship score:

1= Lower-quality carer-child relationship score, ≤13

0= Higher-quality carer-child relationship score, ≥14

Newly defined receptive vocabulary score:

1 = PPVT score in lowest 10%

0 = Other

Adjusted association between receptive vocabulary and quality of carer-child relationship

by income group

Quality of childcare	β	95% CI	*P*
Higher income and higher quality relationship (r)			
Lower income and lower-quality relationship	2.72	1.60, 4.61	<0.001
Lower income and higher-quality relationship	1.40	0.84, 2.32	0.19
Higher income and lower-quality relationship	1.87	1.08, 3.25	0.02

Quantitative Bias Analysis (Based on unadjusted regressions of quality carer-child relationship on receptive vocabulary, by income group)

Exposure Misclassification

Receptive vocabulary score (PPVT) for quality-carer child relationship by lower income

Sensitivity	Specificity	Relative Risk
0.78	0.99	1.67
0.75	0.99	1.69
0.70	0.99	1.73
0.78	0.95	1.77
0.80	0.95	1.75
0.90	0.95	1.70
0.50	0.95	2.28
0.40	0.95	3.54

Receptive vocabulary score (PPVT) for quality-carer child relationship by higher income

Sensitivity	Specificity	Relative Risk
0.78	0.99	1.48
0.75	0.99	1.48
0.70	0.99	1.49
0.78	0.95	1.72
0.80	0.95	1.71
0.90	0.95	1.70
0.50	0.95	1.81
0.40	0.95	1.89

Outcome Misclassification

Receptive vocabulary score (PPVT) for quality-carer child relationship by lower income

Sensitivity	Specificity	Relative Risk
0.78	0.99	1.57
0.75	0.99	1.57
0.78	0.95	1.56
0.80	0.95	1.63
0.90	0.95	1.63
0.99	0.80	2.0
0.20	0.15	0.35
0.53	0.99	1.57

Receptive vocabulary score (PPVT) for quality-carer child relationship by higher income

Sensitivity	Specificity	Relative Risk
0.78	0.99	1.43
0.75	0.99	1.43
0.78	0.95	1.48
0.80	0.95	1.48
0.90	0.95	1.48
0.99	0.80	1.88
0.20	0.15	0.66
0.53	0.99	1.43

End of published article

7 Summary and conclusions

This thesis has investigated the type, time and quality of child care for infants (0-1 years) and toddlers (2-3 years) and children's cognitive and socio-emotional development as they start school (4-5 and 6-7 years). Very few studies have investigated the later developmental effects of different aspects of child care experienced by children aged between birth and three years in the Australian context. The current investigation is timely because growing numbers of children are using child care, and there is increasing government and public interest in the potential benefits that high quality child care may have for children's developmental outcomes as they start school. In this final chapter, key findings and contributions are presented, limitations of this work are discussed and areas with future research potential are highlighted.

7.1 Key findings and contributions

Type and time in child care

The first aim of this thesis was to investigate the effect of total amount of time spent in child care through the first three years of life on children's cognitive and socio-emotional development at age 4-5 years, and to determine whether this effect varied by the primary type of child care children experienced. A review of the literature identified no published studies regarding the cumulative amount of time spent in child care and the effect on children's development as they start school in the Australian setting.

In Chapter 4, using data from the LSAC, I examined the strength of the association between the total amount of time spent in child care through the first three years of life and children's cognitive and socio-emotional development at school entry. The results showed no evidence of benefit for children's receptive vocabulary. However, children who spent more time in child care had higher levels of parent-reported and teacher-reported externalising problem behaviours, but lower levels of parent-reported internalising problem behaviours. There was also evidence that compared to children who did not use child care in the first three years of life; more time spent in centre-based care (but not other types of child care) was associated with higher levels of externalising problem behaviours and lower levels of internalising problem behaviours at age 4-5 years. Similar results were seen when examining effects separately for children aged 0-1 year and 2-3 years.

Quality of child care

The second and third aims of this thesis focused on the quality of formal child care at age 2-3 years and the strength of the association between child care quality and various domains of children's development at school entry and beyond. A good deal is already known about the beneficial effects of high quality child care in countries such as the USA. However, a review of the literature revealed no knowledge regarding associations between child care quality and children's development as they start school in the Australian context. As the government regulatory context for quality differs between countries, local Australian evidence to inform research, policy and practice was considered essential to investigate.

In Chapter 5, only children attending formal child care (centre-based care and family day care) for ≥8 hours per week at age 2-3 years were available for investigation because of the design of the LSAC survey. For the purpose of this thesis, a measure of child care quality, using a multidimensional set of indicators was created and utilised to assess the extent to

which quality influences different domains of children's development considered important for early school success. Three domains of child care quality were identified, including provider and program characteristics of care, activities in child care, and the carer–child relationship.

The results presented in Chapter 5 showed clear evidence that the quality of relationships in formal child care were associated with children's task attentiveness, emotional regulation, receptive vocabulary, literacy and maths proficiency, internalising and externalising behaviours at school entry and these effects, although weaker, continued to exert their influence at age 6-7 years even after two years of formal schooling. The consistent finding of an association between the quality of relationships in formal child care and children's development suggests a robust effect. Surprisingly, the results indicated that the quality of activities in formal child care were only associated with children's emotional regulation and there was no evidence that provider or program characteristics of care were associated with the developmental outcomes measured in this study.

This thesis provides the most comprehensive study of child care quality in Australia to date. These results provide specific information regarding the mechanism through which child care may protect or put children at risk which can then be used for interventions to enhance the quality of child care programs and in turn improve the developmental outcomes of children. Further, with increasing demand for high quality child care and the role child care may have in supporting children's development as they start school these data may provide valuable evidence to inform government, child care providers and parents of the aspects of quality that contribute to children's development.

Quality of child care for disadvantaged children

The fourth and final aim of this thesis was to determine if higher quality child care was associated with better cognitive and socio-emotional outcomes at school entry for children from families with lower versus higher income. The motivation for this work came from the growing interest worldwide that higher quality child care in the years before school may narrow developmental gaps between the richest and poorest children in our societies.

In Chapter 5, we found that only the quality of carer-child relationship in formal child care was associated with children's development, therefore only this domain was selected for investigation in Chapter 6. The results revealed that at the highest level of the quality of relationships in formal child care there was little difference in children's receptive vocabulary, parent-reported and teacher-reported behavioural difficulties between the lower and higher income groups at school entry. Importantly, these findings support the concept that higher quality child care may help children from lower income families reach a more equal start at school entry.

These results may have important public policy implications. Equitable access to high quality child care is an important policy issue for many countries. A key goal of the Australian National Early Childhood Development Strategy is to reduce inequalities in outcomes between socioeconomic groups [23]. Results from this study suggest that experience of better quality relationships in child care may be particularly important for children living in families with less income who otherwise would be more likely to start school behind their more affluent peers.

7.2 Limitations and future directions

The limitations of each individual study have been discussed in the relevant chapter discussions hence will not be repeated here. Here, I discuss the limitations of the study overall and potential areas for future research.

A limitation of the first study was that analyses examining time spent in particular types of child care was not possible. Whilst it would have been ideal to complete these analyses, the dataset did not allow us to create mutually exclusive child care groups. For example, to analyse the developmental effect of time spent in centre-based care we would also need to adjust for time spent in any other types of child care (e.g. family day care; nanny or relative; other) because each child could be observed in multiple types of child care in a week. Moreover, the 0 hours in the other types of child care could represent parental care only or it could represent 0 hours in that particular type of child care but 1 or more hours in another type of child care. We could not tell from the data available. Future analyses using complex statistical methods such as discrete choice models [218], that can handle multiple membership structures, could be conducted.

In the first study, we examined the cumulative time spent in all types of child care and the primary type of child care across the first three years of life. A key finding was that children experiencing centre-based child care (but not other types of child care) had higher levels of parent-reported and teacher-reported externalising problem behaviours at school entry. Further research is required to establish why centre-based child care is linked to elevated levels of externalising behaviour problems. Prior research has suggested that long hours in the presence of large groups of peers is associated with increasing externalising problem behaviours [219]. In addition to peer groups, another plausible reason that may explain why children in centre-based care experience higher parent-reported and teacher-reported externalising problem behaviours could be related to disruptions in the continuity

of care in these settings. In 2011 Gowrie SA (South Australia), a community based organisation that has provided child care and preschool services in Australia since 1940 moved to providing an integrated infant-toddler program where a smaller number of children (13 per room) at different ages develop together without the need for continual change and transitions to other age groups [220]. Assessing the effectiveness of such programs compared to usual practice may be an important direction for future research. Furthermore, the relative contribution of early and later age of entry into child care was not examined, but is an important question for future research.

The primary limitation of the studies reported in Chapters 5 and 6 was that the domains of child care quality were based on carer-reports that may have resulted in an overestimation of quality. Nevertheless, as detailed in Chapters 5 and 6, no single measure is currently accepted as a gold standard, and the domains of carer-reported quality used in this thesis are consistent with domains derived from direct observations. Developing better measures of child care quality may be a useful area for future research.

This thesis was limited to examining the quality of formal child care for children aged 2-3 years. The study of the developmental effect of child care quality for children aged 0-1 year was not possible due to data limitations. Very few infants in the LSAC were reported by parents as using formal child care for ≥8 hours per week on a regular basis. Further research is required to determine whether the beneficial effects of higher quality child care seen at age 2-3 years would hold for children aged 0-1 years. Further, the quality of informal types of child care was not examined therefore further research in this area would be worthwhile.

Australia is one of the few countries that has a national government-funded child care accreditation and quality assurance system for long day care and family day care services. Quality assurance data for each child using government accredited long day care or family day care from the National Child Care Accreditation Council has been linked to the LSAC dataset where contact details of this care were obtained from the primary caregiver. It would be of interest to investigate whether the National Child Care Accreditation Council rating of child care quality for children aged 2-3 years is associated with children's later development. This work is currently in progress.

As detailed in Chapter 2, a goal of the government's National Early Childhood Development Strategy is to build stronger evidence regarding how early childhood programs and services contribute to children's healthy development [23]. Australian policy makers are demonstrating an increasing interest in linking government administrative data across health, education and other community services to facilitate research and evaluation at the population level in the context of government objectives and targets. Whilst there has been a long history of data linkage capability in Australia there has been limited use of research based on linked data to inform government policy. The government Department of Education's Child Care Management System which collects information on child care supply and usage across Australia is one dataset that could potentially be linked to other administrative datasets such as the Australian Early Development Census, a population measure of children's development at school entry [221], so as to answer policy-relevant research questions.

7.3 Concluding remarks

This thesis began with a discussion of the growing use of child care for children during their preschool years. The preschool years were described as crucial in laying strong foundations for cognitive, social and emotional capacities on which further learning and development is built. The family home and child care environments were highlighted as the key caregiving environments where children learn and develop before starting formal education. The evidence (mainly from the USA) regarding the developmental effects of the quality, type and time spent in child care on children's development was presented. An increasing Australian government interest and investment in early childhood was outlined. However, with the demand for child care steadily growing and government commitment to improving child care, a case was made, first, for research describing the effects of different aspects of child care on children's developmental outcomes within the Australian context, and second, that there is a need to expand the evidence base relevant to the Australian setting.

The findings from this thesis present the first comprehensive, longitudinal analysis of the effect of exposure to different types of child care, length of time in child care, and quality of child care on the later development of a nationally representative sample of Australian children aged between birth and seven years. In general, the findings support overseas research that child care influences children's development in both positive and negative ways. The most important finding was that higher quality relationships in formal child care were associated with better cognitive and socio-emotional outcomes at school entry, particularly for children from disadvantaged backgrounds. Ultimately, the knowledge obtained from this thesis provides valuable evidence for parents, policy makers, government and researchers in Australia and internationally that can be used to support children's cognitive and socio-emotional development and well-being.

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