Measuring the impact of a universal childcare program on mental health and substance use behaviours in adolescents: evidence from a longitudinal cohort in Quebec

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Abstract

Background

Social inequalities in health emerge during early childhood. Interventions such as access to quality childcare services have the potential to promote child development, mitigate inequalities in health, and affect the development of human capital. The Quebec Family Policy proposed a series of new measures, including universal childcare and parental leave, and was implemented in 1997 with this objective in mind. It represents a unique opportunity to evaluate the effects of a universal and subsidized childcare program on child health outcomes and socioeconomic inequalities in health. Few studies have evaluated the long-term health effects of childcare and previous research on behavioural and mental health outcomes has produced heterogeneous results.

Objectives

The primary objective of this study was to measure the impact of Quebec's universal childcare policy, and specifically the utilization of subsidized childcare, on children's health, including mental health outcomes and substance use in adolescence. A secondary objective was to evaluate whether the impact varies across socioeconomic status (SES), given that the Quebec Family Policy's aim is to alter the distribution of social determinants of health.

Methods

Data from a longitudinal cohort of children born in Quebec between October 1997 and July 1998 (n= 2,120) was used. Primary childcare arrangement was classified as CPE care (*Centre de la Petite Enfance* affiliated settings; subsidized), non-CPE care (non-affiliated non-subsidized settings), or no formal childcare. Primary outcomes were behaviors, mental health, and substance use in adolescents at age 15, including: internalized and externalized behaviours, physical aggression, depressive and anxiety symptoms, and substance use. A multitude of child and family characteristics were included in the analysis to control for potential confounding using propensity score inverse propensity weights (PS-IPW). The association between childcare attendance,

comparing CPE-care to other childcare arrangements, and outcomes of interest, were estimated by Poisson regression with robust variance estimation or logistic regression, according to the outcome measured, and reported as average treatment effects. Finally, we examined if socio-economic status acted as an effect measure modifier between childcare arrangement and the outcomes of interest, in order to assess the implications of subsidized childcare on social inequalities in health.

Results

While baseline characteristics of participants differed significantly for key covariates including maternal education, income and employment status, we achieved comparability between participants with different childcare arrangements after PS-IPW weighting. Overall, there were no substantial risk differences in outcomes at age 15 between children exposed to CPE-type care compared to non-CPE care, and between children exposed to CPE-type care and those with no formal childcare. Likewise, the effects of childcare on reported outcomes by level of SES did not differ consistently, except for 0.14 (95%CI 0.02-0.27; p=0.02) and 0.11 (95%CI 0.01-0.22; p=0.04) increases in the probabilities of smoking and having smoked more than once per month in the past 12 months respectively, among children whose family belonged to the bottom quartile of the SES index and who attended a CPE-type care compared to those not in formal childcare; these results were not reproducible when using maternal education as the indicator of SES.

Conclusions

Overall, there was no consistent evidence that exposure to different childcare arrangements, following the implementation of the Quebec universal childcare program, influenced externalized and internalized behaviours, or substance use, in adolescence. Additionally, we did not observe differential impacts of subsidized childcare by socio-economic status on these outcomes.

Résumé

Mise en contexte

Les inégalités sociales en santé émergent dès la petite enfance. Ainsi, des interventions visant à favoriser l'accès à des services de garde (SG) de qualité ont le potentiel de promouvoir le développement de l'enfant et d'atténuer ces inégalités, affectant possiblement le développement du capital humain. La Politique familiale du Québec de 1997 a été instaurée avec cet objectif en tête. Cela représente une opportunité unique d'évaluer les effets d'un programme d'éducation à la petite enfance universel et subventionné sur la santé et les inégalités sociales en santé. Peu d'études ont évalué les effets à long terme de fréquenter un SG sur la santé et ces études ont produit des résultats hétérogènes en termes de santé mentale et de comportements à risque.

Objectifs

Le principal objectif de cette étude était de mesurer les impacts du programme universel de services de garde du Québec sur la santé des enfants, particulièrement l'impact de l'utilisation des SG subventionnés sur la santé mentale et la consommation de substances à l'adolescence. De plus, nous avons évalué si l'impact mesuré variait selon le statut socio-économique (SES).

Méthodes

Les données d'une cohorte longitudinale d'enfants nés au Québec entre octobre 1997 et juillet 1998 (n= 2,120) ont été utilisées. Le type principal de SG a été classifié en trois catégories d'exposition : « CPE » (correspondant aux SG subventionnés), « non-CPE » (SG non-subventionnés) et garde parentale. Les indicateurs suivants ont été analysés chez des adolescents de 15 ans : les comportements intériorisés et extériorisés, l'agressivité, les symptômes de dépression et d'anxiété et la consommation de substances. La méthode de pondération inverse sur les probabilités d'être traitées du score de propension (PS-IPW) a été utilisée afin de contrôler pour les facteurs de confusion potentiels. L'association entre l'utilisation d'un SG, comparant la fréquentation d'un SG de type « CPE » aux autres catégories d'exposition, et les variables

d'intérêt a été estimée par des régressions de Poisson avec variance robuste ou des régressions logistiques, et rapportée comme un effet moyen de traitement. Finalement, nous avons examiné si le SES était un modérateur entre le type de SG fréquenté et les variables d'intérêt.

Résultats

Alors que les caractéristiques des participants pour certaines variables, tel le statut d'emploi, l'éducation maternelle et le revenu, différaient significativement selon le type de SG fréquenté, la comparabilité entre les groupes a été atteinte suite à la pondération par PS-IPW. De façon générale, il n'y avait pas de différences de risque substantielles sur les variables étudiées à 15 ans, entre les enfants ayant fréquenté un SG de type « CPE » comparativement à ceux ayant fréquenté un SG de type « non-CPE » ou n'ayant pas fréquenté un SG formel. De plus, les effets de la fréquentation d'un SG ne variaient pas selon le statut socio-économique, à l'exception d'une augmentation de 0.14 (95%CI 0.02-0.27; p=0.02) et de 0.11 (95%CI 0.01-0.22; p=0.04), respectivement, de la probabilité de fumer la cigarette et d'avoir fumé plus d'une fois par mois dans les derniers douze mois, parmi les enfants provenant du quartile inférieur du score indexé du statut socio-économique fréquentant un service de garde de type « CPE » comparativement à ceux n'ayant pas fréquenté de SG formel. Ces résultats n'ont toutefois pas été observés en utilisant le niveau d'éducation maternelle comme indicateur du SES.

Conclusions

Nous n'avons pas détecté de preuves consistantes à l'effet que l'exposition à différents types de SG, suivant l'introduction du programme de garderies subventionnées au Québec, avait influencé les comportements intériorisés et extériorisés, ainsi que la consommation de substance à l'adolescence. De plus, il n'y avait pas de preuves consistantes de l'impact différentiel de la fréquentation d'un SG sur l'ensemble des indicateurs étudiés selon le SES.

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Contribution of authors

Catherine Verreault developed a research question and protocol in collaboration with the research group, analysed the data, interpreted the results and wrote the thesis.

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List of abbreviations

ATE	Average treatment effect
ATT	Average treatment effect on the treated
BEEP	Brookline Early Education Project (USA)
CCPC	Chicago Child-Parent Center (USA)
CNLSY	Children of the National Longitudinal Survey of Youth (USA)
CPE	*Centre de la Petite Enfance*
ECLS	Early Childhood Longitudinal Study (USA)
EMEP	*Enquête sur la maturité scolaire des enfants montréalais (*Quebec)
EPPE	Effective Provision of Pre-school Education (England)
LSYPE	Longitudinal Study of Young People in England
MI	Multiple imputation
MICE	Multiple imputation using chained equations
NCDS	National Child Development Study (England)
NICHD SECCYD	National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (USA)
NLSCY	National Longitudinal Survey of Children and Youth (Canada)
PS	Propensity score
PS-IPW	Propensity score – Inverse probability weights
QLSCD	Quebec Longitudinal Survey of Child Development (Quebec)
QPIP	Quebec Parental Insurance Plan
SES	Socio-economic status

Preface

Overview of thesis

This thesis is divided in six chapters. The introduction provides the reader with an overview of the history of childcare development in Quebec as well as with the rationale and objectives of the study. Chapter two presents a review of the literature on the effects of childcare on child development, focusing particularly on mental health and behavioral outcomes in older children. Chapter three presents the QLSCD and details the methods used in this study, including the use of propensity score methods to address some of the issues discussed in the childcare literature, namely confounding and selection bias, and the use of multiple imputation to compensate for missing data. Chapter four summarizes the overall findings while chapter five presents the interpretation and discussion of the results of these analyses, including discussing the limitations and potential implications of this study. Finally, chapter six contains concluding remarks, followed by a complete list of references and supplementary material. This thesis conforms to the guidelines and requirements of a chapter-based thesis at McGill University.

1. Introduction

Brief overview of the Quebec Childcare Policy

In 1997, the government of Quebec adopted a Family policy (Gouvernement du Québec, 1997), which included the introduction and development of a universal, publicly funded childcare program, with the specific goals of fostering equal opportunity for all children and meeting the growing needs of mothers who wished to return to work. The program was designed to combat social inequality, promote optimal development in early childhood for all children and facilitate work-family balance (Gouvernement du Québec, 1997), through providing low-cost subsidized childcare spots with high quality standards (Giguère et al., 2010).

By providing subsidies so that childcare expenses are limited to a certain amount, the Quebec program differs from most other universal childcare programs, where childcare or prekindergarten spots are allocated directly to children and their parents. It is also unique within Canada: Quebec is the only province offering a large-scale subsidized childcare program. All childcare centres in Canada are licensed by their respective provincial government, however inter-provincial standards and how these are enforced vary (Romano et al., 2010).

Initially, spaces were allotted for 4-year-old children to attend subsidized childcare ($5/day at first) and the program was progressively extended to children aged 0-5 years, until 2000. In 2004, fees increased from 5$ to 7$ per day, and then to 7.30$ in 2014. That same year, the Quebec government also introduced a fee structure modulated by family income. With initially 77,000 places in 1997, the total number of subsidized spaces progressively increased, to 232,000 in March 2017, and are complemented by 61,400 non-subsidized childcare spots (Ministère de la Famille du Québec, 2017).

Regulated childcare services are mandated to follow some operating standards, including the obligation to have trained workers, follow an educational program, and have a maximum ratio of

children-to-worker depending on the age of children. Regulated subsidized spaces are provided through educational childcare centres *(Centre de la Petite Enfance* or *CPE)*, private childcare centres, and CPE-affiliated home childcare. The Quebec childcare system also permits regulated private childcare centres and home childcare, both non-subsidized. Private childcare centres, whether they offer subsidized spots or not, are generally for-profit businesses. While the number of spots in private childcare was initially strictly regulated, the Government of Quebec lifted the moratorium in place in 2003, allowing the growth of private for-profit childcares, while the development of new subsidized spots and new CPE installation was slowed. It greatly modified the allocation of spots in different types of childcare settings since, increasing the proportion of children in non-subsidized childcares, and decreasing the overall proportion of children in CPE-care. As of March 2017, about one third of available spaces in the province of Quebec were in a CPE, while 21% were in non-subsidized childcares (from about 1% in 1997), 32% were in subsidized home childcares and 16% in subsidized private childcares (Ministère de la Famille du Québec, 2017).

Following the implementation of the program, maternal employment and the use of non-parental childcare rose significantly in Quebec (Baker et al., 2008; Haeck et al., 2015; Lefebvre et al., 2011). Haeck et al. (2012) report that, from the mid-1990s until 2008, the proportion of children between 1 and 4 years who attended a center-based childcare rose from 10% to about 60% in Quebec, while it increased from 10% to 20% in other provinces. In contrast, the proportion of children under parental care went down from 55% to about 25% in Quebec, while it remained unchanged around 50% in the rest of Canada. Studies investigating the effect of the program have been mixed and will be briefly reviewed in the next section. During the same period, another major aspect of the Quebec Family policy was launched: the Quebec Parental Insurance Plan (QPIP) was introduced in 2006 and provided income replacement, to a certain limit, to parents (including fathers) during the first year of life of their child.

It is worth noting, and should be kept in mind, that the Quebec Longitudinal Survey of Child Development (QLSCD) was launched when the Quebec Family policy was being implemented. The

availability of childcare spots was increasing rapidly at that time, and children participating in the QLSCD became eligible to access a subsidized spot in 2000, in wave 3 of the survey, when they were approximately 2 ½ years old.

Brief definitions of different types of childcare (Giguère et al., 2010)

A *Centre de la Petite Enfance* (CPE) is a not-for-profit legal person or cooperative, which offers spaces at a reduced parental contribution in a center-based setting.

Private childcare centers are usually for-profit businesses providing daycare services. Some receive subsidies from the government to provide low-cost spaces (referred to as subsidized childcare), while others set their own daily fees, even if regulated (non-subsidized).

Home childcare is run by a self-employed worker who provides childcare services in a private residence and is recognized by a coordinating office (affiliated with CPEs). These are usually subsidized spaces and are regulated by law. A maximum of 6 children, of whom no more than two are under 18 months, are permitted. However, if an assistant is present, 9 children including four under 18 months of age are allowed. Although some of the non-subsidized home childcares are regulated, others are unregulated by law, are not affiliated to a coordinating office and do not require to obtain a permit from the Ministry if they provide services to a maximum of 6 children.

In this manuscript, we will use the following terminology to refer to the different types of childcare: CPE, CPE-affiliated home childcare, non-subsidized home childcare, non-subsidized childcare center and private subsidized childcare center. Moreover, the different exposures, described in detail in the Methods section, are referred as “CPE”, “non-CPE” and “no childcare”. Table 2 describes which types of childcare are included in each exposure group, based on the terminology used in the QLSCD.

Rationale

Work-family policies, including affordable childcare, represent an important intervention for improving child health, as access to affordable childcare might improve child health outcomes and favor child development. The province of Quebec has a distinctive approach to childcare policies. The implementation of the Quebec subsidized childcare program in 1997 (Giguère et al., 2010; Gouvernement du Québec, 1997) provides a unique opportunity to evaluate the effects of this policy on child health outcomes and on socioeconomic inequalities.

Significant resources toward developing early-childhood policies have been devoted by governments in many countries, with the ultimate goal of improving the well-being of children. It is hypothesized that this objective could be achieved either through the direct effects of preschool education on children, through the indirect impact of preschool on maternal employment and income, or both. While the importance of the development of cognitive skills during this period has been established, it is now recognised that socio-emotional and behavioral development are shaped in early life as well (Apps et al., 2013). Labour market outcomes (wages and employment) and educational attainment have been linked to factors and skills, such as early cognitive skills, that are already in place by adolescence (Apps et al., 2013).

From a public health perspective, the potential benefits of early child development should be emphasized. Since social inequalities in health emerge during pregnancy and early-childhood (Najman et al., 2004) and have long term effects (Heckman, J. et al., 2013; Nandi et al., 2012; Yang, S et al., 2007), early child development represents a unique window of opportunities to mitigate socioeconomic inequalities in health and improve the health, well-being and development of at-risk children. Particularly, high quality childcare programs are hypothesized to support the development of important abilities, like language and socio-emotional skills, motivation, self-discipline and self-regulation, which have been linked to better employment, improved social outcomes, physical and mental health, as well as general well-being in adults (Cunha et al., 2007; Heckman, James J., 2007). Economic studies have also highlighted the long-term economic advantages of investing in early childhood education, especially for children from

disadvantaged backgrounds, promoting equity and productivity in the economy and society, and having positive return on investments (Community Preventive Services Task Force, 2015; Garcia et al., 2016; Heckman, J. J., 2006; Heckman, J. J. et al., 2010; Karoly et al., 2016). As such, public policies targeting the preschool period have a great potential in mitigating socioeconomic inequalities and fostering children development (Côté, Sylvana M et al., 2007; Geoffroy, M. C. et al., 2007; Havnes et al., 2011). However, while short-term outcomes have been studied more extensively, evidence of the long-term effects of childcare on cognition and more particularly non-cognitive development is more limited and heterogeneous, which is an important knowledge gap. These topics will be discussed in more details in the next section.

Objectives

While the effect of childcare on cognition and scholastic achievement is more widely recognized, few studies have evaluated the health effects of childcare, and previous research has produced heterogeneous results in terms of physical (Campbell, F. et al., 2014; Geoffroy, M.-C. et al., 2013) and mental health outcomes (Kottelenberg, M. J. et al., 2013), especially among older children. Mixed findings might be attributable to variety in definitions of "exposure" and target populations. The primary objective of this study was to measure the impact of Quebec's universal childcare policy, and specifically the utilization of CPE-care, on children's health outcomes, including mental health and substance use in adolescence, given the importance of these outcomes for adult functioning (Hale et al., 2015). A secondary objective was to evaluate whether the impact varies across socioeconomic status (SES), given that the Quebec Family Policy's aim is to alter the distribution of social determinants of health.

2. Literature review

Quality childcare experiences, as part of meaningful early-life environments, have drawn much attention and enthusiasm as a potential means to impact later-life outcomes, particularly educational, health and well-being, socio-emotional and behavioral outcomes. Overall, while childcare attendance has been demonstrated to have significant effect on school readiness and cognition in childhood (Côté, S. M. et al., 2013; Esping-Andersen et al., 2012; Geoffroy, M. C. et al., 2010; Loeb et al., 2007), the evidence of an impact in adolescence and adulthood is heterogeneous: some studies have reported positive long-term effects of early intervention on school completion, economic outcomes and employment (Campbell, F. A. et al., 2012; Carneiro et al., 2014; Heckman, J. et al., 2010; Heckman, J. J. et al., 2010), while others report worse non-cognitive outcomes (Baker et al., 2015). Some studies have also seen a reduction in crime rate, but results are inconsistent (Baker et al., 2015; Campbell, F. A. et al., 2012; Carneiro et al., 2014; Deming, 2009). Small scale trials in the United States targeting disadvantaged children (i.e. Perry preschool project) have shown good evidence that early childhood education can improve child outcomes and that benefits exceeds the cost (Ruhm et al., 2012). With exceptions, most of these results were not obtained from universal programs, but rather small programs targeting disadvantaged children. Consequently, the generalizability of these results has been questioned.

The literature surrounding the effect of childcare on child development will briefly be reviewed here, with a focus specifically on mental health outcomes and behavioural issues in adolescence and adulthood. The definition of childcare was intentionally broadly defined to encompass all types of early childhood programs, attended before the start of primary education, since it varies greatly across contexts. Universal programs, such as the Quebec childcare program, versus large-scale programs (ex: Head Start) or small intensive programs (ex: Perry Preschool program) targeting a specific population will be differentiated. The pathways by which effects might have occurred will be examined briefly, including quality of childcare. The challenges and limitations of studies in the field will be discussed as well. These aspects will be addressed keeping in perspective the issue of social inequalities in health.

2.1. Gap in providing childcare for those most at risk: children from low SES family

Early childhood represents a key stage for skills acquisition, and this window of opportunity is more important for high-risk children (Campbell, F. A. et al., 2012). Although family characteristics generally have a greater impact on child development than being in non-maternal care (Babchishin et al., 2013; Belsky, Jay et al., 2007; Romano et al., 2010), attending childcare appears to have a larger positive influence than social disadvantage on high-risk children (NICHD Early Child Care Research Network, 2002). In a systematic review, Burger (2010) reviewed the effect of childcare on cognitive outcomes and found that, compared to their peers, children from disadvantaged background attending childcare made at least as much cognitive progress, and often more progress, than their more advantaged peers, highlighting the potential of childcare programs to compensate for socio-economic inequalities.

Likewise, many studies in the literature have underlined that disadvantaged children benefit the most from early childhood education, by improving an array of cognitive and non-cognitive outcomes (Babchishin et al., 2013; Duncan et al., 2013; Geoffroy, M. C. et al., 2010; Ruhm et al., 2012; Schweinhart et al., 2005; Sylva et al., 2004). On an economic level, the long-term effects of universal childcare programs appear to vary across the outcome distribution, benefiting primarily children from low-income families, and was shown to increase intergenerational income mobility (Havnes et al., 2015). Furthermore, based on data from targeted and intensive programs, the rate of return to investment in human capital of disadvantaged children was shown to be the highest during the pre-school period (Heckman, J. J., 2006). Early intervention can therefore reduce disparities in health, leading to better health and improved socio-economic status across the life course (Braveman et al., 2009; Reynolds et al., 2011a).

Cornelissen et al (2018) underline the heterogenous treatment effects of attending childcare, as disadvantaged children were less likely to attend childcare than children from advantaged backgrounds, but benefit the most, because their counterfactual, when not enrolled in childcare, is worse. Similar observations were made in Canada, where children from low SES families were

more likely to be in maternal care and performed lower on cognitive test at school entry. Specifically in Quebec, children of mothers with low education (no high school diploma) are less likely to attend formal childcare (Geoffroy, M.-C. et al., 2012; Geoffroy, M. C. et al., 2007). However, attending childcare reduces observed cognitive inequalities (Geoffroy, M. C. et al., 2007) at school entry.

2.2. Quality of childcare

Quality is defined by a set of criteria, divided between structural and process variables, that foster the physical, social, cognitive and emotional development of children (Japel et al., 2005). Structural variables include caregivers' qualifications, ongoing professional development activities, job satisfaction, adult-child ratio, group size, as well as the physical environment, material, and educational program. Process variables relate to the quality of the interactions between children and the caregiver, parents and the caregiver, as well as the extent to which the caregiver provides a stimulating and safe environment (Bigras et al., 2009b; Japel et al., 2005; Massé et al., 2016; Romano et al., 2010).

Conditional on childcare attendance, children from disadvantaged families are less likely to receive quality childcare, whereas higher SES families are more likely to use higher-quality childcare (Burchinal et al., 2000; Japel et al., 2005). However, high-quality childcare can serve as a protective factor for high-risk children, including those with mothers experiencing mental distress or coming from low SES families, acting as a buffer against the negative effect of the home environment (Bradley et al., 2007; Burger, 2010; Dearing et al., 2009; Love et al., 2005; McCartney et al., 2007; Votruba-Drzal et al., 2010) and even improving the home environment (McCartney et al., 2007).

In many countries, quality varies between the different types of childcare, with integrated center-based childcare generally obtaining the highest rating (Li-Grining et al., 2006; Sylva et al., 2004). In Quebec, CPEs have been shown to offer on average the highest quality, followed by CPE-affiliated home childcare. Non-subsidized childcare centers and non-regulated home daycares

are, on average, of the lowest quality (Bigras et al., 2009b; Drouin et al., 2004; Gingras et al., 2015a, 2015b; Japel et al., 2005). However, it is important to note that in Japel's study (2005), the majority of childcare services obtained a quality score of "minimal", raising concerns. Interestingly, while children with low SES were more likely to attend childcare services of lower quality, there was no differences in the quality of CPEs located in disadvantaged neighbourhoods compared to more privileged neighbourhoods (Japel et al., 2005).

2.3. Cognitive outcomes

Early childhood

Most studies evaluating the effects of childcare attendance on young children or primary school children show improved school readiness, cognition, and academic performance, as summarized in a systematic review by Burger (2010). Long-term effects are somewhat smaller, but still present.

Some heterogeneity, however, exists across studies. Evaluating the effect of Quebec's "low-cost" daycare policy , as opposed to direct childcare attendance, both Haeck et al. (2015), Lefebvre et al. (2011; 2008) and Baker (2008) reported no significant improvement or even negative effects on school readiness and literacy skills at age five, using Canada's National Longitudinal Survey of Children and Youth (NLSCY) data. Herbst (2010) obtained similar negative results when looking at the receipt of subsidies the year prior to kindergarten and cognitive outcomes and behavioral problems at kindergarten entry, using the Kindergarten cohort of the Early Childhood Longitudinal Study (USA).

Multiple studies have also found positive effects of large-scale childcare programs on cognitive development, in Canada and internationally. In Canada, also using the NLSCY, studies have established an association between childcare attendance and language development, and highlighted the moderating role of quality (Côté, S. M. et al., 2013) and SES (Geoffroy, M. C. et al., 2007). Similar results were obtained using the QLSCD: children from low SES (who had a mother

with a low education level) had lower scores on school readiness and achievement tests at 6 and 7 years old, unless they attended a formal childcare in the preschool period (Geoffroy, M. C. et al., 2010). At the population level, attending any childcare service was shown to reduce social inequalities in academic achievement up to early adolescence (12 years old), and even eliminate them if the child had attended a center-based childcare (Laurin, J. C. et al., 2015). Analyses were performed using propensity score sample weights and multiple imputation, and accounting for a large number of confounding variables (Laurin, J. C. et al., 2015). These studies, however, did not differentiate between the different subtypes of childcare (CPE or not). The EMEP (Enquête montréalaise sur l'expérience préscolaire des enfants de maternelle) (Laurin, I. et al., 2015) provides more recent data : the survey was conducted in 2011-2012 in Montreal with a representative sample of kindergarten children. In their model, those from low SES background who attended a CPE were relatively less vulnerable in one domain or more of their development in kindergarten, compared to those who never attended one (3.3 times less) and to those who attended other types of childcare (2.5 times), regardless of the intensity of exposure and age of entry. These results suggest that exclusively attending a CPE serves as a protective factor in the development of children from vulnerable backgrounds and has the potential to decrease social inequalities.

Most international data also show positive impacts of universal early childhood education. In the United States, the Task Force on Community Preventive Services strongly recommends early childhood education programs for high risk children, based on the findings from meta-analysis showing improved cognitive outcomes and school readiness (Anderson et al., 2003). The National Institute of Child Health and Human Development Study of Early Child Care and Youth Development (NICHD SECCYD) showed a positive association between high-quality childcare and improved academic test scores up to third grade (NICHD Early Child Care Research Network, 2002, 2005). In the United Kingdom, the Effective Provision of Pre-School education (EPPE) cohort was launched in 1997 and included a sample of 3000 children attending a range of different pre-schools. At age 7, authors found a positive impact on cognitive and social development,

particularly for children coming from disadvantaged background and the effect was larger if the childcare had a strong educational focus (Sylva et al., 2004).

Universal preschool expansion, in Argentina and Germany, had positive effects on cognition and school readiness, particularly for children living in more impoverished areas (Berlinski et al., 2009) and children of immigrant descent (Dustmann et al., 2013), potentially decreasing inequalities. Other positive short-term cognitive outcomes are widely reported in the literature (Berlinski et al., 2008; Fitzpatrick, 2008; Gormley et al., 2005; Gormley et al., 2018; Loeb et al., 2007; Melhuish et al., 2008)

Late outcomes

Targeted programs

A few small, but well-known programs in the United States have targeted high-risk children and have shown sustainable impacts into adolescence and adulthood. The Carolina Abecedarian Project findings support the importance of the early childhood period as a key stage for the acquisition of cognitive skills (Campbell, F. A. et al., 2012). The project mainly enrolled African-American children living in high risk families, randomizing them to high-quality center-based childcare from infancy or a control group (Campbell, Frances A. et al., 1995). At age 15 and 21, school performance and educational attainment were significantly better amongst teenagers exposed to the program (Campbell, F. A. et al., 2001; Campbell, Frances A. et al., 1995). The follow up of 30-year-old showed that individuals in the treatment group completed significantly more years of education (Campbell, F. A. et al., 2012). The Child-Parent Center (CPC) Education Program was a publicly funded program in Chicago providing services for disadvantaged minority children born in 1980 and included a preschool and school-age component. By age 20, those in the preschool program had overall greater educational attainment (Reynolds et al., 2001). Finally, the Perry Preschool program is a small but unique study conducted in Michigan in the 1960s that enrolled mainly African American children (n=123) with low IQ from a low SES background and randomized them into treatment (intensive childcare program starting at age 3) or control

(parental choice for childcare). Results of a 40 year follow up, cognitive and non-cognitive impacts of the program have been assessed: it boosted academic motivation, particularly in girls, which appears to mediate the positive effect of the program on educational attainment and test scores (Heckman, J. et al., 2010; Heckman, J. et al., 2013; Schweinhart et al., 2005).

Universal programs

Large-scale, universal programs have also been shown to have sustained beneficial effects on cognition. Data from the Longitudinal Study of Young People in England (LSYPE) and National Child Development Study (NCDS) in England showed moderate increases in cognition in adolescents who attended preschool (Apps et al., 2013; Goodman et al., 2005). It was particularly beneficial for girls and for children with disadvantaged socio-economic backgrounds (Apps et al., 2013). Sylva et al. (2012), using the EPPE (England), found an association between preschool attendance and better achievement in math and science at age 14 . In Sweden, preschool attendance was found to close the gap in language test scores at age 13 between children of immigrants and Swedish-born parents, for children born between 1967 and 1982 (Ruhm et al., 2012). In the United States, findings from the NICHD SECCYD suggests that center-based care and high-quality childcare were linked to better educational attainment in high school (Vandell, D. L. et al., 2010; Vandell, Deborah Lowe et al., 2016).

In many countries, changes in childcare provision provided an opportunity to study the effect of childcare expansion. In Denmark, preschool density, following expansion in the late 1970's and early 1980's, was positively associated with completion of schooling and earnings at age 22-30, with a larger effect for disadvantaged children, particularly girls (Ruhm et al., 2012). Similarly, preschool expansion in France in the 1960's and 1970's had a positive impact on test scores, high school graduation rates and adult wages, with a larger effect for children from disadvantaged or intermediate backgrounds (Dumas et al., 2012). Difference-in-difference methodology to study the expansion of subsidized childcare availability in Norway, shifting the use of informal care to formal childcare, showed increased educational attainment and labor market participation and lower welfare use for participants in their early 30s, again with larger effects for girls and children

of less educated mothers, suggesting a role for childcare to reduce the gender wage gap and increase intergenerational mobility (Havnes et al., 2011). Childcare attendance was also found to have a positive effect on Norway's national exam grades at the age of 16, more so for children from low-income families (Black et al., 2014). Finally, in Spain and Uruguay, studies of universal subsidized childcare expansion in the 1990s provided strong evidence for improved reading skills (Felfe et al., 2014) and increased grade completion at age 15, with larger effects if parents were less educated (Berlinski et al., 2008).

2.4. Non-cognitive outcomes

Theoretically, early childcare education represents a unique opportunity to target factors protecting against externalizing behavioral problems and antisocial behavior later in life (Schindler et al., 2015). Externalizing behavior refers to conduct disorders, antisocial behaviour and general aggression. On the other hand, internalizing behavior includes depression and anxiety (Duncan et al., 2013). In the literature, mental health conditions in adolescents have been linked to poorer education and employment outcomes in adulthood (Hale et al., 2015). Moreover, childhood and adolescent externalizing behaviors have been associated with adult substance abuse and antisocial behaviors, as well as internalizing problems in young adulthood, through a series of developmental pathways (Masten et al., 2005; Matt McGue et al., 2005; Weeks et al., 2016). Depression is a significant burden to society, affecting individuals of all age, with significant consequences. From an economic point of view, individuals affected by depression can suffer from employment difficulties and loss of income (McLaughlin 2007).

Studies showed contradictory effect of early childcare programs on socio-behavioral outcomes: both positive and negative relationships are observed. A meta-analysis showed that early childhood education programs with greater emphasis on socio-emotional development were associated with positive effects on behavioral problems (Schindler et al., 2015). Systematic reviews of the literature on the effects of center-based preschool highlighted evidence of positive impacts across the majority of behavioral outcomes and findings suggestive of a reduction in depressive symptoms in adulthood (D'Onise, K. et al., 2010), but the direction and magnitude of

the impact on child and teenager outcomes were more heterogenous, and relied on studies of lower quality with higher risk of bias (D'Onise, Katina et al., 2010). Although the evidence is weak, their analysis suggested a possible small beneficial effect of attending center-based childcare on social competence and mental health outcomes in a high-quality setting, and a lack of evidence to show a decreased risk of alcohol and drug use in adolescence.

Early childhood

A few studies have investigated the effect of the Quebec childcare policy on children behavioral outcomes. Baker (2008), using a difference-in-difference strategy comparing children in Quebec and the rest of Canada before and after program implementation with the NLSCY data, found negative effects of the program on anxiety and physical aggression scores, a social and motor development score and health outcomes (general health, ear and throat infections) of preschool children. In addition, their analyses suggested that parenting practices and family functioning were negatively affected. They hypothesized that the observed effect could be due to the increase in maternal labor supply leading to a change in parenting or to an increase in poor quality childcare spots. While this study examined the impact of access to a universal child-care program, analogous to an intention-to-treat effect, it didn't evaluate the impact of actual childcare attendance and use (Kottelenberg, M. J. et al., 2013). Kottelenberg (2013) attempted to reproduce Baker's results using later cycles of the NLSCY, and their findings were more heterogeneous. Although the intention-to-treat analysis yielded similar negative results on developmental, behavioural and health outcomes as Baker up to 10 years after the reform, evaluation of the impact of subsidized child-care receipt using an instrumental variable approach showed heterogeneity between estimates. In this case, negative results were driven by children who only attended childcare in response to the implementation of the Quebec Family Policy, suggesting that some groups may benefit more from childcare than others. Finally, using an IPW approach to restore conditional randomization, effects on child behavioral outcomes were null and attending childcare positively influenced motor-social development scores, on average (Kottelenberg, M. J. et al., 2013).

Others have obtained opposite results compared to Baker and Kottelenberg. Bigras et al (2009a) found lower internalizing behavioral problem scores for Quebec preschool children attending childcare compared to those not in childcare, with lowest scores found for children in a structured childcare, although differences for externalizing behavioral problems were not apparent. Herba et al. (2013) observed that regulated childcare served as a "buffer" and reduced the risks of internalizing problems amongst Quebec preschool children whose mothers displayed elevated depressive symptoms. Using the QLSCD, Côté et al (2007) showed that children of mothers with lower levels of education attending childcare decreased their risk of high physical aggression up to 60 months of age, with larger effect sizes if childcare was initiated prior to 9 months.

Other studies have highlighted differential impacts of childcare on behavioral problems. For example, Canadian data, based on the NLSCY, showed that childcare in the first year of life may be associated with higher levels of physical aggression and emotional problems for 4 years old girls from low-risk families (small to moderate effect size), suggesting a gender difference (Côté, S. M. et al., 2008). Research has evaluated the effect of childcare type, quantity and quality, also in the first year of life, on behavioral outcomes at 6-7 years: attending a regulated compared to an unregulated childcare environment was associated with less hyperactivity-inattention. Surprisingly, the same study found that center-based care attendance in the first year of life increased hyperactivity-inattention, compared to home-based care, suggesting that the decrease in observed level of hyperactivity-inattention was driven by children in regulated home-based care. This effect was modified by childcare quality and family characteristics (Babchishin et al., 2013). Children attending childcare were found to be less shy and socially withdrawn, but more oppositional and aggressive at school entry, compared to children exclusively in parental care (Pingault et al., 2015). These differences disappeared by the end of elementary school. However, these studies do not precisely assess the impact of the Quebec Family policy and specifically attending a CPE or a subsidized childcare.

Similarly, differential impacts of childcare on behavioral outcomes are observed in other countries as well. Following the expansion of the Danish childcare program, children attending

universal high-quality center-based preschool at the age of three had similar behaviors at age 7 to those not in childcare, whereas those in home-based childcare displayed more behavioral problems (Datta Gupta et al., 2010). These results were mainly driven by boys of mothers with low education. In Germany, expansion of the universal childcare programs showed that children least likely to attend childcare centers, namely boys and those coming from disadvantaged families, gained the most in terms of socio-emotional skills development (Felfe et al., 2018). In two large US cohort, center-based care was associated with greater socio-behavioral issues at kindergarten entry (Coley et al., 2013; Loeb et al., 2007) and externalizing problems through sixth grade (Belsky, Jay et al., 2007). Yet, Loeb et al. (2004) found no association between center-based childcare and externalizing behavioral problems between age 12 and 42 months for children coming from low-income families.

Other than the type of care, the amount of time in childcare also seems to impact child behaviors, since studies from the NICHD showed that the amount of time spent in non-maternal care was associated with higher behavioral problems until the end of kindergarten (NICHD Early Child Care Research Network, 1998, 2003). However this effect faded out during primary school and differences were not observed by age 12 (NICHD Early Child Care Research Network, 2005).

Finally, evaluation of small targeted programs revealed overall positive outcomes. Higher quality of childcare, and not childcare type specifically, predicted lower behavioral problems in elementary school, especially for boys and African American children, using the Three-City Study data targeting low income children in the United States (Votruba-Drzal et al., 2010). The Chicago Child-Parent Center (CPC) educational program expansion phase, a preschool intervention for children living in high poverty neighbourhood, also improved socio-emotional development, on top of literacy, physical health and parental involvement (Reynolds et al., 2016b), showing that a publicly funded program expansion can be effective.

Late outcomes

Targeted programs

Long-term follow-up of small targeted American programs have mostly shown positive lasting impacts or neutral effects on non-cognitive outcomes. For example, McLaughlin et al. (2007) showed that individuals enrolled in the treatment arm of the Abecederian project displayed significantly fewer depressive symptoms at age 21 than their counterparts in the control group. More specifically, children living in a low-quality home environment but assigned to the treatment group had fewer depressive symptoms than those in the control group. This suggested that quality childcare programs could potentially mitigate the effect of the home environment on depression in early adulthood, in a low SES population (McLaughlin et al., 2007). Individuals in the treatment arm were less likely to smoke marijuana, and less likely to be teen parents at age 21. There found no difference in criminal activities at age 21 and 30 (Campbell, F. A. et al., 2012; Campbell, F. A. et al., 2002). However, the analysis by Garcia et al. (2016) differed slightly and they argued that the program had beneficial impacts on crime reduction. Moreover, they calculated a benefit-cost ratio of 6.3 and an annual rate of return of 13%.

Heckman (2010; 2013) and Schweinhart (2005) highlighted the beneficial long-term effect of the Perry Preschool Program on non-cognitive outcomes, including employment, earnings, health behaviors, and criminal activity. Re-analysis of the program accounting for compromised randomization, the large number of outcomes studied, and small sample size, showed a strong effect for economic outcomes (employment, earnings), as well as decreased criminal activity (number of arrests and jail sentences) for males and females at various ages in adulthood (up to 40 years old) (Heckman, J. et al., 2010). The effect of the program on labour market outcomes, behavioral risk factors and criminal activity in adulthood was primarily mediated through improvements in externalizing behavior in primary school (Heckman, J. et al., 2013). Moreover, the estimated annual social rate of return of the program was 7% to 10% per year, meaning that for each dollar invested, 7 to 12$ returns to society, supporting the hypothesis that economic

benefits derive from investing in a strong early childhood education program (Heckman, J. J. et al., 2010).

The Brookline Early Education Project (BEEP) was a community-based family-centered program, with a health and educational component, that provided services to children born between 1973 and 1978 and their families, in Boston and Brookline, up to kindergarten entry. A total of 282 children were enrolled in the study initially (Palfrey et al., 2005). Short term follow-up showed evidence of a positive effect on social development and learning abilities. Follow up of participants also occurred at age 25 (n=120), and comparison subjects were young adults living in the same area matched to meet certain characteristics of the BEEP participants. The authors concluded that BEEP participants living in an urban setting (vs suburban) had higher educational attainment, income, better health and well-being – including less depression and more positive health behaviors (a composite score including substance use) – compared to their counterparts (Palfrey et al., 2005).

By age 20, participants in the preschool program of the Chicago Child-Parent Center (CPC) Education Program showed lower rates of juvenile and violent arrest (Reynolds et al., 2001). In addition to fewer depressive symptoms for the treatment group, similar effects were observed at age 24 (Reynolds et al., 2007). By age 28, compared to children who attended full day kindergarten (regular programs), participants attending the preschool program (n=989) had higher educational attainment, income, SES, and health insurance coverage, as well as lower levels of substance abuse and involvement in the justice-system (Reynolds et al., 2011a). The largest effects on outcomes were observed for men and those with low-educated parents. Authors used a quasi-experimental design and inverse propensity score weighted analysis to account for potential biases due to attrition and confounding. By targeting low-income children with this intervention, the authors argued that their findings strengthened the evidence that a publicly funded early education program is a cost-effective strategy to promote well-being, because of the enduring effects found in the program (Reynolds et al., 2011a). Economic benefits

exceeded the cost of the program, creating a positive return on investment of 10.83$ per dollar invested for society (Reynolds et al., 2011b).

The Head Start Program, initially launched in 1965, aimed to provide services to all preschool children living in poverty across the United States. These services were regulated through the Head Start Act and were provided through center-based or home-based programs, or a combination of both (Carneiro et al., 2014). Long-term impacts of the Head Start program on the behaviors, symptoms of depression and criminal activities of male adolescents and young adults who were born between 1977 and 1996 were shown to be positive (Carneiro et al., 2014). Deming (2009), however, evaluated the long-term impact of the Head Start program by comparing siblings with different exposure and found no impact on criminal activity.

Universal programs

While, as illustrated, the positive long-term effects of high-quality early education programs targeting high-risk individuals in the United States have been fairly well described, the literature available on long-term impacts of universal programs is more heterogenous and scant.

In Canada, Baker and colleagues (2015) reported worsening self-reported health and life satisfaction among teens, as well as increased criminal behavior and crime rates among those exposed to the Quebec universal childcare program, compared to teenagers in other Canadian provinces, using a difference-in-difference approach. These effects were mainly observed in boys. Data comes from multiple datasets, and effects for a particular outcome were sometimes inconsistent across datasets. Exposure was defined as being exposed to the childcare policy, however actual childcare attendance was not evaluated.

Data from the LSYPE, a large English cohort of children born in 1990 and selected in 2004 through their school, revealed that preschool frequentation was not linked to better non-cognitive outcomes, using propensity score matching (Apps et al., 2013). Outcomes measured included intention toward tertiary education, risky behaviours, economic activity in early adulthood (20-

21yrs old), personality traits, mental health and aggressive behaviors. Information on childcare attendance was collected retrospectively, with no details available, therefore authors were estimating an average exposure effect that was potentially subjected to recall bias. In contrast, the EPPSE project (Effective pre-school, Primary and Secondary education), again in the UK, followed approximately 3000 children, starting in 1997. The quality of pre-school weakly predicted socio-behavioral outcomes at age 14 (self-regulation, pro-social behaviors, hyperactivity and anti-social behaviors), as well as math and science achievement (Sylva et al., 2012).

In a large American non-experimental field study, the NICHD SECCYD, high-quality childcare predicted less externalizing behavior at age 15, after controlling for child, maternal and family covariates in early and middle childhood and adolescence, as well as better academic achievement (Vandell, D. L. et al., 2010). However, longer hours in care, but not type of care, was associated with impulsivity and greater risky behaviors, including substance use and petty crime. Participants in the study represented an economically and geographically diverse group of American children who attended regular childcare in their communities, including low- and high-income children. Using the same sample and outcomes, Belsky et Pluess (2011) highlighted the interaction between childcare quality and infant temperament in predicting self-reported externalizing behaviors, with lower externalizing problems at 15 years for children with highly difficult temperament in infancy if they attended a high-quality childcare. In a follow-up study, the relation between childcare and adolescent functioning at the end of high school was examined: the effect of childcare on teen behaviour was moderated by gender, as center-based care was associated with better impulse control and decreased risk taking for girls (Vandell, Deborah Lowe et al., 2016).

2.5. Challenges in the field

It is important to note that childcare characteristics, such as quantity, type, and quality of childcare, can potentially impact behavioral outcomes

Studying the impact of early childhood education can be challenging, given the various influences arising at different levels and their interactions that affect child development, according to the ecological model of development of Bronfenbrenner (1989). It has been hypothesized that positive effects of childcare could be mediated through many paths, such as exposure to literacy and numeracy, acquisition of language skills, socialisation, increased self-confidence and independence, self-regulation and routines (Apps et al., 2013; Schindler et al., 2015). Quality of care, quantity of care and types of care are all possible pathways through which childcare can potentially influence children's development, including behavioral outcomes (Babchishin et al., 2013), and effects are thought to be moderated, amongst others, by age of entry (Lekhal, 2012) and family characteristics (Côté, S. M. et al., 2008). It is also possible that the effects of childcare disappear over time or are confounded by subsequent life events that might prevail on experiences that occurred in the preschool period and might account for different developmental trajectories (Belsky, Jay et al., 2007). However, some effects of early childcare might persist through adolescence, given that development in adolescence builds on prior experiences (Vandell, D. L. et al., 2010). The Five Hypothesis Model of effects for early intervention is a comprehensive framework that attempts to summarize graphically these paths under five sets of mediators (cognitive skills, social adjustment, motivation, family and school support) and suggests that the mechanisms leading to adult well-being are cumulative and mutually reinforcing (Figure 1) (Reynolds et al., 2016a). It illustrates the complexity of evaluating early childhood education impacts on adult well-being.

Challenges in establishing causal connections between early childhood education and its impacts on child development are numerous. First, selection bias is a concern because of the systematic differences in child and family characteristics that can be related to childcare characteristics and functioning of the child (Vandell, D. L. et al., 2010). Consequently, the study sample might not be representative of the target population.

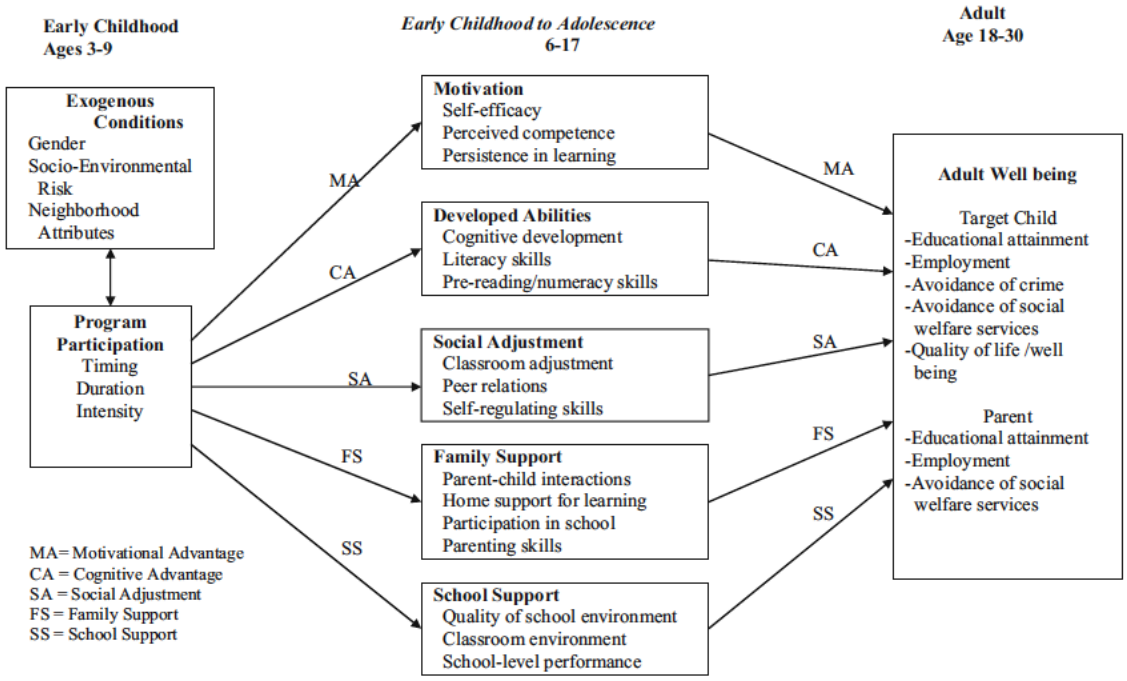

Figure 1 : Five Hypothesis Model of pathways

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Second, controlling for potential confounders is also challenging, since children may have unobserved characteristics that differ from those not in childcare and that would affect outcomes (Apps et al., 2013; Burchinal et al., 2000). Studies have highlighted the differences in profiles of children attending childcare compared to those who did not, in terms of childcare use, type, quality and intensity of care, and family characteristics, confirming the importance of controlling for variables that might contribute to self-selection and are also potential confounders (Guay et al., 2015; Laurin, I. et al., 2015). Since childcare selection is not a random process (Burchinal et al., 2000), mothers who are working and using childcare may differ systematically from those who do not; and children's cognitive abilities might influence the choice of childcare or women's decisions about work (Apps et al., 2013). For example, while childcare might provide protection by reducing exposure to family risks, non-random social selection of children into childcare can confound the association between childcare and the outcome of interest: if children from a low SES background are less likely to receive childcare services, but are more likely to benefit from

them, childcare attendance at the population level might not reduce the inequities in outcomes between children from low SES and higher SES backgrounds (Côté, Sylvana M et al., 2007; Japel et al., 2005).

Third, the variability of results in the literature might also be partially due to the variety of treatments, namely the heterogeneity of childcare policy and childcare programs and characteristics, and the large diversity of populations. These subtleties are easily missed if researchers ignore heterogeneity and examine only average effects of childcare attendance on child development (Apps et al., 2013; Kottelenberg, M. et al., 2014), and make it more difficult to compare programs effectively. Furthermore, the average effect may depend on the policy itself and the environment in which the policy is implemented (quality and type of care, affordability, target population and age of children at enrolment for example). The effect of the policy also depends on the counterfactual: how the policy will affect care arrangements and how it might influence parental employment and income (Ruhm et al., 2012). For example, shifting childcare from parental care to non-maternal care versus from low-quality to high-quality childcare setting might uncover different impact on child development. Therefore, effects of childcare policies may not be uniform across countries or time periods (Ruhm et al., 2012).

In the past, the quality of data typically available, namely the appropriateness, details included, length of follow-up and sample size, has limited the evaluation and understanding of long-term effects of early childhood education (Ruhm et al., 2012). Intensive and small programs targeting specifically disadvantaged children, like Perry Preschool and Abecedarian programs in the USA, showed positive benefits in the short and long-term. However, results from small-sample efficacy trials might not be transposed to large scale subsidized childcare programs offered to the entire population, as suggested by Baker et al. (2008).

In this study, we examined whether different childcare arrangements were associated with non-cognitive outcomes in adolescence in a longitudinal birth cohort in Quebec. Specifically, we

identified children who attended a subsidized childcare facility (CPE) or a non-subsidized care facility (non-CPE) or were under maternal / family care from ages 2 to 5 years and compared internalizing and externalizing behavioral problems at age 15 years, accounting for numerous parental and child characteristics in the cohort. Furthermore, since one of the objectives of the Quebec Family policy is to alter the distribution of social determinants of health, we evaluated if the measured impact varies across socioeconomic status (SES) group to examine implications for social inequalities in health outcomes.

3. Methods

3.1. Sample

The Quebec Longitudinal Study of Child Development (QLSCD) is an ongoing prospective cohort study of singletons born in the province of Quebec (Canada) between October 1997 and July 1998, except those born in Nord-du-Québec, Nunavik, Terres-Cries-de-la-Baie-James, Aboriginal reserves, or with extreme prematurity or incomplete registry records. A total of 2,120 infants were selected through birth registries, being representative of 94.5% of the target population of Quebec births, and eligible at baseline. Children were followed up at 5,17,29, 41 and 45-56 months over the preschool years and at ages 5,6,7,8,10,12,13,15 and 17 years. Sample waves were divided in three periods of interests: the "pre-treatment" period, corresponding to the period before children were eligible for subsidized childcare, the "treatment" period, when children were eligible to access the subsidized childcare program, and the "post-treatment" period, after school entry (Table 1). Varying across waves, data have been collected through a mixture of questionnaires administered to the person knowing the child best (most frequently the mother), their partner (father or other partner), the child, the child's teacher, as well as through activities used to evaluate child development. The QLSCD includes detailed information on daycare arrangements and various health and developmental outcomes for children and their parents. Wave 16, when children were 15 years old, was used to study the outcomes of interest.

Survey sampling and procedures have been described in detail elsewhere (Jetté, 2002) and all survey documentation are available online at: http://www.jesuisjeserai.stat.gouv.qc.ca/.

Table 1: Overview of the QLSCD

	Pre-exposure		Exposure period				Post-exposure
QLSCD wave	1	2	3	4	5	6	16
Collection year	1998	1999	2000	2001	2002	2003	2013
Child age (months)	5	17	29	41	44-56	56-68	15yr
Sample Size	2,120	2,045	1,997	1,950	1,944	1,759	1,466
Response rate	75.3%	72.7%	70.9%	70.5%	69.0%	62.4%	51.6%
Sample Size w/ exposure assigned[1]	1,915	1,906	1,905	1,902	1,902	1,731	1,420

[1]Number of children with treatment allocation assigned (CPE care vs non-CPE care vs no childcare)

3.2. Measures

3.2.1. Definition of exposure

The exposure period included wave E03 to E06 (2000 to 2003), when children were aged 29 months to 5 years old, or waves E03 to E05 (45-56 months old during E05) if they were in kindergarten during wave E06. At wave three, in 2000, children became eligible for the subsidized CPE childcare program, following the latest expansion of the program (in September 1999).

The exposure was defined as the childcare arrangement in which the child spent the majority of their time during the exposure period. Children were included if childcare information was complete for at least 3 of the 4 waves, and otherwise assigned as missing.

First, the total weekly hours of childcare reported (for any type of care) for wave E03 to E06 was summed for each child and used to compute the overall average total weekly hours. Second, the total weekly hours for childcare in a CPE affiliated setting, including home care setting and childcare center (Table 2), was calculated for each subject during the exposure period. Similarly, we calculated the total weekly hours of childcare per week in a CPE unaffiliated setting, including

care in the home of the child (by a relative – excluding care by a brother or sister of the child – or a non-relative), unaffiliated home care and private daycare center (Table 2). Third, the proportions of time spent in CPE-affiliated and non-CPE affiliated childcare over the exposure period were calculated over the average total weekly hours for all types of care. Fourth, we assigned the primary mode of childcare. If the proportion of time spent in CPE affiliated setting was greater or equal to 50% of total childcare hours over the exposure period, the child was assigned to the "CPE" treatment group. If less than 50% of the time was spent in a CPE affiliated setting, the subject was assigned to the "non-CPE" group. Finally, if no childcare or weekly attendance of less than 10hrs was reported for at least 3 of the 4 years of the index period (or 2 years out of 3 if the child attended kindergarten during wave E06), the child was classified in the "No childcare" group. The main treatment variable excludes time spent in kindergarten.

Note that the formulation of the questions related to subsidized childcare in the QLSCD for waves E03 to E05 does not fully capture children attending private subsidized childcare, as the questions can be subject to interpretation (*"Le service de garde assuré par cette/ces personne/s fait-il partie d'un centre de la petite enfance qui détient un permis du gouvernement du Québec? (Place à 5$)",* which is translated in the Questionnaire for wave E04 as: "Is the care provided by this/these person/s monitored by a childcare centre that holds a Quebec government permit (5$ places)?". Therefore, we can assume that children attending a private subsidized centre were included in the CPE treatment group, except for wave E06, when the differentiation could be made and children in private subsidized childcare were grouped in the non-CPE category (n=15 only).

The treatment group included children with CPE-affiliated childcare as the primary childcare arrangement, while the control groups were composed of children whose primary childcare arrangement was a non-CPE daycare or without formal childcare arrangement ("no childcare"). The treatment group was contrasted with each control group for all analyses.

Children with no assigned primary childcare arrangement (N=139) were excluded from the analysis.

Table 2: Exposure allocation

Treatment assignment	**Exposure time**	**Childcare settings[1]**
CPE	≥ 50% of total time spent in a CPE-affiliated setting over the exposure period	CPE-affiliated[2] home childcare[3] by a non-relative CPE-affiliated home childcare by a relative Childcare center – CPE Subsidized private childcare center[4]
Non-CPE	< 50% of total time spent in a CPE-affiliated setting over the exposure period	Unaffiliated home childcare[5] by a non-relative Unaffiliated home childcare by a relative Childcare in own home by a relative (other than brother/sister) Childcare in own home by a non-relative Childcare center – unaffiliated / nonsubsidized "Other type of childcare" - unaffiliated
No childcare		No childcare use Childcare less than 10hrs per week Majority (>50%) of time cared for by a brother or sister (n=1)

[1]Settings based on the terminology used in the QLSCD
[2]Affiliated and unaffiliated refer to affiliation to a CPE.
[3]As of 2006, these are legally governed by coordinating offices.
[4]Based on the questionnaire of the QLSCD, we can assume that subsidized private childcare centers were included in the CPE-affiliated childcare group.
[5]Can be regulated or unregulated

3.2.2. Outcomes

Outcomes were measured at wave 16, in 2013, when children were 15 years old, using an online self-administered questionnaire. Outcomes of interest included internalizing symptoms, such as depression and anxiety, externalizing symptoms, mainly aggression, as well as substance use.

Mental health questions and their derived index variables were taken from the Mental Health and Social Inadaptation Assessment for Adolescents (MIA), a self-report instrument based on the DSM-5 and developed by Côté & al. (2017). The following index scores were used for analysis: depression, generalised anxiety, aggression, internalizing behaviours (mean score of the depression, generalised anxiety and social phobia items) and externalizing behaviours (mean score of the ADHD, conduct disorder, oppositional defiant disorder, delinquency, and aggression items). These scores were each summarized as an index score constructed from multiple questions measured on a Likert scale as (1) never true, (2) occasionally true and (3) often true, with a 12-month reference period. The index scores were rescaled from 0 to 10. The questionnaire has been shown to have adequate internal validity and reliability, although external validity has not been demonstrated (Côté, S. et al., 2017). Cronbach alpha values were good for the generalised anxiety scale (α = 0.86) and excellent for the depression (α = 0.90), aggression (α = 0.96), total internalizing symptoms (α = 0.94) and total externalizing symptoms scales (α = 0.97) (Côté, S. et al., 2017).

Questions related to substance use (cigarettes, alcohol and drugs) were derived from other cross-sectional surveys: the 2006 (Dubé et al., 2007) and 2013 (Traoré et al., 2014) Québec Survey on Smoking, Alcohol, Drugs and Gambling in High School Students (ETADJES), the 1999 Health and Social Survey of Children and Adolescents (ESSEA) ("1999 Health and Social Survey of Children and Adolescents,") and the 2010-2011 Quebec Health Survey of High School Students (EQSJS) ("2010-2011 Quebec health survey of high school students ").

The prevalence of smoking, drinking and drug use in the past 12 months were coded as dichotomous variables, with those who had never used the substance coded as 0. The prevalence of drug use included any use of marijuana, cocaine, heroin, solvents, hallucinogenic drugs, amphetamines/methamphetamines and medication without prescription (i.e. narcotics, benzodiazepine).

The frequency of cigarette smoking, alcohol and drug use in the past 12 months were recoded as 0 “use less than once per month” and 1 “high frequency (more than once per month)”, from multi-categorical variables. Again, drug use included any use of the drugs listed above. Categories were combined due to low cell counts and based on previous work (Traoré et al., 2014). Excessive alcohol consumption (binge drinking) was coded as a dichotomous variable and defined as the consumption of five or more drinks during at least one occasion in the past 12 months.

3.2.3. Covariates

Potential confounders included health, geographic, demographic and socioeconomic variables pertaining to the child, the parents (most often the mother) or the family. They were primarily measured in the second wave, during the pre-exposure period, when children were 17-months-old, and were selected if they could potentially influence the primary childcare arrangement as well as the outcome of interest. Most were reported by the mother, except child birth weights, which were extracted from the Quebec Birth Register. The proportion or mean of selected confounders by treatment groups are presented in Table 3.

To evaluate the impact of the subsidized childcare program on health inequality, we measured if the effect varied by socioeconomic groups. We considered three different socio-economic status indicators. The first two were based on maternal education, dichotomized as either having a university degree versus less or having a high-school diploma or less versus any post-secondary education. The third indicator was generated based on a standardized family SES index, a composite measure based on maternal and spousal education and occupation, as well as household income (Willms et al., 1996). The SES index was dichotomized as belonging to the bottom quartile of the SES index versus not. SES indicators were measured at baseline, prior to childcare enrollment.

3.3. Statistical analysis

3.3.1. Multiple imputation

Twenty-two and one-half percent of the children in the sample with assigned primary childcare arrangement were missing information on at least one covariate, most commonly child height (10%) and weight (4%) (Yang, S. et al., 2018). To address the issue of missing data, and reduce the potential for selection bias in a complete case analysis (Mitra et al., 2011), multiple imputation (MI) via chained equations (MICE) was used (Van Buuren, 2007; White et al., 2011), with augmented regression (White et al., 2010). Multiple imputation uses the distribution of observed data to estimate multiple sets of plausible values. MICE is recognized for its flexibility and ability to sequentially regress different types of variables, under the assumption of being missing at random (White et al., 2011). We imputed 32 descriptive variables with missing values at baseline on 8 predictor variables, including primary childcare arrangement (after excluding children with no assigned exposure). 20 imputed datasets were created.

After MI was performed, children identified as having a mental disability or autism in subsequent waves (up to E16) were further excluded, to avoid skewing our results.

3.3.2. Propensity score

Comparing the means and proportions of baseline covariates in multiply imputed datasets highlighted some imbalances between the treatment and control groups. Therefore, after conducting multiple imputations, we used propensity score methods to address potential confounding using measured covariates in the 20 imputed datasets.

The propensity score is the probability of treatment assignment, conditional on observed baseline characteristics (Rosenbaum et al., 1983). As such, it is a balancing score, where the distribution of observed baseline covariates will be similar between treatment groups, as an attempt to

control for confounding in observational studies (Austin, 2011). The propensity scores can be used directly in estimation of the average treatment effect (ATE), defined as the average effect of moving an entire population from untreated to treated, using inverse probability weights (PS-IPW) (Austin, 2011; Stuart, 2010).

The propensity score was defined as the probability of being exposed to CPE-affiliated childcare conditional on selected measured baseline covariates. Other than achieving balance between the treated and each control group, the goal was to limit inference to regions of "common support", specifically the area with common range of propensity scores between treatment contrasts, avoiding extrapolation (King et al., 2006; Stuart, 2010). The propensity score was estimated using logistic regression in all 20 imputed datasets. A final model optimizing covariate balance, as measured by the standardized mean difference between treatment and control groups (Austin, 2011), was chosen after investigating different propensity score specifications. The propensity score inverse probability weights (PS-IPW) were generated and assigned to each covariate based on the inverse of the probability of treatment allocation (Robins et al., 2000). The PS-IPW was then multiplied by the sampling weights corresponding to the reporting source of the dependent variables of interest (here the child), to ensure that results can be generalised to the survey target population (DuGoff et al., 2014). Descriptive statistics and effect estimates were combined across the 20 imputed datasets, to account for within- and between-imputation variability (Hill, 2004).

3.3.3. Weighting

The longitudinal weights for wave E02 and the cross-sectional weights for E16 provided by the QLSCD were incorporated in the analysis. This was done in order to generalize results to the target population of children who survived and stayed in Quebec (or left the province temporarily) between the 1998 and 1999 waves (longitudinal weights for E02) or the 1998 and 2013 waves (cross-sectional weights for E16). Although attrition was low between the first and second wave, it was significant by wave 16 (weighted response rate of 51.6%; Table 1). Therefore, respondents and non-respondents likely have different characteristics. For example, males and youth with school difficulties represented a smaller proportion of respondents among the 16th wave sample

compared to the ELDEQ target population (47.5% of respondents vs 51.1% of the target population for males and 16.7% vs 21.7% for youth with school difficulties) (Dion et al., 2014b). Therefore, by using weights, we ensure the target population remains the children born in the province of Quebec in 1997-1998 and attending the Quebec school system in the 2012-2013 school year (N=69,890). In E16, 1466 youths responded to at least one of the questionnaires, with 1446 completing the QELJ questionnaire ("Questionnaire en ligne du jeune"; Online youth questionnaire) (Table 1).

The cross-sectional weights for E16 are said to be adequate for variables with a small proportion of missing values (defined as less than 5%) (Dion et al., 2014b). Each of the selected outcomes have a non-response rate of less than 5%, except for the frequency of smoking in the past 12 months, reported to have a non-response rate of 5.7% (Dion et al., 2014a). While this is marginally above the 5% threshold recommended, this variable was incorporated in the analysis given missingness was not related to the exposure and was actually less than 2% when considering only the sub-sample of children with a valid treatment assignment, on which the ATE was estimated. Socio-economic variables from wave 2002 as well as variables obtained from the Ministère de l'Éducation, du Loisir et du Sport du Québec (MELS) are considered in the model to achieve weight adjustment. Further details on weights are described elsewhere (Dion et al., 2014b; Thibault et al., 2003).

3.3.4. Statistical models

We measured the effect of having a CPE as the primary mode of childcare compared to the two control groups on our outcomes of interest in the 20 imputed datasets, weighted by the PS-IPW. The mental health outcomes were modelled separately using Poisson regression with robust variance estimation. Results were presented on the absolute scale, as differences in mental health index scores at age 15. Selected mental health outcomes were general anxiety, depression, aggression, internalized behaviours and externalized behaviours. All were reported by the child. Poisson regression was selected given the index scores were restricted to positive values between

0 and 10. Substance use outcomes, including the prevalence of cigarette, alcohol and drug use in the past 12 months, as well as excessive alcohol consumption (binge drinking), were modeled using a logistic regression with results presented as the absolute difference in probability of substance use between treatment groups. The frequency of use of cigarettes, alcohol and drugs in the past 12 months, coded as high versus low frequency, was also modeled on the risk difference scale using logistic regression. Finally, we examined if socio-economic status acted as an effect measure modifier between childcare arrangement and the outcomes of interest, by adding an interaction term in the regression models, and reporting results by level of SES. All effect estimates were combined across the 20 imputed datasets and treatment contrasts were estimated through post-estimation using the mimrgns program (Klein, 2014) and applying Rubin's rules (Rubin, 2004) to marginal effect estimates.

Analysis were performed using STATA version 14.1 (StataCorp, 2015).

4. Results

4.1. Baseline characteristics

Baseline characteristics of the weighted study sample (N=1884; post MI), when children were 17 months old, are presented in Table 3. Proportion are presented by treatment group: CPE-affiliated childcare, non-CPE affiliated childcare and no childcare. These characteristics are the main ones considered for conducting multiple imputation and estimating propensity scores. Some of the variables predicting the propensity score, presented in Table 3, as well as in Supplementary Table 1a/1b, have been recoded or omitted, due to confidentiality restrictions from the ELDEQ. Overall, the majority of children in the sample were born at term, were in very good or excellent health, had 1 or no siblings, came from Francophone non-immigrant and intact families, and had both parents employed. Most lived in the Montreal census metropolitan area. However, imbalances between treatment groups were present, with socioeconomic variables most affected. The socio-economic status of children's families not attending a regular childcare was significantly lower at

Table 3: Baseline characteristics of children and their family (wave E02 – 17-month-old)[1]

Covariates	Category	Total	CPE	Non-CPE	No childcare
CHILD					
Gender	male	0.50	0.49	0.53	0.48
	female	0.50	0.51	0.47	0.52
Length of pregnancy (Gestational age)	(weeks)	38.97	39.03	39.02	38.85
Birth weight	(kg)	3.38	3.39	3.38	3.35
Age at breastfeeding cessation	(months)	3.87	3.91	3.56	4.07
Birth rank	1	0.45	0.49	0.47	0.36
	2	0.39	0.37	0.40	0.39
	3	0.11	0.09	0.11	0.16
	4 or more	0.05	0.04	0.02	0.09
# siblings in household	0	0.41	0.45	0.43	0.35
	1 other	0.41	0.41	0.43	0.39
	2 others	0.12	0.10	0.12	0.17
	3 or more	0.06	0.04	0.03	0.09
Height-for-age[2]	(z score)	-0.23	-0.30	-0.12	-0.21
Weight-for-age[2]	(z score)	0.82	0.87	0.85	0.74
General health	excellent-very good	0.89	0.90	0.89	0.89
	good-poor	0.11	0.10	0.11	0.11
Presence of chronic condition in wave E01-E02 (5-17months)	no	0.91	0.90	0.91	0.92
	yes	0.09	0.10	0.09	0.08
Frequency of acute infection in past 3 months	0	0.35	0.32	0.34	0.39
	1	0.29	0.29	0.26	0.32
	2	0.18	0.20	0.18	0.16
	3 or more	0.18	0.19	0.21	0.14
Antibiotic treatment in past 6 months	0	0.44	0.41	0.44	0.48
	1	0.28	0.28	0.27	0.28
	2	0.15	0.17	0.15	0.14
	3 or more	0.13	0.15	0.14	0.10
Number of medical consultations in past 12 months		7.95	8.39	7.76	7.41

MOTHER		Total	CPE	Non-CPE	No childcare
Age	(years)	30.39	30.30	30.74	30.22
Immigrant status	non-immigrant	0.87	0.86	0.92	0.85
	European immigrant	0.03	0.01	0.04	0.05
	other immigrant	0.10	0.13	0.04	0.10
Ethnicity	Canadian/European/First Nation	0.84	0.83	0.87	0.83
	Other ethnicity	0.16	0.17	0.13	0.17
Height	(meters)	1.63	1.64	1.63	1.63
Maternal body mass index (BMI)		23.66	23.56	23.33	24.10

General Health	excellent-very good	0.77	0.79	0.83	0.69
	good-poor	0.23	0.21	0.17	0.31
Depression index score	(0-10)	1.39	1.37	1.16	1.62
Smoking status (cigarette)	never	0.70	0.71	0.72	0.67
	occasional	0.04	0.04	0.05	0.03
	daily	0.26	0.25	0.24	0.30
Daily consumption of cigarettes	(# of cigs)	3.88	3.43	3.59	4.83
Alcohol consumption frequency	never	0.23	0.22	0.16	0.30
	once/month or less	0.37	0.37	0.37	0.38
	2-4 times/month	0.30	0.31	0.34	0.23
	2-7 times/week	0.10	0.10	0.14	0.08
Frequency of drinking 5 or more drinks in past 12 months		0.77	1.00	0.69	0.48
Uses of drugs or medication without prescription in past 12 months	none	0.97	0.96	0.98	0.97
	yes	0.03	0.04	0.02	0.03
Positive parenting score (for mother)		8.74	8.75	8.66	8.80
Educational attainment	no high school degree	0.17	0.13	0.11	0.28
	high school degree	0.11	0.09	0.10	0.15
	some post-secondary	0.23	0.24	0.20	0.23
	professional diploma/trade school	0.11	0.11	0.11	0.10
	college degree	0.13	0.15	0.13	0.10
	university degree	0.26	0.29	0.34	0.14
Occupation	not employed	0.31	0.23	0.13	0.60
	professional or executive	0.13	0.16	0.18	0.05
	intermediate manager / technician	0.16	0.17	0.22	0.07
	office workers / sales	0.30	0.33	0.37	0.20
	skilled trade	0.06	0.06	0.07	0.04
	unskilled trade /labourers	0.03	0.03	0.03	0.05
Employment status	not employed	0.30	0.22	0.14	0.56
	employed part time	0.17	0.18	0.17	0.15
	employed full time	0.53	0.60	0.70	0.29

FATHER		**Total**	**CPE**	**Non-CPE**	**No childcare**
Age	(years)	33.07	33.13	33.13	32.93
Educational attainment	no high school degree	0.19	0.15	0.19	0.26
	high school degree	0.12	0.12	0.11	0.13
	some post-secondary (excl. university)	0.18	0.18	0.15	0.20
	professional diploma/trade school	0.11	0.13	0.07	0.12
	college degree	0.13	0.13	0.16	0.09
	incomplete university	0.04	0.04	0.05	0.03
	university degree	0.23	0.25	0.27	0.16
Employement status (past 12 months)	not employed	0.05	0.05	0.02	0.09

	employed	0.95	0.95	0.98	0.91

FAMILY		Total	CPE	Non-CPE	No childcare
Family structure	intact[3]	0.79	0.79	0.84	0.76
	reconstituted	0.11	0.11	0.10	0.12
	single parent	0.10	0.10	0.06	0.12
Place of residence	Montreal CMA[4]	0.48	0.46	0.50	0.51
	Other CMA	0.18	0.20	0.22	0.11
	Census agglomerate of > 10,000	0.11	0.12	0.08	0.12
	Rural	0.23	0.22	0.20	0.27
Language spoken most often at home	French only	0.77	0.78	0.79	0.73
	English only	0.10	0.07	0.12	0.12
	neither French or English	0.07	0.08	0.03	0.08
	French and English	0.04	0.04	0.04	0.04
	French or English & other language	0.03	0.04	0.03	0.03
Main source of household income	salary	0.78	0.81	0.83	0.68
	self-employment earnings	0.09	0.07	0.12	0.10
	social assistance	0.09	0.08	0.02	0.17
	other	0.04	0.04	0.03	0.04
Household income	< 20,000$	0.15	0.14	0.08	0.23
	20,000$ - 29,999$	0.12	0.11	0.10	0.16
	30,000$ - 39,999$	0.15	0.14	0.13	0.19
	40,000$ - 49,999$	0.13	0.13	0.14	0.13
	50,000$ - 59,999$	0.13	0.15	0.12	0.12
	60,000$ - 79,999$	0.17	0.18	0.23	0.09
	80,000$ +	0.15	0.16	0.21	0.08
SES index score		-0.05	0.07	0.25	-0.48

[1] Sample includes missing values estimated through MICE. Values are weighted by sampling weights. Sample size: N=1884. Respondent children are 17 months-old (wave E02 - 1999)

[2] Maternally reported child height and weight, standardized to age following the World Health Organization (WHO) child growth standards using WHO Anthro softare for Stata

[3] Intact families correspond to a child living with both biological parents and siblings

[4] CMA - Census Metropolitan Area

baseline, based on all indicators available. For example, only 14% of mothers who didn't use formal daycare had a university degree, whereas 29% and 34% of mothers who used CPE childcare and non-CPE childcare, respectively, possessed a university degree. As such, the proportion of mothers who did not send their children to childcare with no high school degree was significantly higher. Those mothers were also more likely to be unemployed (56%) compared to mothers using CPE (22%) and non-CPE childcare (14%). They were also more likely to report receiving social assistance as the main source of income (17%) and to report an annual income of less than

20,000$ (23%) relative to the CPE and non-CPE treatment groups (8% and 2% respectively for social assistance; 14% and 8% for income below 20,000$).

Descriptive statistics for the mental health index scores and substance use behaviors measured at age 15 are presented in Table 4 and Table 5. The scales measuring internalizing symptoms had overall higher scores than the scales measuring externalizing symptoms, with the generalised anxiety scale displaying the highest score (mean of 4.02 $\pm$ 2.15). For substance use, 59% (95%CI 0.56-0.62) of children reported alcohol use in the past 12 months, with 6% (95%CI 0.05-0.08) reporting frequency of use of more than once per month. However, 41% (95%CI 0.38-0.44) reported at least one binge drinking episode in the past 12 months (defined as consuming 5 or more alcohol beverages in one occasion). 22% (95%CI 0.20-0.25) of respondents admitted using drugs (of all types) in the past 12 months, with 7% (95%CI 0.06-0.09) using more than once per month. Finally, the 12-month prevalence of cigarette smoking, defined as having smoked at least one full cigarette, was 15% (95%CI 0.13-0.17), with 6% (95%CI 0.05-0.08) using more than once per month.

Table 4: Mental health and behavioral index scores in respondent children aged 15-year-old

Index score[1]	**Mean**	**Median**	**St. Deviation**
Generalised anxiety	4.02	3.89	2.15
Depression	3.41	3.13	2.23
Internalized behaviours	3.31	3.20	1.89
Overall agression	0.75	0.59	0.89
Externalized behaviours	1.44	0.95	1.32

[1]Reporting source: respondent children that answered the QELJ questionnaire. Values are weighted by sampling weight only.

4.2. Propensity score balance

Figure 2 shows the distribution of the propensity score before and after weighting, by treatment contrast and by treatment group. The estimated propensity score (unweighted) varied substantially between the CPE-affiliated childcare and no childcare groups. However, after

Table 5: Substance use behaviors in respondent children aged 15-year-old[1]

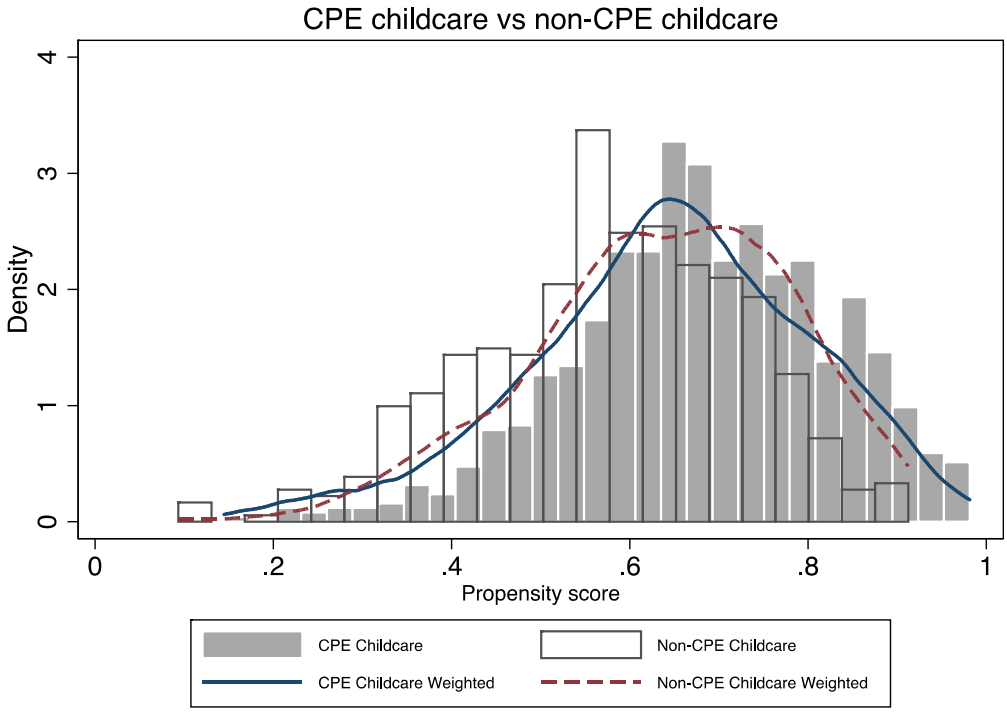
Outcome	Category	Proportion	95% CI
Prevalence of cigarette smoking	yes (ref[2]: no use)	0.15	(0.13, 0.17)
Frequency of cig. Smoking	high (> 1 / month) (ref: no use)	0.06	(0.05, 0.08)
Prevalence of alcohol use	yes (ref: no use)	0.59	(0.56, 0.62)
Frequency of alcohol use	high (> 1 / month) (ref: no use)	0.06	(0.05, 0.08)
Binge drinking	>= 1 time (ref: 0)	0.41	(0.38, 0.44)
Prevalence of drug use	yes (ref: no use)	0.22	(0.20, 0.25)
Frequency of drug use	high (> 1 / month) (ref: no use)	0.07	(0.06, 0.09)

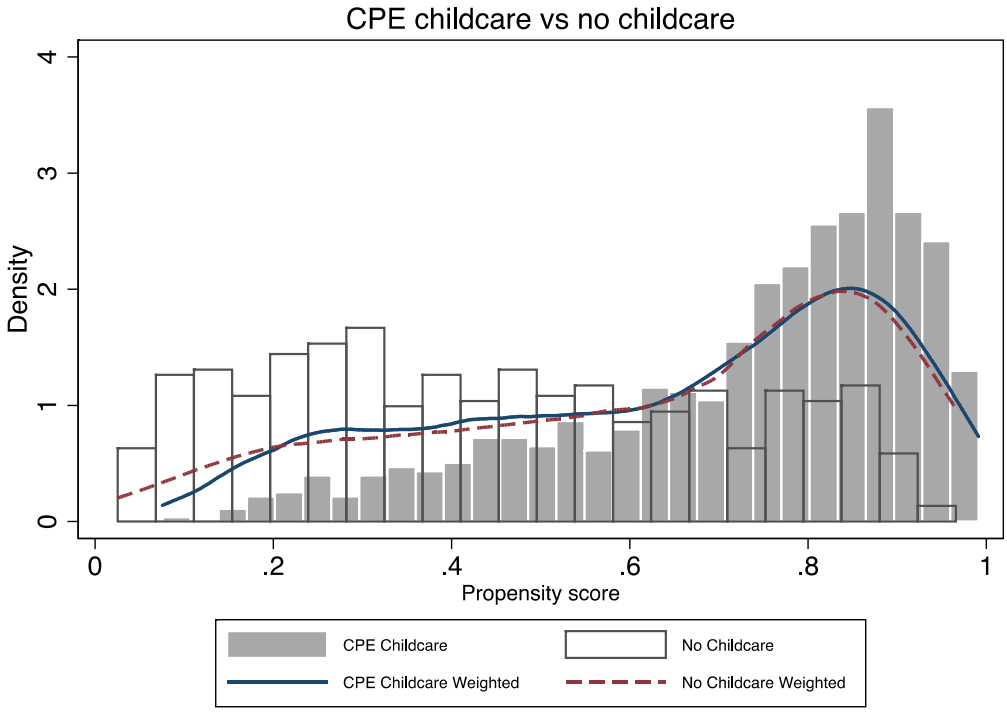
[1]Reporting source: respondent children that answered the QELJ questionnaire. Values are weighted by sampling weight only
[2]Ref: referent category

weighting, the distribution of the propensity score was very similar between both groups, suggesting that balance was achieved. Figure 2 shows individual covariate balance in the PS-IPW sample and restricted to area of common support, compared to the unweighted values, as indicated by the mean standardized difference. The mean standardized difference corresponds to the percentage of the difference of the sample means between treatment groups divided by the mean group standard deviation. Supplementary tables 1a and 1b (Appendix) also display the mean standardized difference in the unweighted and PS-IPW samples, as well as the percentage bias reduction between both. The average of the mean standardized differences in the unweighted sample was 6.6% compared to 1.1% in the weighted sample comparing the CPE and non-CPE groups. In the CPE versus no childcare groups, the standardized bias was reduced from 13.0% to 1.7%. A difference in the mean of covariates of less than 10% has been suggested to be a negligible difference between treatment groups, post PS-IPW, which was achieved (Supplementary tables 1a & 1b) (D'Agostino, 1998).

Due to uncertainty inherent to multiple imputation, there were some variations in the weighted sample across imputed datasets. The weighted sample size varied between 1325 and 1341 (average N=1331.5) for the CPE vs non-CPE affiliated childcare treatment contrast, whereas it ranged from 1346 to 1365 (average N=1353.9) for the CPE vs no childcare treatment contrast.

Figure 2: Distribution of propensity score before and after weighting by treatment allocation





4.3. Main effect estimates

The estimated average marginal effects of attending a CPE as the primary childcare arrangement were estimated from the imputed and weighted (PS-IPW) sample. Results are presented in Table 6, as the absolute risk difference between average mental health index scores in 15 years old children. Results were null for all mental health index scores, namely generalised anxiety, depression, overall aggression, internalizing and externalizing behaviours, indicating no differences in average mental health index scores at age 15 years between children that attended CPE-affiliated childcare compared to non-CPE affiliated childcare or no formal childcare.

Similarly, differences in estimated probabilities of cigarette smoking, alcohol or drug use at age 15 in the past 12 months between children attending a CPE as their primary childcare arrangement compared to each control group were minor (Table 7). Similar results were observed for frequency of substance use.

Table 6: Absolute difference in mental health and behavioural index scores in 15-year-old children in PS-IPW balanced sample by treatment contrast

	CPE vs non-CPE childcare			CPE vs no childcare		
Index score	**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Generalised anxiety	-0.11	(-0.49, 0.26)	0.55	0.05	(-0.29, 0.40)	0.77
Depression	-0.01	(-0.35, 0.34)	0.97	0.04	(-0.33, 0.41)	0.84
Internalised behaviours	-0.03	(-0.35, 0.34)	0.83	0.07	(-0.23, 0.36)	0.66
Overall agression	-0.04	(-0.35, 0.34)	0.59	-0.06	(-0.18, 0.07)	0.38
Externalised behaviours	-0.04	(-0.35, 0.34)	0.62	0.01	(-0.13, 0.15)	0.87

4.4. Effect measure modification

For each treatment contrast, we measured the effects of childcare arrangement by levels of SES. No differences in mental health index scores were observed across levels of SES, for indicators defined by a family SES index score (bottom quartile Q1 vs upper quartiles Q2-Q4) or maternal educational attainment (having a high school degree or less or owning a university degree) (Table

8 and Supplementary Table 2). Tests for interaction of main childcare arrangement and SES indicators were also not significant at p<0.05.

Table 7: Absolute differences in probabilities of substance use in 15-year-old children by treatment contrast in PS-IPW balanced sample

	CPE vs non-CPE childcare			CPE vs no childcare		
Outcome[1]	**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Smoking						
Prevalence	0.01	(-0.05, 0.06)	0.78	0.02	(-0.05, 0.08)	0.65
Frequency (>1 per month vs less)	-0.01	(-0.04, 0.03)	0.68	0.02	(-0.02, 0.07)	0.30
Alcohol consumption						
Prevalence	0.01	(-0.07, 0.09)	0.87	-0.01	(-0.09, 0.07)	0.85
Frequency (>1 per month vs less)	-0.02	(-0.05, 0.02)	0.27	-0.02	(-0.06, 0.03)	0.46
>5 drinks in at least one occasion	0.01	(-0.07, 0.09)	0.79	-0.003	(-0.09, 0.09)	0.94
Drug use						
Prevalence	0.03	(-0.04, 0.09)	0.41	-0.002	(-0.07, 0.07)	0.95
Frequency (>1 per month vs less)	-0.01	(-0.05, 0.03)	0.55	0.01	(-0.03, 0.06)	0.57

[1]Reported in the past 12 months

For substance use outcomes, the differences in predicted probabilities of use (prevalence) and frequency of use were mostly similar across levels of SES, for all three indicators, except for the prevalence and frequency of cigarette smoking in the past 12 months by SES index score, comparing children who attended a CPE to those not in formal childcare (Table 9). Indeed, results showed a 0.14 (95%CI 0.02-0.27; p=0.02) increase in the predicted probability of smoking at age 15 among children from families belonging to the bottom quartile of the SES index score at baseline and who attended a CPE in early childhood compared to those who did not attend regular childcare. There was also a 0.11 (95%CI 0.01-0.22; p=0.04) increase in the predicted probability of having smoked more than once per month in the past 12 months amongst 15-year-old children from families belonging to the bottom quartile of the SES index score, when children who attended a CPE in early childhood were compared to those who did not attend regular childcare. This difference is not observed when looking at effect measure modification when comparing children having attended a CPE vs a non-CPE childcare by level of maternal education (Supplementary Table 3). Finally, although not significant, there was a tendency of decreased

Table 8: Absolute difference in mental health and behavioural index scores in 15-year-old children in PS-IPW balanced sample by levels of SES and treatment contrasts

		CPE vs non-CPE childcare			CPE vs no childcare		
Index score		**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Generalised anxiety	Family SES Q1	0.29	(-0.58, 1.15)	0.52	-0.03	(-0.63, 0.57)	0.93
	Family SES Q2-Q4	-0.24	(-0.63, 0.15)	0.23	0.08	(-0.34, 0.51)	0.70
Depression	Family SES Q1	0.08	(-0.72, 0.88)	0.84	0.20	(-0.40, 0.79)	0.52
	Family SES Q2-Q4	-0.03	(-0.41, 0.35)	0.88	-0.04	(-0.50, 0.43)	0.88
Internalised behaviours	Family SES Q1	0.10	(-0.64, 0.83)	0.79	0.01	(-0.52, 0.53)	0.98
	Family SES Q2-Q4	-0.08	(-0.40, 0.25)	0.65	0.10	(-0.27, 0.46)	0.60
Overall agression	Family SES Q1	-0.08	(-0.36, 0.19)	0.54	0.08	(-0.14, 0.30)	0.49
	Family SES Q2-Q4	-0.02	(-0.17, 0.13)	0.82	-0.11	(-0.26, 0.04)	0.14
Externalised behaviours	Family SES Q1	-0.198	(-0.53, 0.14)	0.25	0.08	(-0.20, 0.36)	0.57
	Family SES Q2-Q4	0.012	(-0.16, 0.18)	0.89	-0.02	(-0.17, 0.14)	0.86

Table 9: Absolute difference in probabilities of substance use in 15-year-old children in PS-IPW balanced sample by levels of SES and treatment contrasts

		CPE vs non-CPE childcare			CPE vs no childcare		
Outcome		**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Smoking							
Prevalence	Family SES Q1	0.00	(-0.16, 0.16)	1.00	0.14	(0.02, 0.27)	0.02
	Family SES Q2-Q4	0.02	(-0.03, 0.07)	0.52	-0.04	(-0.11, 0.03)	0.28
Frequency (>1 per month vs less)	Family SES Q1	0.00	(-0.12, 0.13)	0.98	0.11	(0.01, 0.22)	0.04
	Family SES Q2-Q4	-0.01	(-0.04, 0.02)	0.72	-0.01	(-0.06, 0.03)	0.57
Alcohol consumption							
Prevalence	Family SES Q1	-0.01	(-0.19, 0.18)	0.95	0.07	(-0.06, 0.21)	0.29
	Family SES Q2-Q4	0.01	(-0.07, 0.10)	0.75	-0.04	(-0.15, 0.06)	0.43
Frequency (>1 per month vs less)	Family SES Q1	0.01	(-0.08, 0.11)	0.78	0.06	(-0.03, 0.15)	0.17
	Family SES Q2-Q4	-0.03	(-0.06, 0.01)	0.14	-0.05	(-0.11, 0.00)	0.06
>5 drinks in at least one occasion	Family SES Q1	-0.08	(-0.27, 0.11)	0.41	0.05	(-0.10, 0.19)	0.52
	Family SES Q2-Q4	0.04	(-0.04, 0.12)	0.33	-0.02	(-0.14, 0.09)	0.68
Drug use							
Prevalence	Family SES Q1	0.06	(-0.11, 0.22)	0.51	0.07	(-0.06, 0.20)	0.31
	Family SES Q2-Q4	0.02	(-0.04, 0.09)	0.49	-0.03	(-0.12, 0.06)	0.50
Frequency (>1 per month vs less)	Family SES Q1	-0.02	(-0.14, 0.10)	0.80	0.06	(-0.02, 0.14)	0.15
	Family SES Q2-Q4	-0.01	(-0.05, 0.03)	0.65	-0.01	(-0.07, 0.06)	0.86

[1]As reported in the past 12 months

frequency of alcohol use for children whose family belonged to the upper quartiles of the SES index score, when comparing the CPE and no formal childcare groups (-0.05; 95%CI -0.11-0.00; p=0.06).

5. Discussion

Interventions targeting early childhood, aiming to promote the socio-emotional and cognitive development of children, have gained considerable interest by both scientists and policy makers as an opportunity to mitigate social inequalities and generate significant social benefits in the long run (Heckman, J. J., 2006; Heckman, James J. et al., 2007). Public policies promoting access to high quality childcare is a promising avenue to foster child development.

In this prospective study of a representative sample of children born and living in Quebec, we examined the effect of different childcare arrangements, specifically use of Quebec's universal childcare program providing regulated and subsidized childcare spots at low cost, available to preschool children in Quebec since 1997, on behavioral outcomes in adolescence. We found no evidence of differences at age 15 years in externalizing and internalizing behaviours, or substance use, between children who attended a universal subsidized childcare program (CPE-affiliated care) compared with children in private care (non-CPE affiliated care) or not in formal childcare. We also observed that the impacts of the Quebec universal childcare program on adolescents did not differ across levels of parental socio-economic status, represented by maternal education and a family SES index score, for mental health outcomes, and were inconsistent for substance use outcomes.

Our results are inconsistent with the limited evidence on long-term behavioral outcomes following the introduction of the childcare program in Quebec that reported harmful effects on child behaviors in the long-term (Baker et al., 2015). However, there is an important difference between our study and Baker's study, as their study mainly assessed the impacts of availability of the universal childcare program, rather than the impacts of accessing the program, by aggregating data for Quebec and the rest of Canada from national survey data or routinely collected

administrative data at the provincial level. Our study is in line with recent study by Yang et al. (2018), who found no substantial differences in behaviors at school age between 6-year-old children who attended a CPE versus those who were not in subsidized childcare, using the same cohort and similar analytical approach.

Beside studies focusing on the Quebec childcare policy, our results add to the wide range of results available in the literature. Our results are consistent with a study by Apps et al. (2013) that showed null effects of preschool attendance on mental health outcomes, substance use and petty crime in a large representative English cohort (LSYPE) of adolescents, including disadvantaged children, following the expansion of preschool provision in England. Other studies, however, were heterogenous and found that high quality childcare was positively associated with externalizing behaviors, longer hours in childcare was associated with greater risk taking (which includes alcohol and drug use, petty crime) and impulsivity, and there was no association with the type of care in 15 year old American adolescents (Vandell, D. L. et al., 2010). In the same large and economically diverse sample, the effect of childcare on teen behaviour at the end of high school was moderated by gender, as center-based care was associated with better impulse control and decrease risk taking for girls but not for boys (Vandell, Deborah Lowe et al., 2016). D'Onise et al. (2010) systematically reviewed the literature on the effects of center-based preschool on child and adolescent outcomes. They found that the direction and magnitude of the impact was heterogenous (D'Onise, Katina et al., 2010). Although they relied on studies of lower quality with higher risk of bias, their analysis suggested a possible small beneficial effect of attending center-based preschool on social competence and mental health in a high-quality setting, and lack of evidence showing a decrease risk of alcohol and drug use in adolescence.

The premise of the Quebec subsidized childcare program is the expectation that universal access would help mitigate inequalities in health by promoting optimal child development and educational attainment (Gouvernement du Québec, 1997). Unfortunately, we observed no consistent differences between mental health outcomes by childcare type across SES indicators. However, attending a CPE in early childhood compared no formal childcare arrangement was

associated with a small increase in the predicted probability of smoking (0.14; 95%CI 0.02-0.27; p=0.02) and the predicted probability of having smoked more than once per month in the past 12 months (0.11; 95%CI 0.01-0.22; p=0.04) among 15-year old children from families in the bottom quartile of the SES index score. There was weaker evidence of decreased frequency of alcohol use in children from the top quartiles of the SES index score (-0.05; 95%CI -0.11-0.00; p=0.06). However, this was not reproducible using maternal education as an SES indicator, not observed for the other treatment contrast (non-CPE vs no childcare) nor for other substance use behavior outcomes. While the study by Yang, S. et al. (2018) did not show differential effects by SES on child behavior in primary school, other studies using the same cohort of children have emphasized the role of childcare in closing the gap for disadvantaged children on cognitive (Geoffroy, M. C. et al., 2007; Geoffroy, M. C. et al., 2010; Laurin, J. C. et al., 2015) and non-cognitive outcomes (Côté, Sylvana M et al., 2007).

In general, many factors have been suggested to explain why results seen in the literature are not uniform. It might depend on whether and how the policies affect children's care arrangements, and their influence of socio-economic factors, such as parental employment and income. The characteristics of the target population, the type and quality of care, and age of enrollment are all factors that can play a role. In addition, the effects of such policies will depend on the counterfactual: early education policies that move children into center-based settings from low quality informal care arrangements might have a different effect than those that move children from parental care (Ruhm et al., 2012).

In our sample, maternal and family characteristics were not balanced between groups with different childcare arrangements, with socioeconomic variables most affected. Mothers with children in formal childcare (both CPE and non-CPE care) were more likely to have any degree of post-secondary education compared to mothers who did not use formal care. Children in maternal care were also more likely to come from a low-income family. Thus, those imbalances strongly suggest that the choice of childcare arrangement is not random, and that children who could potentially benefit the most (and are targeted by the policy) might not have access to

subsidized childcare spots. These results are consistent with other studies (Burchinal et al., 2000; Geoffroy, M.-C. et al., 2012; Laurin et al., 2016). Taken together, it highlights the importance of achieving comparability of maternal and family characteristics between children in different childcare arrangements, to avoid the risk of confounding bias. One of the strengths of our study was the wealth of baseline information combined with the use of inverse propensity score weighting approach to balance child and family characteristics between groups. The use of propensity score approach enabled us to make treatment groups as similar as possible, allowing us to achieve comparability and to minimize biases due to observable components, in an attempt to address the issue of social selection.

Another strength of our study is the use of a representative prospective cohort of children from Quebec, allowing us to study a unique universal childcare program. We accounted for missing data, attrition and differential selection by combining multiple imputation and propensity score methods and using a detailed set of controls, particularly family and social characteristics variables. Although the risk of reporting bias is still present, mental health and substance use variables were self-reported by adolescents. Mental health scales have been validated in this sample (Côté, S. et al., 2017).

There are a few limitations to this study. First, the exposure definition of childcare attendance was restricted to 2 to 5-year-old children, due to the timing of implementation of the Quebec childcare policy: eligibility of the QLSCD birth cohort started only when they turned 2 years of age. However, center-based childcare has been associated with better cognition but also higher behavioral issues in some studies (Loeb et al., 2007; NICHD Early Child Care Research Network, 2006). Therefore, if children who attended a large low-quality private center-based facility before being eligible for a CPE spot were more vulnerable to developing problem behaviors than those in other settings, like home childcare or parental care, our results would mask such differential effects related to timing of entry into childcare. Second, a primary childcare arrangement exposure variable was constructed for each participant by aggregating data over the exposure period. Although it reflects the primary mode of childcare where the child spent at least 50% of

their time, it does not account for the timing of initiation of care, the intensity of care or the number of different childcares and type of childcares used by the participant (stability). Third, residual confounding, including confounding by unobserved characteristics not accounted for via propensity score methods, may have biased estimates. Moreover, despite achieving balance between groups, the moderating effect of subsequent experiences at home or school later in life, that may account for developmental trajectories, cannot be completely excluded.

An important caveat was our inability to evaluate directly the quality of childcares, as a potential mediator. Our definition of exposure, partially limited by the data available, did not capture the possible difference in quality between subsidized home childcare and center-based childcare, as the CPE-care group included both CPE, CPE-affiliated home childcare and private subsidized center. Similarly, this distinction cannot be made within the non-CPE care group, which encompassed both non-subsidized home childcare and non-subsidized private center. Importantly, the survey questionnaire didn't allow us to differentiate children attending a subsidized private childcare from those attending an actual CPE.

Variation in quality between childcare settings in Quebec has been demonstrated: on average, CPEs (center-based) obtained the highest quality rating, followed by CPE-affiliated home childcare. Non-subsidized private childcares and non-regulated home daycares were, on average, of lower quality (Drouin et al., 2004; Gingras et al., 2015a, 2015b; Japel et al., 2005). It should be noted that in Japel's study, only one in four childcare setting met the criteria for good, very good or excellent services, while 61% were of minimal quality (Japel et al., 2005). In the survey *Grandir en Qualité 2003* (Drouin et al., 2004), the childcare settings evaluated were on average of "acceptable" quality, but about 40% of the private childcares and 20% of home childcares were of low, unacceptable quality, compared to about 5.5% for CPEs; this raised some concerns, considering the goal of the Quebec childcare policy is to provide a regulated subsidized high-quality childcare program. Although we certainly cannot draw firm conclusions regarding our sample, we can hypothesize that overall, children in the CPE-care category were likely exposed, as a group, to higher quality care compared to the non-CPE group, even if the quality of care

within the CPE and non-CPE groups are most likely variable. However, the quality of care would have more weight than the type of childcare attended (Belsky, Jay et al., 2007). Abner et al. (2013) found little evidence, using a US cohort (ECLS), that the measured quality of childcare mediated the association between types of care and cognitive and non-cognitive outcomes at 4 years of age, however the quality of care may also vary within installations of the same type of care. Unfortunately, we were unable to evaluate the potential role of childcare quality due the unavailability of quality data.

Ruhm and Baker hypothesized that the mixed or negative results found in the literature could be secondary to the rapid expansion of low-quality childcare provision and may have been transitional (Baker et al., 2008; Ruhm et al., 2012). The QLSCD cohort entered childcare just as the policy was implemented and childcare provision in Quebec expanded rapidly during this period. It is possible that the quality of childcare was lower at the time; as Japel (2005) described, more than half of the childcare settings evaluated encountered only minimal criteria for quality. However, it is unclear if the quality has increased significantly over the years, despite governmental efforts (Drouin et al., 2004; Gingras et al., 2015a, 2015b).

6. Conclusion

From a public health perspective, while there is a great potential for early childhood interventions, including childcare programs, to improve population health, there is still a need for robust and innovative research examining the health effects of early interventions, particularly universal childcare program, to build a more coherent body of evidence and orient better public policies. Most of the literature has mainly focused on short term impacts of universal childcare programs, and there is a paucity of evidence, often conflicting, on adolescent and adult outcomes. Our study of the effects of the Quebec universal subsidized childcare program contributes to building this body of evidence by using a large prospective cohort and accounting for the issue of self-selection with propensity score methods that included a large number of potential confounders.

In summary, we found no evidence of differential impacts of attending a subsidized childcare program in Quebec compared to other childcare arrangement on mental health and problematic behaviors in adolescents, even across socio-economic classes, as results by SES were inconsistent. Further studies would benefit from integrating information on the quality of childcare settings to improve our understanding of the impacts of universal subsidized childcare programs on child development and adolescent and adult's health and functioning. A coherent body of evidence to draw more firm conclusions on the impacts of a universal childcare program is needed, considering this unique window of opportunity in early childhood to promote long-term health, healthy lifestyles and help close inequalities in health.

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Appendix

Supplementary Table 1a: Balance from propensity score weighting in children at baseline (wave E02 – 17-month-old); CPE childcare users vs non-CPE childcare[1]

Covariates	Category	Unweighted			PS-Inverse probability weighted			
		non-CPE	CPE	Bias%[2]	non-CPE	CPE	Bias %	Bias reduction (%)
CHILD								
Gender	male	0.52	0.49	-5.86	0.49	0.50	0.92	84.27
	female	0.48	0.51	5.86	0.51	0.50	-0.92	84.27
Lenght of pregnancy (Gestational age)	(weeks)	39.10	39.11	0.13	39.16	39.12	-2.65	-1898.76
Birth weight	(kg)	3.40	3.41	2.63	3.41	3.40	-1.24	52.78
Age at breastfeeding cessation	(months)	3.51	3.86	7.95	3.61	3.66	1.06	86.62
Birth rank	1	0.47	0.49	4.47	0.49	0.49	-0.34	92.37
	2	0.41	0.38	-4.72	0.39	0.40	1.51	67.95
	3	0.10	0.09	-4.29	0.10	0.10	-0.89	79.19
	4 or more	0.02	0.03	8.31	0.02	0.02	-1.73	79.16
# siblings in household	0	0.43	0.44	3.58	0.44	0.44	0.10	97.11
	1 other	0.43	0.42	-2.76	0.42	0.43	0.20	92.78
	2 others	0.12	0.10	-4.87	0.11	0.11	0.21	95.62
	3 or more	0.03	0.04	6.05	0.03	0.03	-1.02	83.12
Height-for-age[3]	(z score)	-0.13	-0.24	-6.04	-0.21	-0.21	0.03	99.52
Weight-for-age[3]	(z score)	0.86	0.88	1.09	0.85	0.87	1.66	-52.03
General health	excellent-very good	0.90	0.90	1.59	0.90	0.90	0.52	67.39
	good-poor	0.10	0.10	-1.59	0.10	0.10	-0.52	67.39

Presence of chronic condition in wave E01-E02 (5-17mo)	no	0.91	0.90	-4.01	0.89	0.90	1.89	52.86
	yes	0.09	0.10	4.01	0.11	0.10	-1.89	52.86
Frequency of acute infection in past 3 months	0	0.33	0.31	-5.93	0.31	0.32	0.94	84.10
	1	0.26	0.29	7.81	0.27	0.28	1.30	83.36
	2	0.19	0.20	1.93	0.21	0.20	-2.16	-12.19
	3 or more	0.21	0.20	-3.69	0.20	0.20	-0.31	91.70
Antibiotic treatment in past 6 months	0	0.44	0.39	-9.34	0.42	0.41	-1.46	84.42
	1	0.27	0.29	2.90	0.28	0.29	1.21	58.34
	2	0.14	0.16	5.79	0.15	0.15	0.32	94.43
	3 or more	0.15	0.16	3.35	0.15	0.15	0.16	95.20
Number of medical consultations in past 12 months		7.85	8.49	9.45	8.54	8.31	-2.19	76.82
MOTHER								
Age	(years)	30.71	30.29	-8.64	30.41	30.42	0.29	96.69
Immigrant status	non-immigrant	0.93	0.90	-10.74	0.92	0.93	0.65	93.97
	European immigrant	0.04	0.01	-16.84	0.02	0.02	0.43	97.47
	other immigrant	0.03	0.09	23.81	0.06	0.05	-0.96	95.97
Ethnicity	Canadian/European/First Nation	0.89	0.87	-5.61	0.88	0.89	0.59	89.48
	Other ethnicity	0.11	0.13	5.61	0.12	0.11	-0.59	89.48
Height	(meters)	1.63	1.64	5.62	1.64	1.64	-0.63	88.69
Maternal body mass index (BMI)		23.42	23.53	2.48	23.53	23.51	-0.30	87.86
General Health	excellent-very good	0.84	0.80	-8.87	0.82	0.82	-0.31	96.54
	good-poor	0.16	0.20	8.87	0.18	0.18	0.31	96.54
Depression index score	(0-10)	1.12	1.32	15.23	1.19	1.21	1.47	90.38
Smoking status (cigarette)	never	0.73	0.71	-4.46	0.72	0.71	-1.49	66.63
	occasional	0.04	0.04	-0.66	0.04	0.04	-0.29	56.81
	daily	0.23	0.25	4.99	0.24	0.25	1.70	65.89

Daily consumption of cigarettes	(# of cigs)	3.43	3.40	-0.47	3.40	3.54	1.67	-253.93
Alcohol consumption frequency	never	0.15	0.18	9.11	0.16	0.16	-0.44	95.16
	once/month or less	0.37	0.37	1.19	0.38	0.38	-1.22	-2.28
	2-4 times/month	0.35	0.33	-4.79	0.33	0.34	1.44	69.96
	2-7 times/week	0.13	0.11	-5.16	0.12	0.12	0.29	94.30
Frequency of drinking 5 or more drinks in past 12 months		0.67	0.88	6.69	0.84	0.81	-0.79	88.24
Uses of drugs or medication without prescription in past 12 months	none	0.98	0.96	-12.96	0.97	0.97	-3.53	72.74
	yes	0.02	0.04	12.96	0.03	0.03	3.53	72.74
Positive parenting score		8.67	8.74	6.49	8.70	8.71	1.05	83.82
Educational attainment	no high school degree	0.10	0.11	5.39	0.10	0.10	0.16	97.00
	high school degree	0.09	0.08	-4.18	0.10	0.09	-1.73	58.67
	some post-secondary	0.20	0.24	8.06	0.23	0.23	-0.01	99.90
	professional diploma/trade school	0.11	0.10	-2.92	0.10	0.11	1.01	65.55
	college degree	0.14	0.15	4.42	0.15	0.15	-1.81	59.00
	university degree	0.35	0.31	-9.45	0.32	0.33	1.85	80.39
Occupation	not employed	0.12	0.21	23.76	0.18	0.17	-2.32	90.24
	professional or executive	0.19	0.18	-2.67	0.18	0.19	1.36	49.16
	intermediate manager / technician	0.23	0.19	-12.10	0.21	0.21	0.72	94.02
	office workers / sales	0.36	0.34	-4.03	0.35	0.35	0.13	96.75
	skilled trade	0.06	0.05	-4.48	0.05	0.06	0.96	78.66
	unskilled trade /labourers	0.03	0.03	0.94	0.03	0.03	-0.58	38.43
Employment status	not employed	0.13	0.20	18.84	0.18	0.17	-1.78	90.56
	employed part time	0.17	0.19	5.71	0.18	0.18	-0.43	92.43
	employed full time	0.70	0.61	-19.41	0.64	0.65	1.83	90.55
FATHER								
Age	(years)	33.15	32.98	-2.97	32.96	32.96	0.02	99.37

Educational attainment	no high school degree	0.18	0.14	-11.75	0.15	0.16	2.66	77.37
	high school degree	0.10	0.11	2.84	0.11	0.11	-0.88	69.16
	some post-secondary (excl. university)	0.16	0.18	5.43	0.17	0.17	-0.27	94.94
	professional diploma/trade school	0.07	0.13	18.85	0.11	0.10	-1.97	89.56
	college degree	0.16	0.14	-4.33	0.15	0.15	0.96	77.77
	incomplete university	0.05	0.04	-3.13	0.05	0.05	-0.53	83.06
	university degree	0.27	0.25	-4.59	0.26	0.26	-0.26	94.42
Employement status (past 12 months)	not employed	0.02	0.04	8.77	0.03	0.03	-1.43	83.71
	employed	0.98	0.96	-8.77	0.97	0.97	1.43	83.71
FAMILY								
Family structure	intact[4]	0.85	0.79	-15.66	0.82	0.81	-2.40	84.70
	reconstituted	0.10	0.12	5.58	0.11	0.11	0.79	85.76
	single parent	0.05	0.10	16.39	0.07	0.07	2.65	83.85
Place of residence	Montreal CMA[5]	0.46	0.43	-5.85	0.44	0.44	-0.68	88.38
	Other CMA	0.24	0.24	-1.29	0.23	0.24	1.49	-15.45
	Census agglomerate of >10,000	0.09	0.13	12.56	0.12	0.12	-0.06	99.52
	Rural	0.21	0.20	-1.26	0.21	0.20	-0.62	51.01
Language spoken most often at home	French only	0.83	0.83	0.91	0.84	0.84	1.42	-55.97
	English only	0.10	0.06	-13.49	0.07	0.07	-0.63	95.33
	neither French or English	0.02	0.05	14.94	0.03	0.03	-2.66	82.23
	French and English	0.03	0.03	0.67	0.03	0.03	-0.15	78.27
	French or English & other language	0.02	0.03	3.18	0.02	0.02	1.90	40.21
Main source of household income	salary	0.84	0.83	-1.31	0.83	0.84	1.09	17.07
	self-employment earnings	0.11	0.07	-14.79	0.09	0.09	0.70	95.29
	social assistance	0.02	0.06	19.86	0.04	0.04	-1.55	92.19
	other	0.03	0.04	4.28	0.04	0.04	-1.24	70.98
Household income	< 20,000$	0.07	0.11	15.53	0.09	0.09	-0.48	96.94

20,000$ - 29,999$	0.08	0.10	6.53	0.09	0.09	0.50	92.41
30,000$ - 39,999$	0.13	0.13	0.69	0.14	0.14	-0.48	30.57
40,000$ - 49,999$	0.15	0.13	-4.82	0.14	0.14	0.10	98.02
50,000$ - 59,999$	0.12	0.15	8.84	0.13	0.13	1.12	87.32
60,000$ - 79,999$	0.23	0.20	-7.09	0.21	0.21	-1.28	81.95
80,000$ +	0.22	0.17	-12.69	0.19	0.19	0.73	94.28
SES index score	0.30	0.14	-17.21	0.20	0.21	0.42	97.53

[1]Sample includes missing values estimated through MICE. Results do not use survey sampling weights. Unweighted N=1365. PS-IPW weighted sample average N=1331.5 (sample size between 1325 and 1341). Note that certain variables predicting the propensity score have been altered in or omitted from the above table due to confidentiality restrictions.

[2]The % bias corresponds to the standardized mean difference, which is the difference of the sample means in the CPE and non-CPE childcare groups as a percentage of mean group standard deviation. Standard deviation was estimated by mean treatment-specific sample sizes given common-support restrictions resulted in multiply imputed datasets of varied size.

[3]Maternally reported child height and weight, standardized to age following the World Health Organization (WHO) child growth standards using WHO Anthro software for Stata

[4] Intact families correspond to a child living with both biological parents and siblings

[5] CMA - Census Metropolitan Area

Supplementary Table 1b: Balance from propensity score weighting in children at baseline (wave E02 – 17-month-old); CPE childcare users vs no childcare[1]

Covariates	Category	Unweighted			PS-Inverse probability weighted			
		no childcare	CPE	Bias%[2]	no childcare	CPE	Bias %	Bias reduction (%)
CHILD								
Gender	male	0.49	0.49	0.34	0.49	0.49	-0.87	-155.01
	female	0.51	0.51	-0.34	0.51	0.51	0.87	-155.01
Lenght of pregnancy (Gestational age)	(weeks)	38.96	39.11	9.63	39.11	39.08	-2.07	78.54
Birth weight	(kg)	3.39	3.41	4.74	3.42	3.41	-2.62	44.69
Age at breastfeeding cessation	(months)	3.98	3.86	-2.65	3.68	3.82	2.58	2.71
Birth rank	1	0.37	0.49	25.11	0.45	0.46	0.63	97.50
	2	0.40	0.38	-3.40	0.38	0.39	0.71	79.11
	3	0.15	0.09	-17.87	0.12	0.11	-2.98	83.30
	4 or more	0.08	0.03	-20.86	0.04	0.05	1.79	91.40
# siblings in household	0	0.35	0.44	19.90	0.42	0.42	-0.44	97.81
	1 other	0.40	0.42	2.78	0.40	0.41	1.56	44.00
	2 others	0.16	0.10	-17.84	0.12	0.11	-0.61	96.56
	3 or more	0.09	0.04	-20.65	0.06	0.06	-1.30	93.68
Height-for-age[3]	(z score)	-0.19	-0.24	-2.73	-0.25	-0.23	0.87	68.15
Weight-for-age[3]	(z score)	0.78	0.88	8.31	0.85	0.84	-0.92	88.98
General health	excellent-very good	0.90	0.90	0.66	0.90	0.91	2.94	-342.28
	good-poor	0.10	0.10	-0.66	0.10	0.09	-2.94	-342.28
Presence of chronic condition in wave E01-E02 (5-17mo)	no	0.92	0.90	-7.44	0.93	0.91	-4.82	35.21
	yes	0.08	0.10	7.44	0.07	0.09	4.82	35.21
Frequency of acute infection in past 3 months	0	0.37	0.31	-13.88	0.30	0.32	2.17	84.36

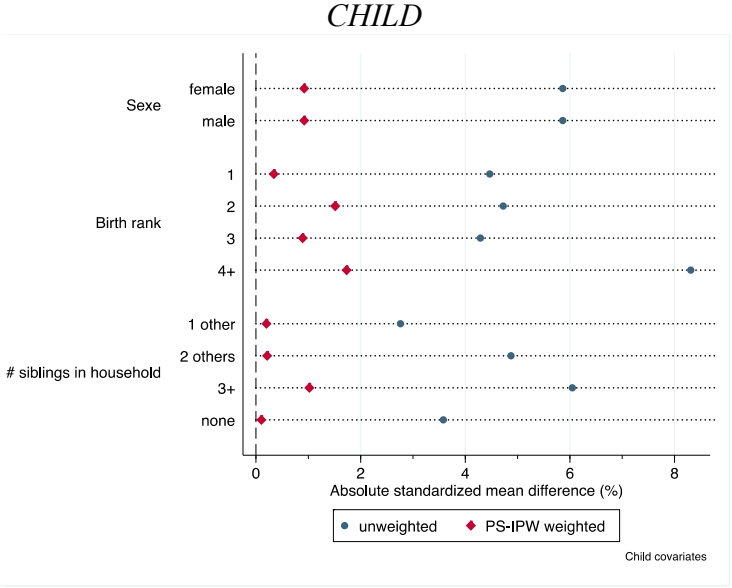
	1	0.34	0.29	-8.67	0.32	0.33	0.80	90.75
	2	0.15	0.20	11.88	0.19	0.18	-1.69	85.80
	3 or more	0.14	0.20	16.20	0.18	0.18	-1.49	90.82
Antibiotic treatment in past 6 months	0	0.49	0.39	-20.07	0.41	0.44	4.76	76.28
	1	0.27	0.29	3.34	0.30	0.28	-3.33	0.49
	2	0.13	0.16	8.99	0.14	0.15	0.30	96.63
	3 or more	0.11	0.16	15.44	0.15	0.14	-2.20	85.74
Number of medical consultations in past 12 months		7.33	8.49	19.23	8.23	8.12	-1.35	92.98
MOTHER								
Age	(years)	30.08	30.29	3.79	29.92	30.11	2.83	25.26
Immigrant status	non-immigrant	0.89	0.90	4.38	0.89	0.90	1.95	55.46
	European immigrant	0.04	0.01	-15.83	0.02	0.02	-0.81	94.88
	other immigrant	0.08	0.09	3.85	0.09	0.08	-1.75	54.50
Ethnicity	Canadian/European/First Nation	0.87	0.87	0.35	0.86	0.87	2.71	-682.63
	Other ethnicity	0.13	0.13	-0.35	0.14	0.13	-2.71	-682.63
Height	(meters)	1.63	1.64	16.64	1.64	1.64	-0.66	96.06
Maternal body mass index (BMI)		24.11	23.53	-11.94	23.72	23.63	-1.55	87.05
General Health	excellent-very good	0.71	0.80	21.36	0.76	0.77	2.82	86.80
	good-poor	0.29	0.20	-21.36	0.24	0.23	-2.82	86.80
Depression index score	(0-10)	1.54	1.32	-16.21	1.37	1.37	0.16	98.98
Smoking status (cigarette)	never	0.69	0.71	5.00	0.69	0.70	2.04	59.18
	occasional	0.03	0.04	7.25	0.04	0.04	-1.82	74.92
	daily	0.29	0.25	-8.13	0.27	0.26	-1.22	84.97
Daily consumption of cigarettes	(# of cigs)	4.65	3.40	-16.30	3.87	3.77	-1.16	92.90
Alcohol consumption frequency	never	0.28	0.18	-21.96	0.21	0.22	1.05	95.20
	once/month or less	0.40	0.37	-5.70	0.41	0.39	-4.58	19.68
	2-4 times/month	0.24	0.33	19.98	0.27	0.29	3.80	80.98

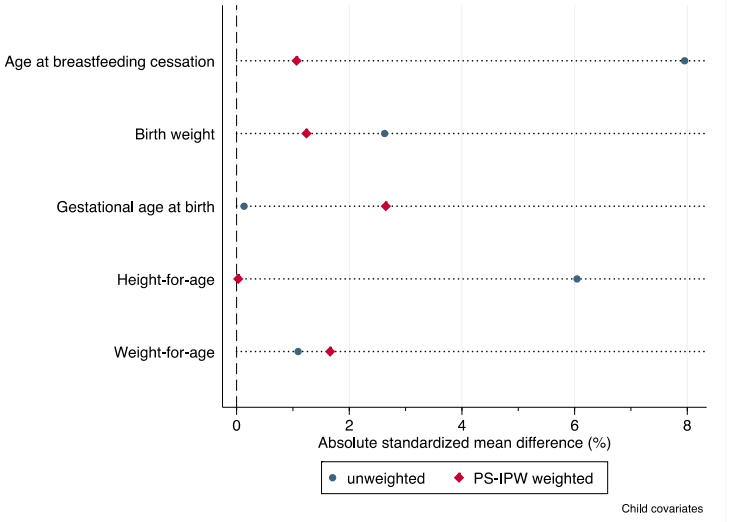
	2-7 times/week	0.08	0.11	9.98	0.10	0.10	0.62	93.84
Frequency of drinking 5 or more drinks in past 12 months		0.50	0.88	13.74	0.69	0.63	-1.85	86.51
Uses of drugs or medication without prescription in past 12 months	none	0.97	0.96	-10.09	0.95	0.97	5.57	44.78
	yes	0.03	0.04	10.09	0.05	0.03	-5.57	44.78
Positive parenting score		8.82	8.74	-8.63	8.78	8.81	2.32	73.07
Educational attainment	no high school degree	0.26	0.11	-38.60	0.17	0.17	0.85	97.79
	high school degree	0.14	0.08	-17.93	0.09	0.09	-0.52	97.07
	some post-secondary	0.24	0.24	0.52	0.26	0.24	-4.33	-729.50
	professional diploma/trade school	0.10	0.10	2.08	0.11	0.11	0.32	84.66
	college degree	0.11	0.15	11.74	0.13	0.14	3.09	73.71
	university degree	0.15	0.31	37.42	0.24	0.25	1.44	96.16
Occupation	not employed	0.58	0.21	-80.88	0.34	0.34	0.68	99.16
	professional or executive	0.05	0.18	40.15	0.15	0.14	-3.26	91.87
	intermediate manager / technician	0.08	0.19	31.11	0.14	0.15	0.80	97.44
	office workers / sales	0.21	0.34	28.63	0.29	0.30	1.98	93.09
	skilled trade	0.03	0.05	9.94	0.04	0.04	-0.19	98.08
	unskilled trade /labourers	0.04	0.03	-6.26	0.03	0.04	0.32	94.86
Employment status (lagged over one year)	not employed	0.53	0.20	-72.88	0.32	0.32	-1.00	98.62
	employed part time	0.16	0.19	7.08	0.19	0.18	-0.33	95.29
	employed full time	0.30	0.61	63.89	0.49	0.50	1.17	98.17
FATHER								
Age	(years)	32.77	32.98	3.67	32.76	32.74	-0.21	94.29
Educational attainment	no high school degree	0.26	0.14	-29.81	0.18	0.18	-1.29	95.67
	high school degree	0.12	0.11	-2.40	0.13	0.12	-0.22	90.88
	some post-secondary (excl. university)	0.19	0.18	-3.44	0.18	0.19	1.49	56.68

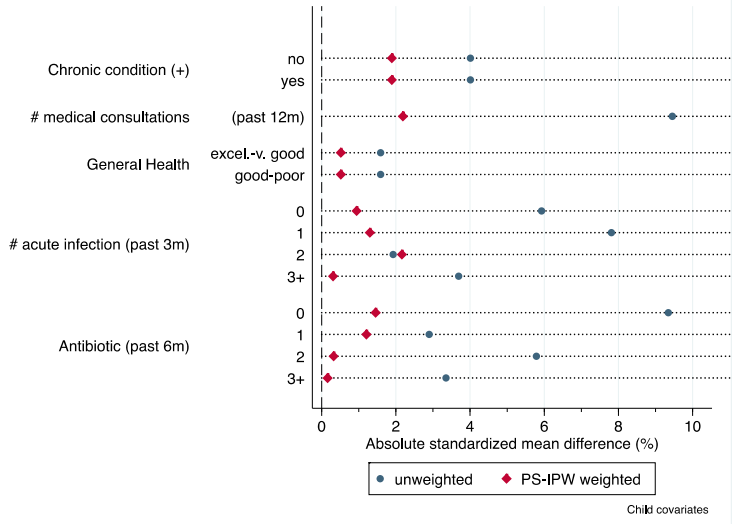
	professional diploma/trade school	0.12	0.13	2.99	0.12	0.12	1.37	54.19
	college degree	0.10	0.14	11.98	0.12	0.12	0.57	95.23
	incomplete university	0.03	0.04	5.37	0.04	0.04	-0.54	89.87
	university degree	0.17	0.25	20.15	0.23	0.23	-1.13	94.37
Employement status (past 12 months)	not employed	0.08	0.04	-16.33	0.05	0.05	0.91	94.45
	employed	0.92	0.96	16.33	0.95	0.95	-0.91	94.45
FAMILY								
Family structure	intact[4]	0.79	0.79	-0.10	0.79	0.80	1.73	-1706.56
	reconstituted	0.11	0.12	1.10	0.11	0.11	-1.73	-56.87
	single parent	0.10	0.10	-1.05	0.10	0.10	-0.47	54.90
Place of residence	Montreal CMA[5]	0.47	0.43	-7.63	0.46	0.44	-2.01	73.60
	Other CMA	0.14	0.24	25.16	0.18	0.20	4.58	81.78
	Census agglomerate of >10,000	0.13	0.13	0.79	0.14	0.12	-2.98	-276.07
	Rural	0.27	0.20	-14.83	0.23	0.23	0.88	94.06
Main source of household income	salary	0.71	0.83	29.66	0.78	0.78	-0.41	98.63
	self-employment earnings	0.11	0.07	-12.51	0.09	0.09	0.05	99.59
	social assistance	0.15	0.06	-28.31	0.09	0.09	-0.33	98.84
	other	0.04	0.04	-1.12	0.03	0.04	1.45	-29.57
Household income	< 20,000$	0.20	0.11	-23.00	0.15	0.15	-0.64	97.21
	20,000$ - 29,999$	0.16	0.10	-16.12	0.13	0.13	0.37	97.68
	30,000$ - 39,999$	0.19	0.13	-14.19	0.14	0.15	1.79	87.40
	40,000$ - 49,999$	0.14	0.13	-2.28	0.14	0.14	-1.40	38.48
	50,000$ - 59,999$	0.13	0.15	4.49	0.14	0.14	-0.12	97.22
	60,000$ - 79,999$	0.10	0.20	29.21	0.16	0.15	-1.50	94.86
	80,000$ +	0.09	0.17	23.78	0.13	0.14	1.68	92.92
SES index score		-0.40	0.14	56.53	-0.06	-0.06	0.32	99.43

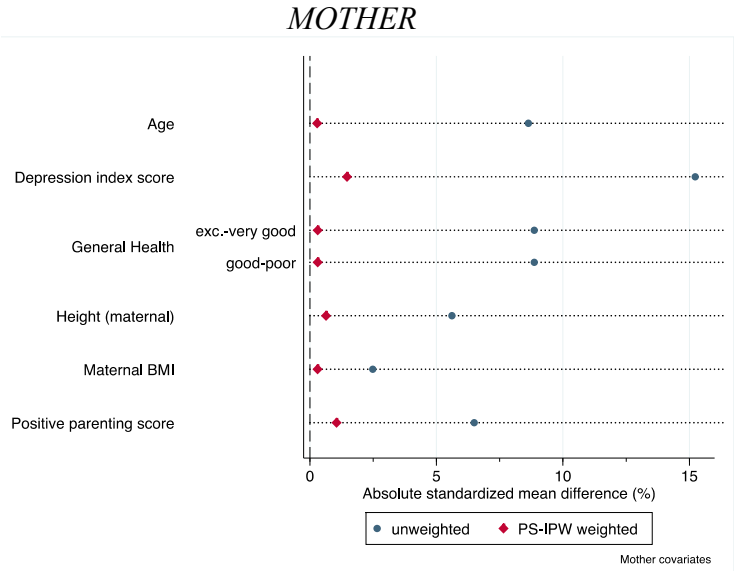
[1]Sample includes missing values estimated through MICE. Results do not use survey sampling weights. Unweighted N=1398. PS-IPW weighted sample average N=1353.9 (sample size between 1346 and 1365). Note that certain variables predicting the propensity score have been altered in or omitted from the above table due to confidentiality restrictions.
[2]The % bias corresponds to the standardized mean difference, which is the difference of the sample means in the CPE and non-CPE childcare groups as a percentage of mean group standard deviation. Standard deviation was estimated by mean treatment-specific sample sizes given common-support restrictions resulted in multiply imputed datasets of varied size.
[3]Maternally reported child height and weight, standardized to age following the World Health Organization (WHO) child growth standards using WHO Anthro software for Stata
[4] Intact families correspond to a child living with both biological parents and siblings
[5] CMA - Census Metropolitan Area

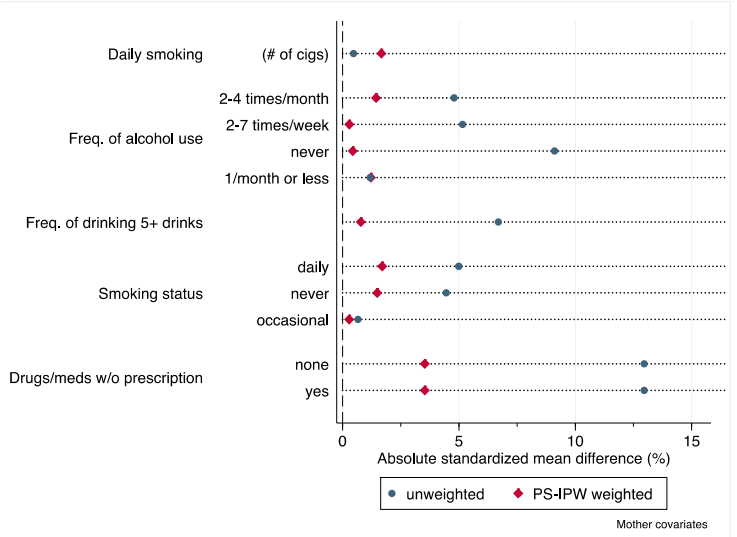
Supplementary Figure 1a: Standardized mean differences of covariates before and after PS-IPW; CPE childcare users vs non-CPE childcare users

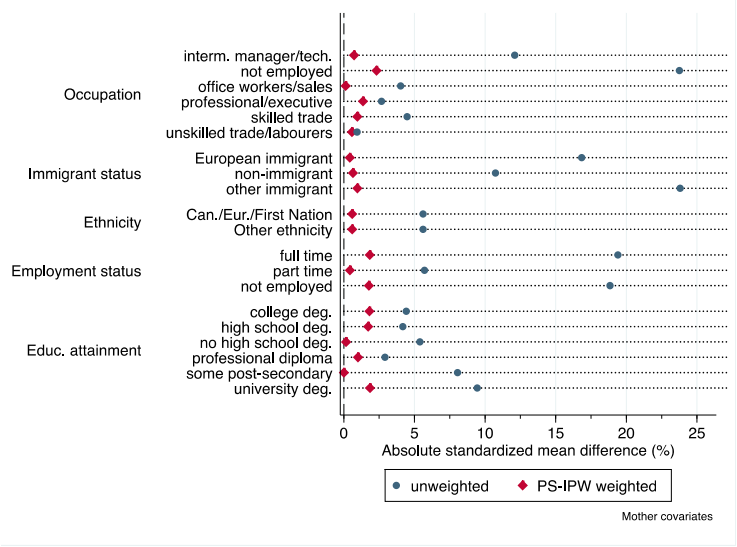




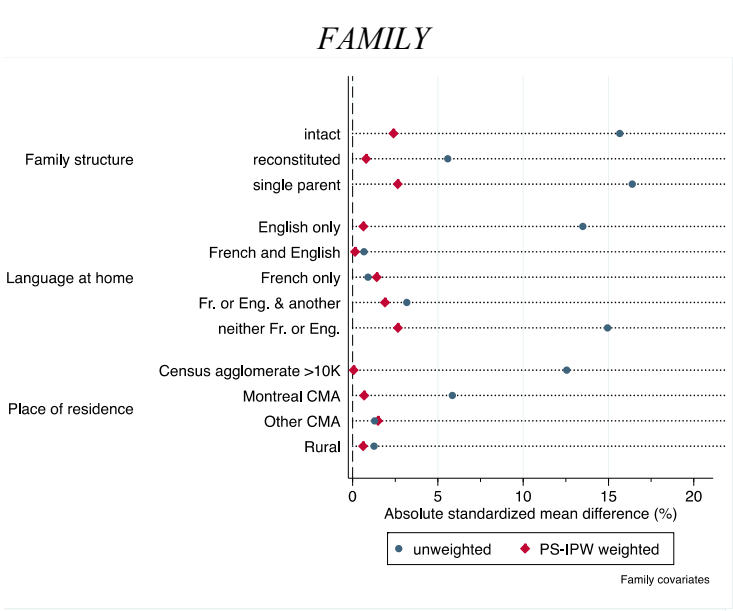


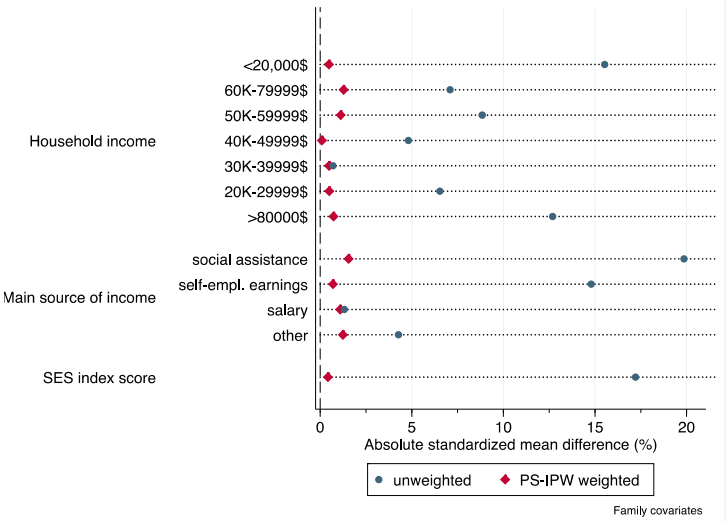


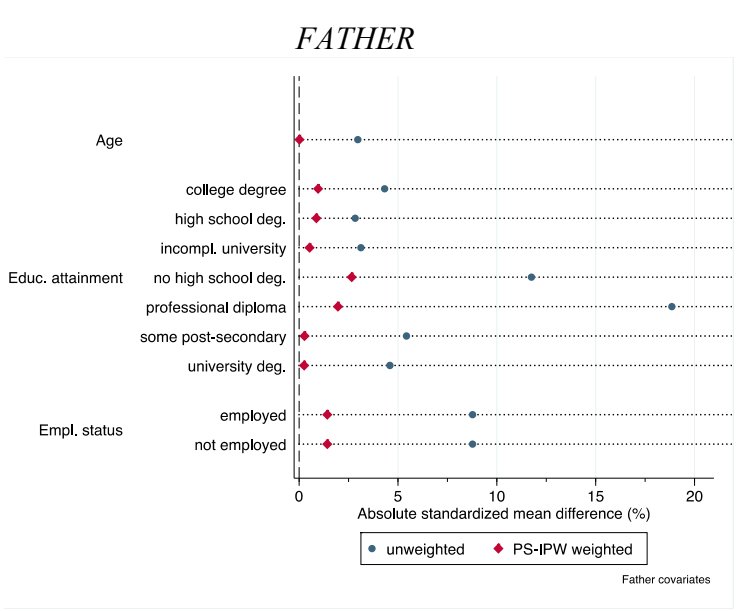




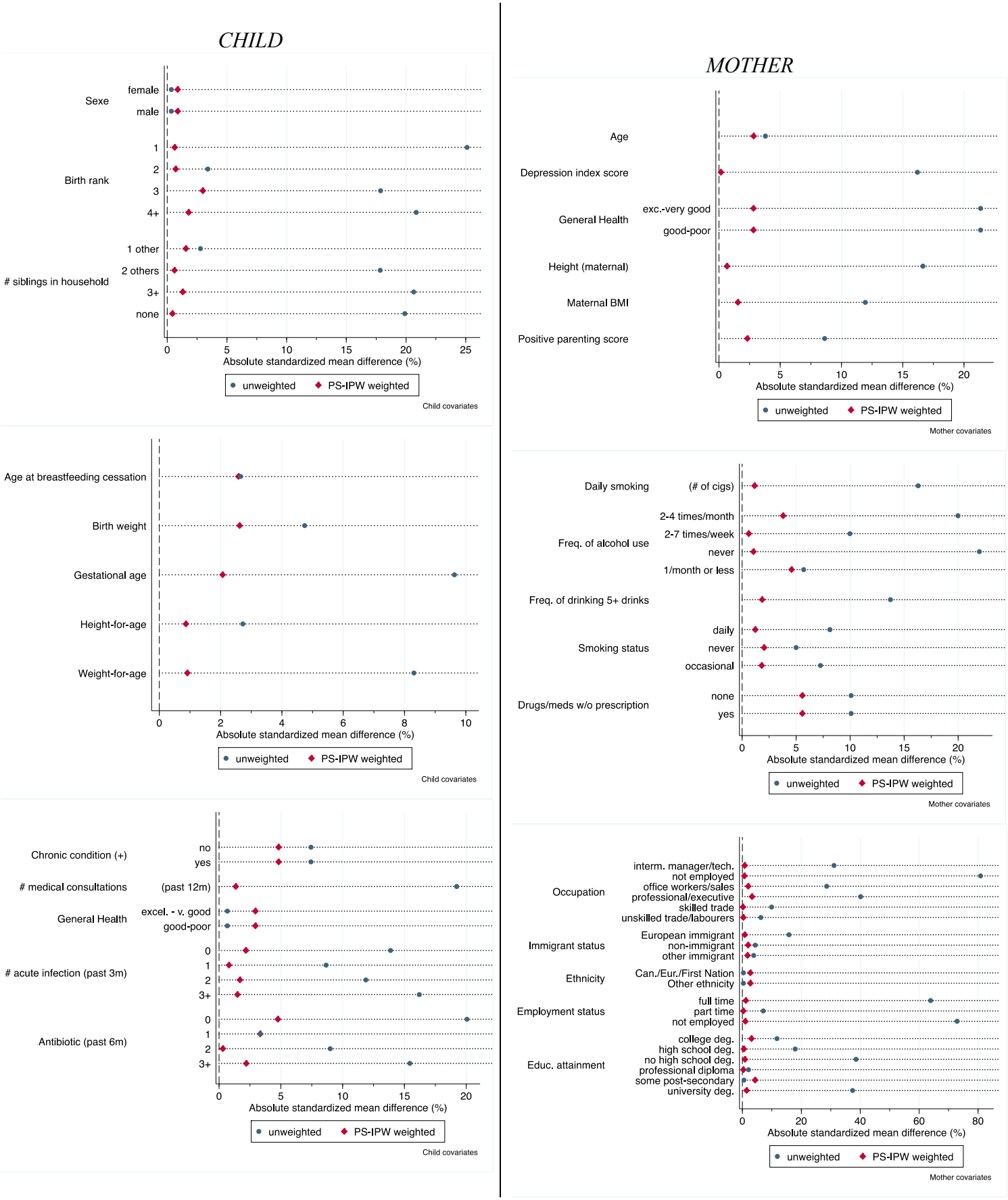
Supplementary Figure 1a: Standardized mean differences of covariates before and after PS-IPW; CPE childcare users vs non-CPE childcare users (cont.)



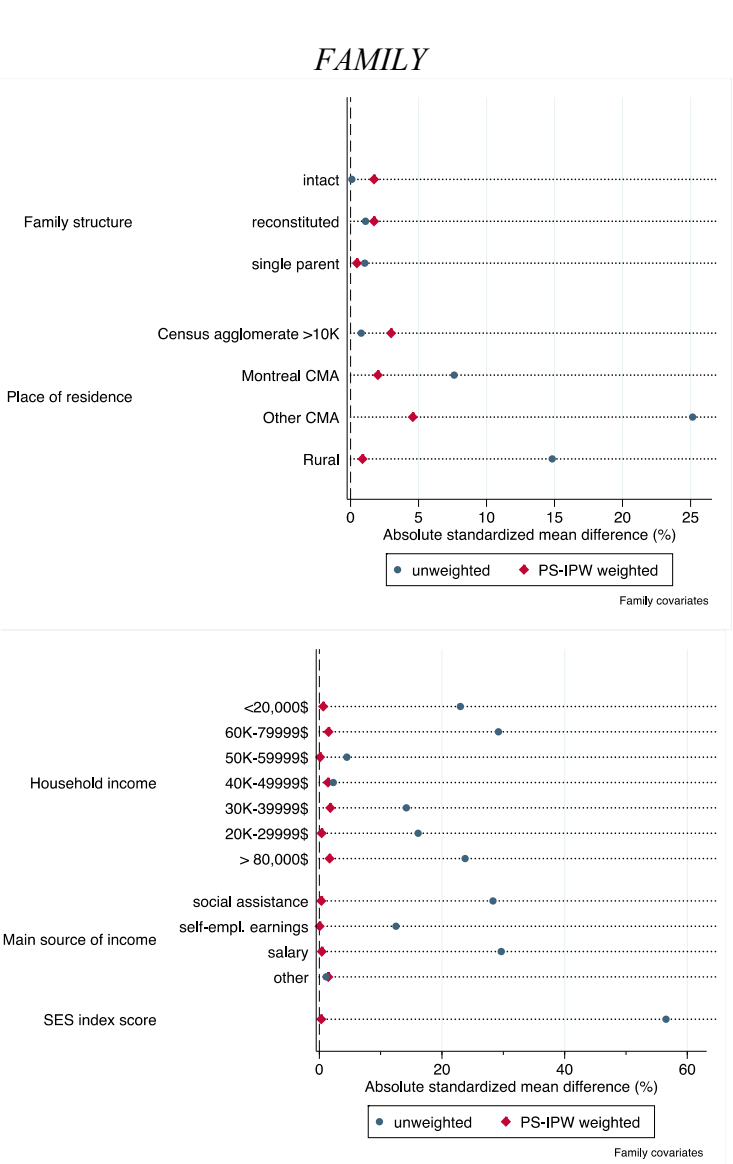


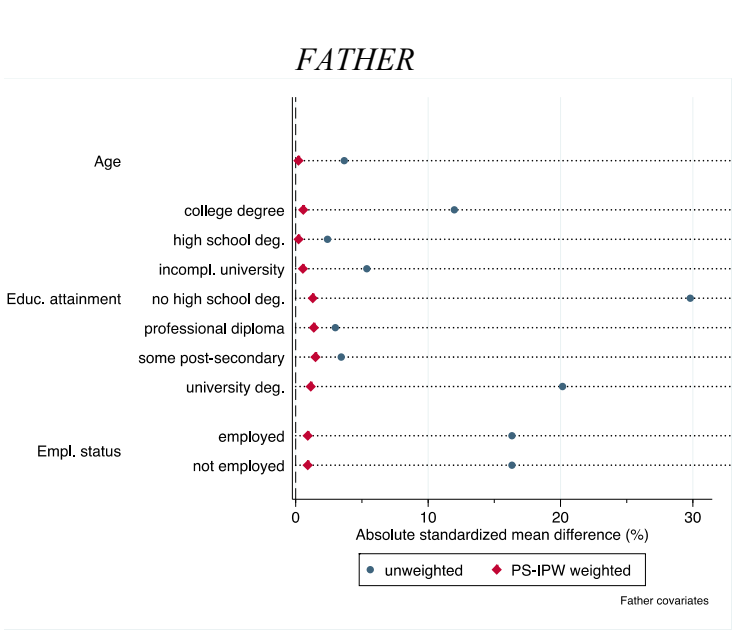


Supplementary Figure 1b: Standardized mean differences of covariates before and after PS-IPW; CPE childcare users vs no childcare



Supplementary Figure 1b: Standardized mean differences of covariates before and after PS-IPW; CPE childcare users vs no childcare





Supplementary Table 2: Absolute difference in mental health and behavioral index scores in 15-year-old children in PS-IPW balanced sample by levels of mother education and treatment contrasts

		CPE vs non-CPE childcare			CPE vs no childcare		
Index score		**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Generalised anxiety	Less than university degree	-0.19	(-0.68, 0.30)	0.45	-0.04	(-0.43, 0.35)	0.84
	University degree	0.06	(-0.48, 0.59)	0.84	0.36	(-0.36, 1.08)	0.33
	High school degree or less	-0.10	(-0.84, 0.64)	0.80	0.44	(-0.18, 1.05)	0.16
	Greater than high school	-0.12	(-0.54, 0.31)	0.59	-0.11	(-0.53, 0.31)	0.60
Depression	Less than university degree	0.02	(-0.42, 0.47)	0.93	0.02	(-0.41, 0.44)	0.94
	University degree	-0.07	(-0.60, 0.46)	0.80	0.10	(-0.66, 0.86)	0.80
	High school degree or less	-0.03	(-0.85, 0.79)	0.94	0.51	(-0.10, 1.12)	0.10
	Greater than high school	0.00	(-0.38, 0.38)	1.00	-0.16	(-0.62, 0.30)	0.49
Internalised behaviours	Less than university degree	-0.03	(-0.42, 0.36)	0.89	0.00	(-0.33, 0.34)	0.98
	University degree	-0.04	(-0.50, 0.43)	0.88	0.27	(-0.37, 0.90)	0.41
	High school degree or less	-0.02	(-0.63, 0.59)	0.94	0.39	(-0.14, 0.92)	0.15
	Greater than high school	-0.04	(-0.38, 0.31)	0.84	-0.07	(-0.43, 0.29)	0.71
Overall agression	Less than university degree	-0.08	(-0.26, 0.09)	0.36	-0.05	(-0.20, 0.09)	0.48
	University degree	0.06	(-0.12, 0.24)	0.53	-0.05	(-0.25, 0.15)	0.60
	High school degree or less	0.02	(-0.24, 0.27)	0.88	0.01	(-0.23, 0.24)	0.96
	Greater than high school	-0.05	(-0.20, 0.10)	0.53	-0.07	(-0.22, 0.07)	0.32
Externalised behaviours	Less than university degree	-0.101	(-0.30, 0.10)	0.32	-0.01	(-0.17, 0.15)	0.94
	University degree	0.085	(-0.14, 0.31)	0.45	0.09	(-0.20, 0.38)	0.53
	High school degree or less	0.103	(-0.18, 0.38)	0.474	0.08	(-0.22, 0.38)	0.60
	Greater than high school	-0.072	(-0.25, 0.10)	0.421	-0.01	(-0.16, 0.15)	0.93

Supplementary Table 3: Absolute difference in probabilities of substance use outcomes in 15-year-old children in PS-IPW balanced sample by levels of mother's education and treatment contrasts

		CPE vs non-CPE childcare			CPE vs no childcare		
Outcome[1]		**Difference**	**95%CI**	**p-value**	**Difference**	**95%CI**	**p-value**
Smoking							
Prevalence	Less than university degree	0.00	(-0.07, 0.07)	0.94	0.03	(-0.05, 0.10)	0.46
	University degree	0.02	(-0.04, 0.09)	0.51	-0.02	(-0.12, 0.08)	0.68
	High school degree or less	0.08	(-0.07, 0.23)	0.30	0.10	(-0.04, 0.24)	0.15
	Greater than high school	-0.01	(-0.06, 0.05)	0.75	-0.02	(-0.08, 0.05)	0.66
Frequency (>1 per month vs less)	Less than university degree	-0.01	(-0.06, 0.04)	0.75	0.03	(-0.02, 0.09)	0.26
	University degree	-0.01	(-0.04, 0.02)	0.54	0.00	(-0.03, 0.04)	0.79
	High school degree or less	0.04	(-0.06, 0.14)	0.42	0.05	(-0.06, 0.16)	0.40
	Greater than high school	-0.02	(-0.06, 0.02)	0.35	0.017	(-0.03, 0.06)	0.43
Alcohol consumption							
Prevalence	Less than university degree	0.00	(-0.1, 0.10)	0.95	-0.02	(-0.11, 0.08)	0.75
	University degree	0.01	(-0.11, 0.14)	0.83	0.03	(-0.14, 0.20)	0.75
	High school degree or less	0.05	(-0.13, 0.22)	0.60	0.11	(-0.03, 0.25)	0.12
	Greater than high school	0.00	(-0.09, 0.09)	0.96	-0.05	(-0.15, 0.05)	0.31
Frequency (>1 per month vs less)	Less than university degree	-0.04	(-0.08, 0.01)	0.13	-0.01	(-0.06, 0.04)	0.71
	University degree	0.01	(-0.04, 0.06)	0.64	-0.05	(-0.15, 0.05)	0.35
	High school degree or less	-0.01	(-0.08, 0.07)	0.81	0.01	(-0.05, 0.07)	0.67
	Greater than high school	-0.02	(-0.06, 0.02)	0.27	-0.03	(-0.09, 0.03)	0.31
>5 drinks in at least one occasion	Less than university degree	-0.02	(-0.12, 0.08)	0.72	-0.02	(-0.12, 0.08)	0.72
	University degree	0.07	(-0.06, 0.19)	0.31	0.06	(-0.11, 0.23)	0.47
	High school degree or less	0.07	(-0.11, 0.25)	0.42	0.08	(-0.07, 0.24)	0.30
	Greater than high school	0.00	(-0.09, 0.08)	0.93	-0.04	(-0.15, 0.07)	0.53
Drug use							
Prevalence	Less than university degree	0.00	(-0.08, 0.08)	0.99	0.01	(-0.08, 0.09)	0.84
	University degree	0.07	(-0.01, 0.15)	0.08	-0.03	(-0.15, 0.09)	0.64
	High school degree or less	0.09	(-0.07, 0.24)	0.26	0.05	(-0.08, 0.18)	0.46
	Greater than high school	0.01	(-0.06, 0.08)	0.74	-0.02	(-0.11, 0.07)	0.64
Frequency (>1 per month vs less)	Less than university degree	-0.03	(-0.08, 0.03)	0.30	0.02	(-0.04, 0.07)	0.62
	University degree	0.02	(-0.02, 0.06)	0.35	0.02	(-0.03, 0.06)	0.40
	High school degree or less	0.04	(-0.03, 0.12)	0.26	0.073	(-0.01, 0.15)	0.07
	Greater than high school	-0.03	(-0.07, 0.02)	0.27	-0.01	(-0.07, 0.05)	0.76

[1]As reported in the past 12 months