



'Dose-response' relations between participation in integrated early childhood services and children's early development



Sejal Patel^{a,*}, Carl Corter^b, Janette Pelletier^b, Jane Bertrand^c

^a School of Early Childhood Studies, Faculty of Community Services, Ryerson University, 350 Victoria Street, Toronto, ON M5B 2K3, Canada

^b Dr Eric Jackman Institute of Child Study, Ontario Institute for Studies in Education (OISE), University of Toronto, 45 Walmer Road, Toronto, ON M5R 2X2, Canada

^c Margaret and Wallace McCain Family Foundation, 54 Shannon Street, Toronto, ON M6J2E7, Canada

ARTICLE INFO

Article history:

Received 1 August 2014

Received in revised form 8 December 2015

Accepted 11 December 2015

Available online 25 March 2016

Keywords:

Early childhood program dose effects

Integrated services for children and families

Ecology of child development

ABSTRACT

This study investigated the effects of participation levels (dose) on child development (response) in five school sites offering integrated early childhood services as part of the Toronto First Duty (TFD) demonstration project. The TFD model offered an integrated school-based service array for children under 6, including public school kindergarten, childcare, family literacy, parenting supports and other early childhood services. While investigating program dose effects, this study also considered the social ecology of the child, including family- and school-level characteristics that might alter the effectiveness of community-level service integration efforts to improve child development outcomes in kindergarten as children enter school. The ecology of participation effects was examined through generalized linear modeling techniques analyzing a linked dataset ($N = 272$) including intake data on family demographics and parents' goals on service use, systematic tracking data on hours of program use, service integration level data across school sites, and child development data across five domains on the Early Development Instrument (EDI). The results provide evidence that the early childhood integrated service model has potential to improve children's developmental outcomes: participation dose predicted children's physical health and well-being, language and cognitive development, and communication and general knowledge, after taking into account demographic, parent engagement and site factors. Parents' being less child-centered in their goals for service use and less interested in school involvement were significant risk factors associated with children's developmental outcomes. This study has implications for understanding the ecological complexities of early human development and integrated service supports in a school-as-hub model.

© 2016 Elsevier Inc. All rights reserved.

1. Introduction

A strong conceptual argument has been made for integrating multiple early childhood services on the basis of a social-ecological analysis of how complex social contexts affect child development and parenting (Lerner, Rothbaum, Boulos, & Castellino, 2002; Patel & Corter, 2011), following Bronfenbrenner (1979) theory. In short, if services are to be effective, they need to affect multiple points in the child's social ecology, in mutually reinforcing ways. In terms of social ecology, service integration can work to improve service and family microsystems where bi-directional interactions directly shape the child's development. Service integration also bridges the mesosystem—the dynamic links among microsystems supporting

the child, including connections among child and family services and between services and home. Service integration also operates beyond the front lines of the child's microsystems and their direct mesosystem connections. At the exosystem level, it necessarily entails local organizational support for integrated community-level service delivery, and at the macrosystem level it reflects the broad social policy environment (Lerner et al., 2002).

Kindergarten, childcare, and other early childhood community programs represent multiple microsystems where the interactions surrounding children help to support development. Time spent in, or dose of, high-quality program microsystems should enhance development, and there is evidence that settings where programs are integrated on site are higher in quality than their separate equivalents (Cortner et al., 2009; Melhuish et al., 2007; Sylva, Melhuish, Sammons, Siraj-Blatchford, & Taggart, 2004). Arguments for service integration have also been made on the basis of the importance of building continuity across the mesosystem linking

* Corresponding author.

E-mail address: patel.sejal@ryerson.ca (S. Patel).

service microsystems with each other and with the microsystem of the home (Corter, Patel, Pelletier, & Bertrand, 2008; Pelletier & Corter, 2006). Continuity works horizontally as the parent and child move across settings and vertically as the child moves through developmental transitions in time (Saracho & Spodek, 2003). Service integration can work horizontally and vertically, and it may help foster greater continuity in programming and fewer daily transitions, as well as easing developmental transitions across home, early childhood programs, and school (Pelletier, 2012; Regional Educational Laboratories' Early Childhood Collaboration Network, 1995). When integrated services include parent–child programming such as family literacy, continuity in terms of language learning opportunities may develop between home and program microsystems. When integrated services include public school kindergarten programs in a school-as-hub model, these links may produce greater engagement between parents and schools (Patel & Corter, 2013; Zigler & Finn-Stevenson, 2007).

Evidence from qualitative process analysis also suggests that an integrated community of multiple services at a single site may have more diverse appeal to families and may thus help bridge the mesosystem between home and services in other ways, for example, by facilitating outreach and enrolment (Patel & Corter, 2008) and by building family–service relationships and parents' motivations, with parents being more confident in supporting learning at home and in communicating with professionals, as well as drawing more social support from them (Arimura & Corter, 2010; Patel & Corter, 2013). In turn, such mesosystem engagement may enhance the quality of the child's microsystems. Service integration may also change the organizational exosystem surrounding service microsystems in ways that benefit their quality and thereby indirectly enhance child development outcomes. For example, service integration has been shown to bring about practical improvements in organizations through opportunities for staff support (Selden, Sowa, & Sandfort, 2006), professional development and collaboration (Corter et al., 2008).

Beyond conceptual arguments for service integration and the evidence to date on processes through which it may support early development, the interest and experimentation have extended to international contexts for program and policy development. In the UK, the Sure Start national policy initiative targeted multiple service supports to low economic neighborhoods with a shift from service networks to integrated neighborhood centers as the policy was refined on the basis of evidence from the EPPE study pointing to the value of integrated care and education programs (Melhuish, Belsky, & Barnes, 2010). In the US and Canada, a number of integrative initiatives have provided school-linked services for young children and parents in low economic neighborhoods, including the Chicago Child-Parent Center (CPC) program (Reynolds, 2004b), the Ontario Better Beginnings, Better Futures (BBBF) project (Peters et al., 2010), and the Schools of the 21st Century (21C) initiative implemented across a number of states in the US (Zigler & Finn-Stevenson, 2007). The evaluation evidence from these initiatives is promising. Short-term and long-term benefits for children and for parenting were found in both the CPC (Reynolds, Temple, & Ou, 2010) and BBBF evaluations (Peters et al., 2010); benefits for parents were found in Sure Start, although there were no lasting benefits for children (Melhuish et al., 2010).

Outside of Western countries, integrated early childhood programs targeting families with lower socioeconomic status often integrate health with education, as in India's Project Grow Smart program, which combines nutrition supplementation and support for parenting and early learning through home visiting (Fernandez-Rao et al., 2014). International interest in the integration of early education and care is also seen in the policy work of the Organisation for Economic Co-operation and Development (OECD, 2006) and United Nations Educational, Scientific and Cultural Organiza-

tion (UNESCO; Kaga, Bennett, & Moss, 2010), with related program initiatives extending beyond Western countries. Both UNESCO and OECD promote integration of child care and early education as a universal approach to supporting child development for all by optimizing the auspice and delivery of services, not simply as a targeted approach to risk.

1.1. Program participation and 'dose-response' effects

Who enrolls and how much they attend are critical questions for examining the effects of programs, whether they involve targeted or universal approaches, and whether they involve single services or multiple services with varying degrees of integration. Across different types of early childhood programs, child and family participation typically varies from one family to the next (Gomby, 1999; Gomby, Culross, & Behrmann, 1999; St. Pierre, Layzer, & Barnes, 1995). Furthermore, evaluated programs often are not delivered with the same level of intensity that program developers planned for (Gomby, 1999). Although such variability in participation is an important contributor to outcomes (Spath & Redmond, 2000), it is rarely accounted for in research on program effectiveness (Hill, Brooks-Gunn, & Waldfogel, 2003). Thus, the role of "dose," "dosage," or "intensity" has been identified as one of the most influential, yet poorly researched, aspects of early childhood interventions (Reynolds, 2004a; Shonkoff & Phillips, 2000). Studying the effectiveness of programs at different doses or intensities has implications for understanding what might be an appropriate program intensity (Warren, Fey & Yoder, 2007), and the topic is timely given the growing attention to implementation processes in approaches such as implementation science (Odom et al., 2010).

The findings in the Effective Provision of Pre-School Education Project (EPPE) study in the UK showed developmental benefits of quantity of formal, quality early childhood programming, based on a variety of service types, at school entry and up to seven years of age (Sammons, 2010; Sylva et al., 2004). The EPPE study examined children whose experience came from play groups, nursery classes, child care, or integrated care and education, although only about 6% of participants were in integrated programs. Since program effects are likely to reflect both quantity and quality of program experience, it is notable that program quality of integrated care and education in this study was higher than for other program types. With respect to quantity, duration of program experience across program types and measured in months predicted better child development outcomes at school entry on a variety of cognitive measures; number of sessions attended also predicted cognitive development, but not as strongly. Effects on social development at school entry were more modest. Interestingly, while the number of individual sessions attended, months of experience, and years of experience were predictive, half-time vs. full-time enrolment was not predictive, although this comparison was complicated by program type since few types were full-time (Siraj-Blatchford, 2010). While the EPPE results show that cumulative program experience was key, along with the quality of service, the half-time vs. full-time finding illustrates that exposure–outcome relations may not always be linear, and that there may be both ceiling and threshold effects (Nicholson, Lucas, Berthelsen, & Wake, 2010).

Research investigating program participation in comprehensive early childhood programs with multiple services targeted to risk has primarily focused on investigations comparing the intervention group to a control group who did not participate in the intervention (Campbell & Ramey, 1994; Reynolds, 2004b), or on program duration defined by naturally occurring variations in number of years of enrolment (Reynolds, 2004b), or half-day vs. full-day participation (Reynolds et al., 2014), or "high" participation dose group versus "low" participation dose group comparisons within a treatment group (Hill et al., 2003). In summary, there has been

little research investigating program intensity defined in terms of dosage of sessions or hours for individual children in comprehensive or integrated early childhood programs; this is particularly true for integrated programs designed for universal application. The present study adds to the existing literature by investigating whether the cumulative number of hours of participation in early childhood integrated programs, available to all children in a community, successfully predicted children's development in kindergarten.

1.2. Context for the study – Toronto First Duty Project

The Toronto First Duty (TFD) demonstration project aimed to integrate previously separate early childhood community services in school hubs as a universal platform to support child development and parenting (see <http://www.toronto.ca/firstduty/>). Five school sites located in culturally diverse and mixed economic neighborhoods in Toronto, Ontario, Canada offered integrated early childhood services to all young children and families in the community. Core services at every site included kindergarten, childcare, and parenting support or family literacy programs. Other services varied across sites and included public health, family counseling, library, and other community resources. During the initial phase of TFD (2001–2006), half-day, non-mandatory kindergarten for 4 and 5 year olds was universally available in Ontario schools as part of the public education system.

In the TFD project, the Early Development Instrument (EDI), a kindergarten teacher-completed measure of children's development in five major domains (Janus & Offord, 2000; Janus & Offord, 2007), was an important part of assessing potential effects of programming on children. In comparisons of cohorts across the implementation of TFD, improvements in EDI scores were noted. A comparison of 5-year-old children at TFD schools who were in senior kindergarten in 2003 ($N=361$) and those who were in senior kindergarten in 2005 ($N=319$), found modest but significant improvements in the emotional maturity and social competence domains of the EDI in the 2005 group (Corter et al., 2008). Evidence for the impact of TFD on emotional maturity and social competence also appeared in quasi-experimental comparisons of children who were in senior kindergarten in 2005 across four TFD sites ($N=222$) and four matched school sites ($N=222$) where integrated early childhood programs were not available (Corter et al., 2008). School sites were matched on an omnibus demographic risk index, based on census data on factors such as low income, single parent status, and education level (Toronto District School Board; TDSB, 2005, 2007). The within-TFD comparisons across cohorts as the project "matured," as well as the comparisons between TFD and matched school sites, provide converging evidence suggesting that TFD programming had a positive population-level influence on children's social competence and emotional maturity. Benefits to children were expected, given that quality of integrated services increased across project implementation, with "good" to "excellent" overall quality on the Early Childhood Environment Rating Scale (ECERS-R) in all five TFD sites at the point of program maturity (Corter et al., 2007, 2009). Furthermore, social and emotional development were targeted for particular attention in the integrative programming at TFD sites, whereas language and literacy were a focus at both comparison and TFD sites (Corter et al., 2008). Physical health was not an explicit program focus in either the TFD or comparison sites.

While these findings are promising evidence for possible benefits of integrated early childhood services, using teacher ratings to test an intervention when teachers are part of the intervention introduces the possibility of bias (Pianta, Steinberg, & Rollins, 1995). Thus, a concern with the comparison of EDI teacher ratings across school sites with and without TFD is that ratings might be affected differentially by teacher bias stemming from teachers becoming

personally invested in the TFD model (Corter et al., 2008). Unlike the aforementioned study investigating school level differences, the design of the present study eliminates potential effects of such bias on the results, since all of the dose analyses are comparisons within TFD sites.

1.3. The present study

The present study advances previous work on the effects of integrated services by investigating how the dose or intensity of participation within TFD integrated early childhood services relates to outcomes in child development, while considering demographic, parenting, and school site variables. The approach of the study follows an ecological conceptual framework. Rimm-Kaufman and Pianta (2000) and the recent edited volume by Perry, Dockett, and Petruwskyj (2014) highlight the importance of acknowledging the combined influence of the interacting elements of the child's social ecology (Bronfenbrenner, 1979) in the measurement and understanding of children's development and school readiness. We reasoned that dose effects of TFD integrated early childhood programming might have operated by increasing supports for child development through mesosystem connections between parents and programs, increasing continuity across program staff and program approaches, and giving children and parents more time in quality program microsystem settings. In keeping with the ecological framework, we also analyzed nested predictors ordered from those that were proximal to the child (child/family demographics) to those that bridged the mesosystem between home and program (parent engagement with services), to the more distal site-level differences in level of service integration.

The basic question of the study was whether children's participation or variations in time spent in quality integrated settings would predict differences in early child development. We hypothesized that more participation, or higher doses, of integrated early childhood programming would benefit development, but might do so differently across the domains represented on the EDI. Time spent in high-quality service microsystems relates to child development outcomes in many studies, but the effects are not the same across all domains (Sylva et al., 2004).

Based on the ecological framework, we also hypothesized that demographic factors would predict developmental outcomes for children in TFD settings, and that parental interests and experiences in utilizing community services, as well as site-level differences in service integration levels would add to the predictive effects. Demographic factors, such as parental education, are consistently related to outcomes, with effects that persist long after participation in early childhood programs (Melhuish, 2010). Parents' goals for participation, their interest in school involvement and the extent of their previous use of other early childhood community services could also add to the prediction of child development outcomes. Greater interest and histories of service use could improve parents' engagement with TFD services, including their interactions on site, or their bringing practices into the home from site-based services such as family literacy programs (Patel & Corter, 2013). Organizational levels of service integration could have a variety of indirect effects on child development outcomes; for example, through their effects on staff work and program quality (Selden et al., 2006).

2. Method

2.1. Participants

Most 4- and 5-year-old kindergarten-aged children in TFD community sites attended non-mandatory half-day kindergarten

Table 1
Descriptives of Categorical Independent Variables (N = 272).

		N	N(%)
JK (0)/SK (1)	JK	137	50.37%
	SK	135	49.63%
	Total	272	100.00%
Sex of child (0 = F, 1 = M)	Female	148	54.41%
	Male	124	45.59%
	Total	272	100.00%
EL1 Status = 0, EAL Status = 1	EL1 Status	205	75.37%
	EAL Status	67	24.63%
	Total	272	100.00%

regardless of whether families chose to participate in additional TFD services. Junior and senior kindergarten, for 4- and 5-year-olds respectively, are part of the public education system in Ontario and elective enrolment is nearly universal; enrolment in other services such as child care and family support programs is much lower. For example, in the Toronto District School Board (TDSB) enrolment in senior kindergarten is 97%, whereas parental reports of enrolment in early childhood services is approximately 27% in child care centers and 32% in other early childhood programs (TDSB, 2009).

Focal participants in this study included 272 children who attended kindergarten in TFD schools and who participated in other TFD services to varying degrees, along with their parents. This sample of convenience was drawn from families who were registered in a TFD Intake and Tracking system, which included TFD participants from 2002 to 2006, and whose intake and participation data could be matched with school-board-wide kindergarten assessment on the EDI. The total number of kindergarten children at the five sites during this period for whom EDI data were available was 501; thus, the sample of 272 represented 54.3% of the total. The children in this study were in half day kindergarten as 4-year-olds (Junior Kindergarten-JK) or 5-year-olds (Senior Kindergarten-SK) in 2003 or 2005. Children were culturally diverse, with one quarter (24.6%) speaking English as an additional language (EAL), and the remaining 75.4% speaking English as a first language (EL1). Just over half of the children in the sample were females (54.4%), and there were almost equal proportions of JK and SK children. Over one third of the children's mothers in the sample had a high school education level or less (39.7%), with approximately one third (29.8%) having completed a college diploma or a university degree.

2.2. Measures

This study examines linked data from three sources: (1) TFD Intake and Tracking data, which include parental self-reports at intake on demographic and parent engagement factors and staff-entered tracking data on program attendance, (2) site level data on the level of integration across the TFD sites, and (3) Early Development Instrument (EDI) data, which include teacher-report data on demographic factors and ratings of 4- and 5-year-old children's developmental outcomes (Janus & Offord, 2007). By parent, we refer to the adult(s) who deal with the early childhood programs and services such as the parent, guardian, grandparent, etc. Descriptive statistics of all independent variables can be found in Tables 1 and 2. Intake and Tracking data were collected through intake interviews and records of attendance entered in a specially designed software system by TFD site staff. Interviews took place when families first enrolled in any of the TFD integrated services.

2.2.1. Demographic measures

Intake interviews with the adults who deal with services (e.g., mother, father, grandparent) asked about parental education level, language status (EL1, EAL), and employment status.

2.2.2. Parent engagement measures

Intake interviews also asked about parents' goals in accessing early childhood services, parents' level of interest in school involvement, and parents' prior program use, with a list provided for families to select options from. Parents' goals were categorized as parent-centered and child-centered goals (Dix, 1992). Child-centered goals in accessing early childhood services included items such as supporting children's development, preparing children for school, and enabling children to meet other children. Parent-centered goals included items such as parents wanting to be a part of a group, to learn more about parenting, and to have the chance for a break. A proportion of child-centered goals score was calculated based on the percentage of overall goals selected by parents that were child centered. Parents reported their level of interest in school involvement by selecting from a list of activities on the intake form including parents' willingness to organize special events, to be contacted by the school, and to participate on committees, among other activities that involve interaction between parents and the school. The number of school involvement activities that parents reported interest in were tallied. The intake form also asked about parents' prior early childhood program and service use. From this information, the number of programs parents used prior to TFD was quantified. These data were entered into the Intake and Tracking system, managed through the City of Toronto, one of the TFD partners.

2.2.3. Participation dose

The Intake and Tracking system also tracked the cumulative total number of hours that each family participated in TFD services. The total cumulative hours of participation averaged 780 h per child. While families participated in a unique combination of specific services, most families accumulated the bulk of their total participation hours from their children's participation in early childhood education outside of kindergarten (average of 729 h per child) and children's participation with a family member in parent-child programs (average of 49 h). For further information regarding the TFD Intake and Tracking system, which includes data collected based on families who participated in TFD between 2002 and 2006, see Patel, Corter, and Pelletier (2008) and Patel (2009).

2.2.4. Levels of service integration

In order to support and assess site-level progress toward the goal of school-based service integration, the Indicators of Change tool (Toronto First Duty Research Team, 2005) was developed as a management tool and research measure. The Indicators of Change broadly describes service integration as a continuum with five levels: Coexistence (level 1), Coordination (level 2), Collaboration (a) (level 3), Collaboration (b) (level 4), and Integration (level 5). These levels are applied across five key dimensions of integration: Early Learning Environment, Early Childhood Staff Team, Seamless Access, Parent Participation, and Governance. The Indicators of Change was completed across TFD sites in 2003 and 2005 through structured group interviews with frontline staff and members of the site management committee. Each TFD site received an integration score out of 120. There is evidence that the Indicators of Change tool provides an objective assessment of integration levels (Cortier et al., 2009). The evidence includes correspondence between levels of integration from Indicators of Change assessments and concurrent conclusions from detailed case study observations of functioning programs, meetings, document analysis, interviews, and surveys with frontline staff, site management, and parents. In particular, correspondence was found between the Indicators of Change and program quality ratings (Cortier et al., 2007, 2009), using the Early Childhood Environment Rating Scale-Revised (ECERS-R; Harms,

Table 2
Descriptives of Continuous Independent Variables ($N = 272$).

	<i>N</i>	Minimum	Maximum	Mean	Std. deviation
Cohort (0 = 2003, 1 = 2005)	272	0	1.00	.74	.44
Maternal education (1 = Elem, 2 = SomeHS, 3 = CompHS, 4 = SomeColl, 5 = CompColl, 6 = SomeUni, 7 = UniDeg, 8 = GradDeg)	251	1.00	8.00	4.42	1.94
Proportion (%) of child-centered goals (# of child-centered goals/# of total goals)	264	0	1.00	.60	.23
Interest in school involvement? (level 0–5)	272	0	5.00	2.43	1.76
Number of other programs/services used by family prior to TFD (0–13)	272	0	10.00	2.22	1.92
Indicators of Change level of service integration	272	49.50	86.16	68.01	13.43
Total cumulative hours of TFD participation	272	0	3851.50	779.80	1124.91
Valid <i>N</i> (listwise)	272				

Clifford, & Cryer, 2005), with TFD site level ratings in the good to excellent range on the ECERS-R (Cortner et al., 2006).

2.2.5. Early development instrument (EDI)

Early Development Instrument data were collected by the Toronto District School Board, one of the TFD partners, as part of their board-wide collection in 2003 and 2005. The EDI is an inventory of early development, or school readiness (Janus and Offord, 2007), that kindergarten teachers complete in the Spring, after approximately six months of experience with their class (Offord Centre for Child Studies, 2005). The core section of the EDI (2005 version) consists of 103 items categorized into the following child development domains: physical health and well-being (13 items), language and cognitive development (26 items), communication skills and general knowledge (8 items), social competence (26 items), and emotional maturity (30 items) (Janus & Offord, 2007). The domain scores vary from 0, representing low ability, to 10, representing high ability. Individual items on the EDI are generally rated on 5-point or 3-point scales, or answered with a yes or no response. The physical health and well-being domain includes gross and fine motor skills and assesses whether the child has adequate energy for classroom activities, shows independence, and demonstrates daily living skills. The language and cognitive development domain includes a child's age-appropriate writing and numeracy skills and information recall. The communication and general knowledge domain includes a child's ability to engage in socially appropriate communication, the symbolic use of language and knowledge about his or her life and the world. The social competence domain includes whether the child demonstrates self-control, cooperates with others, respects authority, and is able to play with other children. The emotional maturity domain includes a child's ability to reflect before acting, and to deal with feelings age-appropriately. The EDI also has demographic items such as the child's gender, English as an additional language status, and JK/SK status. The five EDI domains are based on a factor analysis, which included data on more than 16,000 kindergarten children, and demonstrated satisfactory internal consistency reliability levels; a subsequent reliability and validity study examining the EDI ($N = 82$) demonstrated good inter-rater and parent-teacher reliabilities, as well as concurrent and convergent validity (Janus & Offord, 2007). In the present study, satisfactory levels of internal consistency for each of the five EDI domains were also found (see Table 3).

2.3. Data analyses

2.3.1. Preliminary analyses

The focal linked study sample ($N = 272$) is a subsample of the full Intake and Tracking sample, which contains data recorded on all TFD participants. Preliminary analyses were also conducted on an unlinked dataset ($N = 501$) drawn from the full sample of children who were in JK and SK in 2005 at the TFD school sites. EDI

data were not available for these children but their participation, demographics, and site level data on the level of integration were available. In order to check for generalizability and sample bias in the 2005 cohort of the focal sample, parallel analyses of demographic and site predictors of TFD program participation were carried out in both the focal and unlinked sample. The analyses of datasets yielded similar results, with the exception of the role of English as a first language as a predictor of TFD participation. This difference is likely an artifact of the underrepresentation of families who speak English as an additional language in the linked sample (24.2% of linked 2005 sample, vs. 58.4% of unlinked 2005 sample). As a result of these comparisons, all analyses reported in the present study control for demographic factors. These analyses are reported in detail in Patel (2009) and tables reporting on these comparisons can be found in Appendix A of the online Supplementary material.

2.3.2. Justification of analysis techniques

The distributions for all EDI domain scores were analyzed for normality through the Kolmogorov–Smirnov test and by examining the skewness and kurtosis values. The values indicated that their distributions were non-normal. Thus, data analysis approaches that did not require normal distributions were used. In order to explore the predictors of each of the five EDI domains, generalized linear models (GZLM) were employed, with a gamma distribution and a log link. GZLM is a statistical approach that allows models to be fit to data with non-normal distributions. The EDI domain scores were transformed to reflect a positively skewed gamma distribution by subtracting each total domain score from 11. Thus, the transformed scores are indicators of lack of readiness in developmental outcomes, rather than developmental strengths or “readiness”. All results are reported for transformed scores, unless otherwise noted. See Appendix B of the online Supplementary material for a correlation matrix based on the EDI domain scores. Descriptive statistics of the EDI domain scores after transformation can be found in Table 3. The gamma distribution was selected because the aforementioned dependent variables have a lower limit of zero, are positively skewed, and the gamma distribution represented the best fit to the distribution of the dependent variables. A log link was selected as it applies to positive numbers and guarantees a positive mean (Ruppert, Wand, & Carroll, 2003).

To judge model fit and compare models in parallel analyses investigating predictors of the EDI domain scores, the following indices were considered simultaneously to look for converging evidence: (1) Deviance/degrees of freedom, (2) Pearson's χ^2 /degrees of freedom, (3) Omnibus Likelihood Ratio test, (4) Akaike's Information Criterion, and (5) Pearson's χ^2 model comparisons. In GZLM analyses, $\text{Exp}(B)$ is an indicator of effect size and indicates the proportional difference in the dependent variable when the value of a predictor increases by one unit. See Appendix C of the online Supplementary material for further information regarding the interpretation strategy for the GZLM analyses.

Table 3
Descriptives of Dependent Variables ($N = 272$): Lack of Readiness in EDI Domain Scores.

	<i>N</i>	Minimum	Maximum	Mean	Std. deviation	Cronbach's Alpha
Lack of readiness in physical health and well-being (1–11)	264	1.00	8.31	2.32	1.38	0.777
Lack of readiness in language and cognitive development (1–11)	264	1.00	10.23	3.35	2.29	0.924
Lack of readiness in communication and general knowledge (1–11)	272	1.00	11.00	3.84	2.87	0.935
Lack of readiness in social competence (1–11)	272	1.00	9.57	3.07	1.97	0.956
Lack of readiness in emotional maturity (1–11)	270	1.00	8.67	3.15	1.53	0.926
Valid <i>N</i> (listwise)	254					

2.3.3. Focal linked dataset

A generalized linear modeling (GZLM) analysis approach was utilized with three nested models examining predictors of each of the EDI domains. The analyses were conducted using the full linked sample ($N = 272$), including both the 2003 and 2005 cohorts. In “step 1” or Model 1, child and parent demographic independent variables were entered, including JK/SK status, gender, cohort, English as an Additional/First Language (EAL/EL1), and maternal education. In all analyses, Model 1 was compared with the null model with no predictors using the omnibus likelihood ratio test. In Model 2, the parent engagement independent variables were added to the “step 1” variables, including “Proportion of child-centered goals,” “Interest in school involvement,” and the “Number of other programs used prior to TFD” (“step 2”). In Model 3, the site level independent variables, “Indicators of Change” measure of level of integration, and the “Total number of hours of TFD Participation” were added to the “step 2” variables (“step 3”). Interactions were tested between the independent variables and English as an Additional/First Language status, maternal education, JK/SK status and 2003/2005 cohort in each of the models. When a significant interaction was found, both interaction terms were retained. All relevant interaction terms for Indicators of Change were entered in Model 3, regardless of their significance, to ensure that demographic variability across sites was appropriately controlled. Descriptive statistics for the variables examined in these analyses can be found in Tables 1–3. The models reported below are the most parsimonious and optimal according to Pearson's χ^2 model comparisons and the Akaike's Information Criterion (AIC), which is an indication of goodness of fit.

3. Results

Parallel analyses of predictors of each of the transformed Early Development Instrument domain scores help to ascertain demographic and parent engagement factors associated with lack of readiness in the TFD context as well as whether the dose or intensity of participation in TFD early childhood services matters. Informed by a social ecological conceptual perspective of child development (Bronfenbrenner, 1979; Lerner et al., 2002), predictors were analyzed ordered from those that were proximal to the child to those that were more distal. For the analyses of transformed EDI domain scores, results for Model 3 are reported for physical health and well-being, language and cognitive development, and communication and general knowledge. Results for transformed EDI scores for Model 2 are reported for the social competence and emotional maturity domains. The final models reported for each domain were optimal in that all were significantly better than the null model without predictors ($p < .001$) and offered reductions in AIC. Level of service integration in Model 3 had no main effects or interactions for any of the developmental domains tested.

3.1. What are the predictors of lack of readiness in children's level of physical health and well-being?

Participation benefited children by reducing lack of readiness in physical health and well-being. In the final model (Model 3), after

accounting for demographic factors and parental motivations, the dose or total number of hours in TFD early childhood services was a significant negative predictor of lack of readiness in physical health and well-being ($\text{Exp}(B) = 0.999$). A one hour increase in families' total participation hours reduced lack of readiness by 0.01%. Thus, a 100 h increase in participation reduces lack of readiness by 1%, and a 1000 h increase in participation reduces lack of readiness by 10%, corresponding to a one point change on the 10 point physical health and well-being scale.

Furthermore, parents' goals for their children were predictors of their development in physical health and well-being. Children of parents who reported a higher proportion of child-centered goals were less unready in physical health and well-being ($\text{Exp}(B) = 0.694$). A noteworthy interaction emerged in relation to maternal education level and interest in school involvement. This interaction was a significant predictor in Model 2, but not in the final model selected (Model 3). However, there is converging evidence relating to the effects of this interaction, since it appears as a significant predictor of other domain-specific child development outcomes. This interaction demonstrates that if a mother had less education and if she reported no interest in school involvement, her child was at additional risk of lower readiness in physical health and well-being. Interest in school involvement, which taps into the home-school relationship, appears to act as a mechanism influencing the effects of maternal education.

The results also demonstrated a significant main effect for JK/SK status, after including interactions, whereby JKs were 60% less unready in physical health and well-being ($\text{Exp}(B) = 0.614$), or in other words, were advanced in physical development in comparison to SKs. This counter intuitive effect must be interpreted with caution because of the significant interaction between JK/SK status and maternal education. In examining the transformed raw mean physical health and well-being domain scores for JKs (Mean = 2.43) vs. SKs (Mean = 2.21), as expected, SKs are higher in physical development overall.

There was a significant interaction between JK/SK status and maternal education ($\text{Exp}(B) = 1.094$), whereby, if a child was in JK, maternal education did not have any influence on his or her physical health and well-being. In contrast, for children who were in SK, higher maternal education predicted lower levels of lack of readiness, or higher readiness in children's physical health and well-being.

A summary of the significant predictors of lack of children's physical health and well-being can be found in Table 4 and the model comparisons are described in Appendix C of the Supplementary online material.

3.2. What are predictors of lack of readiness in children's level of language and cognitive development?

Participation benefited children's language and cognitive development by reducing lack of readiness. In the final model (Model 3), the total number of hours of participation in TFD early childhood services was a significant negative predictor of lack of readiness ($\text{Exp}(B) = 0.999$), with the same effect size as for physical health and well-being. Thus, a 100 h increase in participation reduces lack

Table 4
Examining predictors of lack of readiness in physical health and well-being.

Independent variables entered	B	Std. Error of B	Wald χ^2		Exp(B)
			χ^2	Sig.	
Model 3: Sets 1 + 2 + 3					
Intercept	1.720	.602	8.173	.004	
JK	-.487	.221	4.851	.028*	0.614
Female	-.088	.070	1.593	.207	0.916
EL1	-.478	.441	1.172	.279	0.620
JK*EL1	.140	.166	.712	.399	1.150
2003Cohort	.030	.231	.017	.895	1.030
JK*2003Cohort	.184	.240	.591	.442	1.202
Maternal Ed'n	-.184	.101	3.331	.068	0.832
JK*Maternal Ed'n	.090	.037	5.808	.016*	1.094
Proportion child-centered goals	-.366	.157	5.426	.020*	0.694
Interest in school involvement	-.084	.058	2.058	.151	0.919
Maternal Ed'n*Interest school involvement	.020	.011	3.675	.055	1.020
EL1*Interest school involvement	-.010	.045	.055	.814	0.990
#Other programs used prior to TFD	-.012	.018	.419	.518	0.988
Total TFD participation	-.000	.000	7.132	.008*	0.999
Indicators of Change	.002	.008	.050	.823	1.002
EL1*Indicators of Change	.006	.006	.980	.322	1.006
Maternal Ed'n* Indicators of Change	.001	.001	.152	.697	1.001
(Scale)	.264	.023			1.302

Note: Although Model 1 yielded an optimal model in model comparisons, Model 3 yielded a significantly better model than the null model without predictors ($p = .001$) and offered reductions in AIC. See online Supplementary materials for further information.

of readiness by 1%, and a 1000 h increase in participation reduces lack of readiness by 10%.

Further, similar to the physical health and well-being domain, a significant interaction for language and cognitive development was found between JK/SK status and maternal education ($\text{Exp}(B) = 1.084$), whereby if a child was in JK, maternal education did not have any significant influence on his or her language and cognitive development. In contrast, for children who were in SK, as maternal education increased, her child's language and cognitive development increased.

The results also demonstrated a significant main effect whereby when maternal education increases by one level, children are 70% less unready in language and cognitive development ($\text{Exp}(B) = 0.773$). Furthermore, there was a significant interaction between maternal education level and parental reports of interest in school involvement ($\text{Exp}(B) = 1.035$), as well as a significant main effect for interest in school involvement. Parents who reported higher levels of interest in school participation had children who were less unready in language and cognitive development ($\text{Exp}(B) = 0.883$). The significant interaction between maternal education level and interest in school involvement shows that a child is at greater cumulative risk for lack of readiness in language and cognitive development outcomes if maternal education is lower and parents have less interest in school involvement. Thus, when maternal education levels are low, interest in school involvement may serve as a protective factor. Note that this interaction also emerged as a marginally significant predictor of outcomes in physical health and well-being.

A summary of the significant predictors of children's language and cognitive development can be found in Table 5 and the model comparisons are described in Appendix C of the Supplementary online material.

3.3. What are predictors of lack of readiness in children's level of communication and general knowledge?

Participation benefited children's communication and general knowledge by reducing lack of readiness. In the results of the final model (Model 3), total hours of TFD participation negatively predicted lack of readiness in this domain ($\text{Exp}(B) = 0.999$). The effect size for dose was the same as that found in the other domains of

physical health and well-being and language and cognitive development.

Further, a significant main effect was observed for maternal education ($\text{Exp}(B) = 0.761$), whereby children whose mothers were one level higher in education level, were 76% less unready in communication and general knowledge. Similar to the language and cognitive development and physical health and well-being domains, a significant interaction for communication and general knowledge was observed between JK/SK status and maternal education ($\text{Exp}(B) = 1.116$). If a child was in JK, maternal education did not have any influence on his or her communication and general knowledge. In contrast, for children who were in SK, higher maternal education predicted lower levels of lack of readiness in communication and general knowledge.

The results demonstrated a significant main effect for cohort, as well as a significant JK/SK status by cohort interaction. The cohort main effect implies that the SKs in the 2003 cohort were over 50% less unready in communication and general knowledge than the SKs in the 2005 cohort ($\text{Exp}(B) = 0.570$). However, the mean lack of readiness in communication and general knowledge scores tell a different story with the 2003 cohort showing greater average lack of readiness (Mean = 4.18) in comparison with the 2005 cohort (Mean = 3.72). There was a significant JK/SK status by cohort interaction ($\text{Exp}(B) = 1.921$). The JKs in the 2003 cohort were significantly less ready than the JKs in the 2005 cohort. Between 2003 and 2005, the gap in communication and general knowledge development among JKs decreased. This may be evidence of an implementation effect.

A summary of the significant predictors of children's communication and general knowledge can be found in Table 6 and the model comparisons are described in Appendix C of the Supplementary online material.

3.4. What are the predictors of lack of readiness in children's level of social competence?

The total hours of TFD participation was not a significant predictor of lack of readiness in children's level of social competence. However, the results of the final model (Model 2) demonstrated a significant main effect for maternal education, with mothers who are one level higher in education level, having children who are 90% less unready in social competence ($\text{Exp}(B) = 0.900$), or in

Table 5
Examining predictors of lack of readiness in language and cognitive development.

Independent variables entered	B	Std. error of B	Wald χ^2		Exp(B)
			χ^2	Sig.	
Model 3: Sets 1 + 2 + 3					
Intercept	1.207	.572	4.453	.035	
JK	.051	.214	.057	.812	1.052
Female	-.117	.067	3.029	.082	0.890
EL1	.383	.425	.813	.367	1.467
JK*EL1	.224	.161	1.940	.164	1.251
2003Cohort	.342	.225	2.314	.128	1.408
JK*2003Cohort	-.020	.231	.007	.932	0.980
Maternal Ed'n	-.257	.097	6.978	.008*	0.773
JK*Maternal Ed'n	.081	.036	5.106	.024*	1.084
Prop. child-centered goals	-.249	.157	2.514	.113	0.780
Interest in school involvement	-.124	.058	4.623	.032*	0.883
Maternal Ed'n*Interest school involvement	.034	.010	10.681	.001*	1.035
EL1*Interest school involvement	-.039	.044	.788	.375	0.962
#Other programs used prior to TFD	.005	.018	.081	.776	1.005
Total TFD participation	-.000	.000	3.929	.047*	0.999
Indicators of Change	.013	.007	3.019	.082	1.013
EL1*Indicators of Change	-.009	.005	2.804	.094	0.991
Maternal Ed'n* Indicators of Change	.001	.001	.248	.619	1.001
(Scale)	.243	.022			1.275

Note: Although Model 1 yielded an optimal model in model comparisons, Model 3 yielded a significantly better model than the null model without predictors ($p = .000$) and offered reductions in AIC. See online Supplementary materials for further information.

Table 6
Examining predictors of lack of readiness in communication and general knowledge.

Independent variables entered	B	Std. error of B	Wald χ^2		Exp(B)
			χ^2	Sig.	
Model 3: Sets 1 + 2 + 3					
Intercept	2.807	.713	15.522	.000	
JK	-.429	.266	2.611	.106	0.651
Female	-.084	.083	1.022	.312	0.919
EL1	-.784	.534	2.158	.142	0.457
JK*EL1	.124	.203	.372	.542	1.132
2003Cohort	-.562	.279	4.060	.044*	0.570
JK*2003Cohort	.653	.289	5.112	.024*	1.921
Maternal Ed'n	-.273	.119	5.288	.021*	0.761
JK*Maternal Ed'n	.110	.045	6.035	.014*	1.116
Prop. child-centered goals	-.198	.199	.986	.321	0.820
Interest in school involvement	-.052	.071	.552	.457	0.949
Maternal Ed'n*Interest school involvement	.024	.013	3.267	.071	1.024
EL1*Interest school involvement	-.080	.053	2.241	.134	0.923
# Other programs used prior to TFD	-.024	.022	1.217	.270	0.976
Total TFD participation	-.000	.000	15.925	.000*	0.999
Indicators of Change	-.002	.009	.031	.859	0.998
EL1*Indicators of Change	.003	.007	.220	.639	1.003
Maternal Ed'n* Indicators of Change	.002	.001	.973	.324	1.002
(Scale)	.388	.033			1.474

Note: Although Model 1 yielded an optimal model in model comparisons, Model 3 yielded a significantly better model than the null model without predictors ($p = .000$) and offered reductions in AIC. See online Supplementary materials for further information.

other words, are higher in social competence. Further, parents' child-centered goals mattered, with parents who reported a greater proportion of child-centered goals having children who are lower in lack of readiness in social competence ($\text{Exp}(B) = 0.686$).

Also notable is that a significant interaction for social competence was found between interest in school involvement and EAL/EL1 status ($\text{Exp}(B) = 0.882$). For families who spoke English as a first language, greater interest in school involvement was associated with significantly lower levels of lack of readiness in social competence. For families who spoke English as an additional language, greater interest in school involvement was not significantly associated with social competence in children. Thus, EAL parents who reported more interest in school involvement at intake had children who were rated lower in social competence at the time of EDI administration. The significant interaction between EAL/EL1 status and interest in school involvement in the case of social competence suggests that the protective effects of interest in linking to schools operate differently for EAL vs. EL1 families, and further-

more, that these effects operate differentially across some of the EDI domains.

A summary of the significant predictors of children's social competence can be found in Table 7 and the model comparisons are described in Appendix C of the Supplementary online material.

3.5. What are predictors of lack of readiness in children's level of emotional maturity?

The total hours of TFD participation was not a significant predictor of lack of readiness in children's level of emotional maturity. However, the results of the final model (Model 2) demonstrated a significant gender main effect ($\text{Exp}(B) = 0.796$), with females being 80% less unready in emotional maturity than males. Further, as the parent reports of the number of other programs accessed prior to TFD intake increased by one level, the children were 96% less unready in emotional maturity ($\text{Exp}(B) = 0.959$).

Table 7
Examining predictors of lack of readiness in social competence.

Independent variables entered		B	Std. error of B	Wald χ^2	Sig.	Exp(B)
				χ^2		
Model 2: Sets 1 + 2	Intercept	1.837	.224	67.322	.000	
	JK	-.045	.233	.037	.847	0.956
	Female	-.111	.074	2.260	.133	0.895
	EL1	-.061	.166	.135	.713	0.941
	JK*EL1	.188	.170	1.226	.268	1.207
	2003Cohort	.286	.238	1.441	.230	1.331
	JK*2003Cohort	-.216	.259	.696	.404	0.806
	Maternal Ed'n	-.105	.039	7.397	.007 [†]	0.900
	JK*Maternal Ed'n	.050	.038	1.699	.192	1.051
	Proportion child-centered goals	-.377	.168	5.031	.025 [†]	0.686
	Interest in school involvement	-.001	.061	.000	.988	0.999
	Maternal Ed'n*Interest school involvement	.016	.011	1.993	.158	1.016
	EL1*Interest school involvement	-.125	.047	7.051	.008 [†]	0.882
	#Other programs used prior to TFD	-.033	.020	2.770	.096	0.968
	(Scale)	.311	.027			1.365

Note: Although Model 1 yielded an optimal model according to model comparisons, Model 2 yielded a significantly better model than the null model without predictors ($p = .000$) and offered substantial reduction in AIC. See online Supplementary materials for further information.

As was the case in findings on social competence, a significant interaction for emotional maturity was found in Model 3 between interest in school involvement and EAL/EL1 status. For families who spoke English as a first language, greater interest in school involvement was correlated with higher levels of emotional maturity in children. For families who spoke English as an additional language, greater interest in school involvement was not significantly associated with emotional maturity in children. The significant interaction between EAL/EL1 status and interest in school involvement in examining predictors of emotional maturity suggests that the protective effects of parents' interest in school involvement operate differently for EAL vs. EL1 families, and furthermore, that these effects operate differentially across some of the EDI domains.

A summary of the significant predictors of children's emotional maturity can be found in Table 8 and the model comparisons are described in Appendix C of the Supplementary online material.

4. Discussion

4.1. Program intensity matters

From a social ecological perspective (Bronfenbrenner, 1979), comprehensive community initiatives are aimed at supporting the child's holistic development; thus, the individual is the unit of intervention. From a population health perspective (Dunn & Hayes, 1999; Geddes et al., 2014; Rose, 1992), the aim of programs is to reduce inequities by improving child development outcomes at a population level; the community is the level of intervention. Similarly, research can investigate children's developmental outcomes at the community and individual levels.

The findings from the present study reveal dose effects for individuals, complementing the earlier community-level group comparisons from the same Toronto First Duty project. At the community level, previous studies comparing TFD and matched community sites included all children across TFD sites, regardless of the duration or intensity with which families participated in TFD services. Results showed that TFD programming was associated with modest improvements in emotional maturity and social competence on the EDI. While it is hard to make specificity arguments (Reynolds, 2004a) with respect to the effects of integrated services initiatives with broad programming content, group-level effects for social and emotional development in the TFD case are consistent with the program design and implementation, including professional development with a focus on social and emotional

development in child care and kindergarten classrooms (Corter et al., 2008). Since all children in TFD assessed by the EDI were in kindergarten classrooms, whatever their additional program hours were, it is possible that effects of TFD programming operated at a group level, particularly since social and emotional development are strongly influenced by the collective peer environment.

In contrast to the community comparisons described above, the present study examined within-group effects of dose at the individual level across the five TFD sites to assess whether the intensity of participation influences children's domain-specific developmental outcomes. The individual-level dose effects found in this study suggest that the number of hours of participation in integrated early childhood services did influence children's outcomes in three domains: physical health and well-being, language and cognitive development, and communication and general knowledge, after taking into consideration demographic, parent, and site factors.

Other studies have generally investigated the role of participation primarily through examination of duration (years or months), through comparisons of high "dose" participation and low "dose" participation groups, as well as comparisons of a program group with a control group. Only a few studies have looked at more fine-grained participation metrics in early childhood programs, such as number of sessions in the UK EPPE study of various early childhood program types (Sylva et al., 2004). This is the first study of integrated early childhood services investigating dose-response relations, or whether the cumulative number of hours of participation influences children's developmental outcomes.

Domain-specific child development outcomes varied in the degree to which they were predicted by the number of hours of participation in TFD early childhood services. Dose of TFD services was a significant predictor of three domains of the EDI; namely, children's physical health and well-being, language and cognitive development, and communication and general knowledge. The participation data were positively skewed, with the mean hours of participation of families investigated in this study being 780 h per child. A 100 h increase in participation reduced lack of readiness by 1%, and a 1000 h increase in participation reduced lack of readiness by 10%, which corresponds to a one point improvement on the 10 point physical health and well-being, language and cognitive development, and communication and general knowledge domains. The dose effects on all three domains were linear and therefore consistent with gradient effects, rather than ceiling or threshold effects (Nicholson et al., 2010). Note too that none of the dose effects were qualified by interactions of the dose factor with other sociodemographic factors. It is notable that these dose effects emerged in the

Table 8
Examining predictors of lack of readiness in emotional maturity.

Independent variables entered		B	Std. error of B	Wald χ^2		Exp(B)
				χ^2	Sig.	
Model 2: Sets 1 + 2	Intercept	1.494	.183	66.496	.000	
	JK	-.020	.187	.012	.913	0.980
	Female	-.228	.059	14.773	.000*	0.796
	EL1	-.032	.131	.059	.808	0.969
	JK*EL1	.111	.135	.670	.413	1.117
	2003Cohort	.294	.189	2.422	.120	1.342
	JK*2003Cohort	-.162	.206	.620	.431	0.850
	Maternal Ed'n	-.033	.031	1.155	.283	0.968
	JK*Maternal Ed'n	.025	.031	.659	.417	1.025
	Proportion child-centered goals	-.119	.136	.760	.383	0.888
	Interest in school involvement	.020	.049	.161	.689	1.020
	Maternal Ed'n*Interest school involvement	.004	.009	.194	.660	1.004
	EL1*Interest school involvement	-.063	.038	2.811	.094	0.939
	#Other programs used prior to TFD	-.042	.016	6.848	.009*	0.959
	(Scale)	.199	.018			1.220

Note: Although Model 1 yielded an optimal model according to model comparisons, Model 2 yielded a significantly better model than the null model without predictors ($p = .000$) and offered substantial reduction in AIC. See online Supplementary materials for further information.

analyses after accounting for ecological complexities. These factors included demographic characteristics and parental motivations in service use, and the interactions of these factors, which undoubtedly affect service utilization and child outcomes.

4.2. Ecological complexities

Investigating the predictors of children's developmental outcomes highlighted the ecological complexities associated with child development in the TFD context. It is important to note that demographic variables predicted each of the domain-specific child development outcomes in different ways, with unique interactions. Maternal education predicted children's social competence, language and cognitive development, and communication and general knowledge. Maternal education is treated as a proxy for unmeasured variables such as potential financial resources, quality of parenting, and home early learning environment.

Additionally, a significant interaction was found between maternal education and JK/SK status. Specifically, for children in JK, maternal education did not have a significant influence on developmental domains, but for children in SK, higher maternal education significantly predicted stronger development in three of five domains (physical health and well-being, language and cognition, and communication and general knowledge). This is further evidence that socioeconomic gaps in academic achievement have roots in early child development and begin to accelerate during the transition years to school. This pattern is consistent with the findings that socioeconomic gaps in child development and academic achievement in areas such as language and literacy skill widen with age (Chatterji, 2006; Melhuish, 2010).

At the mesosystem level, various aspects of parents' engagement with services were also predictors of children's outcomes. The proportion of child-centered goals reported by parents at program entry was a significant positive predictor of children's social competence and physical health and well-being. Parents' level of interest in school involvement was a significant predictor of children's language and cognitive development. However, the findings on interest in school involvement were qualified by interactions with demographic variables. For example, there was a significant interaction between parents' level of interest in school involvement and maternal education in predicting children's language and cognitive development outcomes. This interaction suggests that a child is at greater risk for lower levels of language and cognitive development if his or her mother has a lower education level, and the parent reports less interest in school involvement. Thus,

when maternal education level is low, interest in school involvement may serve as a protective factor. Further, relating to children's social competence, a significant interaction was found between language status and parents' interest in involvement in the school. For families who spoke English as a first language, greater interest in school involvement was associated with significantly higher levels of social competence in children. Conversely, for families who spoke English as an additional language, greater parental interest in school involvement was correlated with lower levels of social competence in children. Perhaps families who spoke English as an additional language were more likely to report interest in school involvement if they were concerned about their child's socioemotional adjustment. Thus, families' reasons for operating in the mesosystem between home and school may vary by family characteristics and parental role construction. Together these findings highlight the complexities of the effects of potential mediating (parents' child-centeredness, parents' interest in school involvement) and moderating (maternal education, language status) factors on children's developmental outcomes, with parent engagement variables acting as protective factors on children's developmental outcomes.

Moving beyond family demographic characteristics and parent engagement to the variations across sites, we failed to find any main effects or interactions in relation to level of service integration, as measured by the Indicators of Change Instrument. This instrument assessed integration levels across five dimensions spanning the ecological levels of the microsystem (early learning environment and staff team), the mesosystem (parent involvement and seamless access), and the exosystem (governance). Since our findings and those of others had shown positive association between service integration levels and program quality assessments (Corter et al., 2009; Melhuish et al., 2007), we had expected that the overall integration level would predict child outcomes via direct and indirect effects on quality of the microsystem service environments for children (e.g., classrooms, parent-child centers). However, an important limiting factor in our analysis was the relatively small variation in quality of microsystems across the sites with all ratings in the good to excellent range on the ECERS-R (Corter et al., 2006).

Broadly speaking, the dose-response results in this study fit the general conclusion in the literature that experience with high-quality early childhood programming, including child care and other preschool program types, helps foster cognitive, communication, and language gains (Cleveland et al., 2006; Sylva et al., 2004). The dose-response results also align with the findings from

research investigating comprehensive, integrated early childhood programs (Campbell, Pungello, Miller-Johnson, Burchinal, & Ramey, 2001; Reynolds, 2004a; Reynolds et al., 2014). Note that “experience” in these studies is not defined in terms of graded intensity as it is in the present study. Beyond this general correspondence with the literature on program benefits for cognition, language and communication, the finding of dose effects on physical development also corresponds to recent findings. Studies of comprehensive early childhood programs have pointed to both short-term (Reynolds et al., 2014) and long-term physical health effects (Belfield & Kelly, 2013). In the current study, the dose effects extend beyond health since the EDI physical health and well-being domain includes items on energy level, physical independence, and motor abilities. While health and physical development “programming” was not explicit in TFD, other elements may have fostered physical development and healthy well-being. These elements included active play, which was an important part of the TFD high-quality early childhood programming, along with the act of ‘getting out to programs’ from the confines of the home, and the programming supports for parents.

Although the five domains of the EDI are thought to represent the construct of children’s school “readiness” broadly speaking (Janus & Offord, 2007), this study provides evidence of the ecological complexities of school readiness, with each of the domains operating differently. We know from the analysis of early development in general, that outcomes and mechanisms are rarely ever the result of a single set of factors or a single factor (Feinstein & Peck, 2008). Even after attempting to control and account for interactions between sociodemographic characteristics and child, parent, and site factors, it is not possible to examine all relevant elements of the social ecology, as the present study is limited by the data that were available. Further, even when interactions are controlled for statistically, they are thought to be a weak mathematical approximation of the complexity of the dynamic processes of real interaction (Feinstein & Peck, 2008). Without the knowledge of higher order interactions, it is hard to get a convincing picture of dose-response relations in early childhood programs. Considering the complexities of the child’s social ecology – the potential moderating and mediating demographic, parent, and site factors – is imperative. There are dangers in oversimplification.

4.3. Policy implications

The TFD model was designed as a universal platform of kindergarten with additional integrated early childhood services available to all children and parents in a community. While it was intended to benefit development of all children, it also was intended to reduce inequities in service uptake and outcomes for all children. In this context, the finding that the effects of dose were unqualified by demographic characteristics is important. On the one hand, it provides evidence of the universal value of the model with participation benefits for all children, regardless of sociodemographic background. On the other hand, it also shows the value of the model for equity in effectiveness and outcomes since higher participation intensity worked equally well for children who speak a minority language, once enrolled. In fact, other data from TFD show that the integrated service array was successful in attracting and retaining marginalized families who were previously underrepresented in stand-alone early childhood programs, but who enrolled and participated in TFD at the same levels as other families (Patel & Corter, 2012). Nevertheless, the findings from the present study also suggest that gaps in children’s development based on socioeconomic levels widen between junior and senior kindergarten, as has been found in other research following children beyond early childhood programs (Melhuish, 2010).

This study illustrates that fine-grained measurement of participation, or in this case dose of cumulative program hours, is

an important metric when services are elective or attendance is highly variable. For the TFD initiative, fuller understanding of program effectiveness in supporting different developmental domains came from supplementing quasi-experimental program evaluation with dose analyses. The dose analyses employed in this study also reduce the potential for rater bias in measures like the EDI. In quasi-experimental comparisons, greater teacher personal investments in a program could lead to higher ratings as compared to teacher ratings in control sites (Corter et al., 2008; Pianta et al., 1995).

In addition to its role in formal evaluation, dose monitoring could also be used in ongoing assessment for continuous program improvement and attention to individual families who may need additional participation supports. In the implementation of the TFD model, feedback to sites on participation levels, EDI patterns, and program quality were all part of continuous program improvement efforts (Corter et al., 2007; Corter et al., 2008).

The current study does not answer the question of how to optimize cumulative hours in order to boost development. However, it does point to the OECD-recommended blending of child care and kindergarten education as an efficient means for increasing time spent in high-quality early childhood settings. In TFD, child care contributed more hours to the cumulative total than any of the other integrated services that were additional to kindergarten. In fact, following the appearance of early evidence from TFD on the feasibility and potential value of service integration for child development, the Province of Ontario established and funded universal full-day kindergarten, with child care and teaching professionals collaborating to deliver early learning and care (Pelletier, 2014).

The results from the present study demonstrated the importance of parental goals in children’s developmental outcomes. These findings also have policy implications in that they suggest that attention should be paid in building and supporting parental motivation for service use across the mesosystem as part of an integrated approach, while paying attention to what families want (Patel et al., 2008). Evidence shows that integration of parent and child programming contributes to longer-term effects on parenting, which may contribute to long-term benefits for children (Reynolds, 2004a; Peters et al., 2010). The findings from TFD suggest that programming for parents should go beyond building parenting skills to include assessing and supporting parents’ motivations and goals and building capacity for engagement (Patel et al., 2008; Patel & Corter, 2013).

4.4. Limitations and future directions

There are important methodological limitations as well as strengths in the approaches chosen for the analyses in this study. Using statistical techniques that appropriately account for the distribution of the dependent variables is a necessity. The present study has avoided model misspecification, which would result from using ordinary least squares (OLS) techniques such as multiple regression. However, no matter what the statistical technique, there is the concern that estimations of the average relations between measures can mask underlying patterns of continuity and discontinuity that may occur for subgroups of the population (Feinstein & Peck, 2008). Furthermore, it is impossible to avoid random error and measurement issues with measures such as those used in this study. For example, the EDI is a teacher-report measure and is subject to potential teacher bias in reporting (Corter et al., 2008; Pianta et al., 1995).

Although the total site level Indicators of Change integration scores appeared to provide objective assessment of integration levels and have been found to correlate with program quality measures on the ECERS-R (Corter et al., 2009), there are challenges associated with validation due to the complex and amorphous nature of the construct of integration (Corter et al., 2009). Nevertheless, the

Indicators of Change is only one of the many possible site level variables which may influence outcomes, as we know from research on community level factors in early development (Leventhal & Brooks-Gunn, 2000).

In relation to the Intake and Tracking system, there was room for error in the manual data entry of daily participation that site staff made time for in the face of competing priorities. We do not have independent estimates on the reliability of the resulting participation data. Note too, that treating tracking data on participation as a global measure of hours in TFD optional programs neglected the possibility that participation in different program types might show different relations to both predictors and child outcomes. The decision to analyze participation as a global measure was dictated partly by the uneven distribution of participants and hours across program category types; some categories did not have sufficient numbers of participants for meaningful analysis. There was variation in the way the intake form was administered to parents: it was available in English and required translation assistance by staff through intake interviews on an “as needed” basis. Although the intake form asked demographic questions about parents’ education levels, employment status, goals, prior service use, interests in involvement, among other details, the form did not report who filled it out (i.e., mother, father, grandparent, etc.).

A final limitation of the present study was the sample size. Despite the large number of families in the full Intake and Tracking database accumulated over a number of years ($N = 2,643$), the linked dataset sample was a much smaller subset. The EDI data were not available across all years of the TFD Project, and even when the data were available, family mobility further reduced the number of children who ended up attending kindergarten in schools where they had earlier attended TFD early childhood programming. Nevertheless, the subset of children in these analyses appeared to be a match for the larger population of participants in terms of demographic factors. In addition, by controlling child factors and testing the interactions between the independent variables and both maternal education level and English as an additional language status in each of the analyses, important aspects of potential selection bias were controlled.

Future research investigating the role of participation in integrated services in children’s developmental outcomes should investigate the specific service uptake patterns (Leventhal, Brooks-Gunn, McCormick, & McCarton, 2000; Mahoney, Lord, & Carryl, 2005) to understand different types of “dose” participation intensity, and the array of services and programs utilized by children and families.

5. Conclusion

The present study breaks new ground by analyzing dose-response relations between intensity of participation in school-based integrated early childhood services and children’s developmental outcomes. It employed a generalized linear modeling approach to analyses, a relatively recent analytic technique. The results demonstrated that participation in integrated early childhood services has the potential to reduce disparities in children’s developmental outcomes, while benefiting all children regardless of background. Demographic, parenting, and site factors predicted each of the domain-specific child development outcomes in different ways, with parenting variables acting as protective factors on children’s developmental outcomes. Considering the complexities of the child’s social ecology – the potential moderating and mediating demographic, parenting, and site factors – is an important challenge for future research. There are dangers in oversimplification as we move to understand the processes by which program participation and parenting affect children’s outcomes. This study

provides evidence that offering a variety of early childhood services using an integrated platform, as in the TFD project, has potential in supporting the “whole child” during the transition to school across the various domains of early development.

Acknowledgements

This study was supported in part by the Social Sciences and Humanities Research Council of Canada doctoral fellowship awarded to the first author. In addition, the study was supported by research grants from the Atkinson Charitable Foundation, the City of Toronto and the Social Sciences and Humanities Research Council of Canada to the second author. We are grateful to all of the family participants who contributed data to our research, with special thanks to research community partners from the City of Toronto Children’s Services, Toronto District School Board and Atkinson Charitable Foundation.

Appendices. Supplementary data

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.ecresq.2015.12.006>.

References

- Arimura, T., & Corter, C. (2010). School-based integrated early childhood programs: Impact on the well-being of children and parents. *Interaction*, 24(1), 23–28. http://dx.doi.org/10.1007/978-94-007-0573-9_16
- Belfield, C. R., & Kelly, R. (2013). Early education and health outcomes of a 2001 U.S. Birth Cohort. *Economics and Human Biology*, 11, 310–325. <http://dx.doi.org/10.1016/j.ehb.2012.05.001>
- Bronfenbrenner, U. (1979). *The ecology of human development: experiments by nature and design*. Cambridge, MA: Harvard University.
- Campbell, F. A., & Ramey, C. T. (1994). Effects of early intervention on intellectual and academic achievement: a follow-up study of children from low-income families. *Child Development: Special Issue: Children and Poverty*, 65(2), 684–698. <http://dx.doi.org/10.1111/1467-8624.ep9405315161>
- Campbell, F. A., Pungello, E. P., Miller-Johnson, S., Burchinal, M., & Ramey, C. T. (2001). The development of cognitive and academic abilities: growth curves from an early childhood educational experiment. *Developmental Psychology*, 37(2), 231–242. <http://dx.doi.org/10.1037/0012-1649.37.2.231>
- Chatterji, M. (2006). Reading achievement gaps, correlates, and moderators of early reading achievement: evidence from the early childhood longitudinal study (ECLS) kindergarten to first grade sample. *Journal of Educational Psychology*, 98(3), 489–507. <http://dx.doi.org/10.1037/0022-0663.98.3.489>
- Cleveland, G., Corter, C., Pelletier, J., Colley, S., Bertrand, J., et al. (2006). *A review of the state of the field of early childhood learning and development in child care, kindergarten and family support programs*. In *Prepared for the Canadian Council on Learning*. Toronto: Atkinson Centre for Society and Child Development, OISE/University of Toronto.
- Cortier, C., Bertrand, J., Pelletier, J., Griffin, T., McKay, D., Patel, S., & Ioannone, P. (2006). *Toronto First Duty Phase 1 Summary Report: Evidence-based understanding of integrated foundations for early childhood*. Retrieved from City of Toronto website: http://www.toronto.ca/firstduty/TFD_Summary_Report_June06.pdf.
- Cortier, C., Bertrand, J., Pelletier, J., Griffin, T., McKay, D., Patel, S., & Ioannone, P. (2007). *Toronto first duty phase 1 final report: evidence-based understanding of integrated foundations for early childhood*. Retrieved from City of Toronto website: http://www.toronto.ca/firstduty/tfd_phase1_finalreport.pdf.
- Cortier, C., Patel, S., Pelletier, J., & Bertrand, J. (2008). The early development Instrument as an evaluation and improvement tool for school-based, integrated services for young children and parents: the Toronto first duty project. *Early Education and Development*, 19(5), 1–22. <http://dx.doi.org/10.1080/10409280801911888>
- Cortier, C., Pelletier, J., Janmohamed, Z., Bertrand, J., Arimura, T., Patel, S., Mir, S., Brown, D. (2009). *Toronto First Duty Phase 2, 2006–2008: Final Research Report*. Retrieved from City of Toronto website: http://www.toronto.ca/firstduty/TFD_phase2_final.pdf.
- Dix, T. (1992). Parenting on behalf of the child: empathic goals in the regulation of responsive parenting. In I. E. Sigel, A. V. McGillicuddy-DeLisi, & J. J. Goodnow (Eds.), *Parental belief systems: the psychological consequences for children* (2nd ed., pp. 319–346). Hillsdale, NJ: Erlbaum.
- Dunn, J. R., & Hayes, M. V. (1999). Toward a lexicon of population health. *Canadian Journal of Public Health*, 90(S1), S7–S10. <http://search.proquest.com/docview/231995447?accountid=14771>
- Feinstein, L., & Peck, S. C. (2008). Unexpected pathways through education: why do some students not succeed in school and what helps others beat the odds?

- Journal of Social Issues*, 64(1), 1–20. <http://dx.doi.org/10.1111/j.1540-4560.2008.00545.x>
- Fernandez-Rao, S., Hurley, K. M., Nair, K. M., Balakrishna, N., Radhakrishna, K. V., Ravinder, P., & Black, M. M. (2014). Integrating nutrition and early child development interventions among infants and preschoolers in rural India. *Annals of the New York Academy of Sciences*, 1308(1), 218–231. <http://dx.doi.org/10.1111/nyas.12278>
- Geddes, R., Woolfson, L. M., McNicol, S., Booth, J. N., Wray, S., Hardie, S., & Frank, J. (2014). Translating research into practice: a cross-sectional study using the Early Development Instrument to assess early years interventions in local level public health practice. *The Lancet*, 384, S33. [http://dx.doi.org/10.1016/s0140-6736\(14\)62159-0](http://dx.doi.org/10.1016/s0140-6736(14)62159-0)
- Gomby, D. (1999). Understanding evaluations of home visitation programs. *The Future of Children*, 9(1), 27–43. <http://dx.doi.org/10.2307/1602720>
- Gomby, D., Culross, P., & Behrman, R. (1999). Home visiting: recent program evaluations—analysis and recommendations. *The Future of Children*, 9(1), 4–26. <http://dx.doi.org/10.2307/1602719>
- Harms, T., Clifford, R. M., & Cryer, D. (2005). *Early childhood environment rating scale*. New York: Teachers College, Revised Edition.
- Hill, J. L., Brooks-Gunn, J., & Waldfogel, J. (2003). Sustained effects of high participation in an early intervention for low-birth-weight premature infants. *Developmental Psychology*, 39(4), 730–744. <http://dx.doi.org/10.1037/0012-1649.39.4.730>
- Janus, M., & Offord, D. (2000). Readiness to learn at school. *ISUMA*, 1(2), 71–75.
- Janus, M., & Offord, D. (2007). Development and psychometric properties of the Early Development Instrument (EDI): a measure of children's school readiness. *Canadian Journal of Behavioral Science*, 39(1), 1–22. <http://dx.doi.org/10.1037/cjbs2007001>
- Kaga, Y., Bennett, J., & Moss, P. (2010). Caring and learning together: a cross-national study on the integration of early childhood care and education within education. Retrieved from UNESCO website: <http://unesdoc.unesco.org/images/0018/001878/187818E.pdf>
- Lerner, R., Rothbaum, F., Boulos, S., & Castellino, D. (2002). Developmental systems perspective on parenting. In M. H. Bornstein (Ed.), *Handbook on parenting* (Vol. 2) (2nd ed., Vol. 2, pp. 407–437). Englewood, NJ: Erlbaum.
- Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: the effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin*, 126(2), 309–337. <http://dx.doi.org/10.1037/0033-2909.126.2.309>
- Leventhal, T., Brooks-Gunn, J., McCormick, M. C., & McCarton, C. M. (2000). Patterns of service use in preschool children: correlates, consequences, and the role of early intervention. *Child Development*, 71(3), 802–819. <http://dx.doi.org/10.1111/1467-8624.00186>
- Mahoney, J. L., Lord, H., & Carryl, E. (2005). An ecological analysis of after-school program participation and the development of academic performance and motivational attributes for disadvantaged children. *Child Development*, 76(4), 811–825. <http://dx.doi.org/10.1111/j.1467-8624.2005.00879.x>
- Melhuish, E., Belsky, J., Anning, A., Ball, M., Barnes, J., Romaniuk, H., & NESS Research Team. (2007). Variation in community intervention programmes and consequences for children and families: the example of Sure Start local programmes. *Journal of Child Psychology and Psychiatry*, 48(6), 543–551. <http://dx.doi.org/10.1111/j.1469-7610.2007.01705.x>
- Melhuish, E., Belsky, J., Barnes, J. (2010). Sure Start and its evaluation in England. In: R.E. Tremblay, R.G. Barr, R. DeV. Peters, M. Boivin (Eds.), *Encyclopedia on Early Childhood Development* [Online] (pp. 1–6). Retrieved from <http://www.child-encyclopedia.com/Pages/PDF/Melhuish-Belsky-BarnesANGxp.pdf>
- Melhuish, E. (2010). Why children, parents and home learning are important. In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford, & B. Taggart (Eds.), *Early childhood matters: evidence from the effective pre-school and primary education project*. London: Routledge.
- Nicholson, J. M., Lucas, N., Berthelsen, D., & Wake, M. (2010). Socioeconomic inequality profiles in physical and developmental health from 0–7 years: Australian national study. *Journal of Epidemiology and Community Health*, 66, 81–87. <http://dx.doi.org/10.1136/jech.2009.103291>
- Odom, S. L., Hanson, M. J., Lieber, J., Diamond, K., Palmer, S., Butera, G., et al. (2010). Prevention, early childhood intervention, and implementation science. In B. Doll, W. Pfohl, & J. Yoon (Eds.), *Handbook of youth prevention science* (pp. 413–444). New York, NY: Routledge.
- OECD. (2006). *Starting strong II: early childhood education and care*. Paris: OECD. <http://dx.doi.org/10.1787/9789264035461-en>
- Offord Centre for Child Studies (2005). Early Development Instrument guide. Retrieved from www.offordcentre.com/readiness/files/2005.EDI.ENG.Guide.pdf
- Patel, S. (2009). Integrated early childhood program participation, parenting, and child development outcomes: The Toronto First Duty Project. In *Graduate department of human development and applied psychology*. University of Toronto (Unpublished doctoral dissertation)
- Patel, S., & Corter, C. (2008). Reaching out and listening to diverse parents in school-based preschool service hubs: Let's get systematic. In *Paper presented at the annual meeting of the American Educational Research Association New York*.
- Patel, S., Corter, C., & Pelletier, J. (2008). What do families want? Understanding their GOALS for early childhood services. In M. Cornish (Ed.), *Promising practices for partnering with families in the early years* (pp. 103–135). Family School Community Partnership Monograph series. Information Age.
- Patel, S., & Corter, C. (2011). Chapter 16: early intervention research, services, and policies. In A. Slater, M. Lewis, G. Anzures, & K. Lee (Eds.), *Introduction to infant development, Canadian Edition* (pp. 268–285). Oxford University.
- Patel, S., & Corter, C. (2012). Further findings from TFD Phase 1: equity, participation and benefits for children. In C. Corter, Z. Janmohamed, & J. Pelletier (Eds.), *Toronto first duty phase 3 report*. Atkinson centre for society and child development. Toronto, Canada: OISE/University of Toronto.
- Patel, S., & Corter, C. (2013). Building capacity for parent involvement through school-based preschool services. *Early Child Development and Care*, 183(7), 981–1004. <http://dx.doi.org/10.1080/03004430.2012.701625>
- Pelletier, J. (2012). New directions in integrated early childhood services in school-as hub models: lessons from Toronto first duty and peel best start. In N. Howe, & L. Prochner (Eds.), *New directions in early childhood care and education in Canada* (pp. 367–396). Toronto, ON: University of Toronto Press.
- Pelletier, J. (2014). Ontario's full-day kindergarten: a bold public policy initiative. In *Public sector digest*. 41–49: Health & Education. June Issue.
- Pelletier, J., & Corter, C. (2006). Integration, innovation, and evaluation in school-based early childhood services. In B. Spodek, & O. Sarracho (Eds.), *Handbook of research on the education of young children* (3rd ed., pp. 477–496). Mahwah, NJ: Erlbaum.
- Perry, B., Dockett, S., & Petriwskyj, A. (Eds.). (2014). *Transitions to school: international research, policy and practice*. In: Springer: Dordrecht The Netherlands.
- Peters, R. D., Bradshaw, A. J., Petrunka, K., Nelson, G., Herry, Y., Craig, W. M., & Rossiter, M. D. (2010). The better beginnings, better futures ecological, community-based early childhood prevention project: findings from grade 3 to grade 9. *Monographs of the Society for Research in Child Development*, 75(3), 1–174. <http://dx.doi.org/10.1111/j.1540-5834.2010.00577.x>
- Pianta, R. C., Steinberg, M., & Rollins, K. (1995). The first two years of school: teacher–child relationships and deflections in children's school adjustment. *Development and Psychopathology*, 7(2), 295–312. <http://dx.doi.org/10.1017/S095457940006519>
- Regional Educational Laboratories' Early Childhood Collaboration Network (1995). *Continuity in early childhood: a framework for home, school, and community linkages*. Retrieved from <http://www.sedl.org/pubs/catalog/items/fam17.html>
- Reynolds, A. J. (2004a). Research on early childhood interventions in the confirmatory mode. *Children and Youth Services Review*, 26(1), 15–38. <http://dx.doi.org/10.1016/j.childyouth.2003.11.001>
- Reynolds, A. J. (2004b). Dosage-response effects and mechanisms of change in public and model programs. In E. Zigler, & S. J. Styfco (Eds.), *The head start debates* (pp. 379–396). Baltimore, MD: Paul H. Brookes.
- Reynolds, A., Richardson, B. A., Hayakawa, M., Lease, E. M., Warner-Richter, M., Englund, M. M., & Sullivan, M. (2014). Association of a full-day vs part-day preschool intervention with school readiness, attendance, and parent involvement. *Journal of the American Medical Association*, 312(20), 2126–2134. <http://dx.doi.org/10.1001/jama.2014.15376>
- Reynolds, A. J., Temple, J. A., & Ou, S. (2010). Impacts and implications of the child–parent center preschool program. In A. J. Reynolds, A. Rolnick, M. M. Englund, & J. Temple (Eds.), *New York: Cambridge University Press*.
- Rimm-Kaufman, S. E., & Pianta, R. C. (2000). An ecological perspective on the transition to kindergarten: a theoretical framework to guide empirical research. *Journal of Applied Developmental Psychology*, 21(5), 491–511. [http://dx.doi.org/10.1016/s0193-3973\(00\)00051-4](http://dx.doi.org/10.1016/s0193-3973(00)00051-4)
- Rose, G. (1992). *The strategy of preventive medicine*. Oxford: Oxford University Press.
- Ruppert, D., Wand, M. P., & Carroll, R. J. (2003). *Semiparametric regression*. Cambridge: Cambridge University Press.
- Saracho, O., & Spodek, B. (2003). Recent trends and innovations in the early childhood education curriculum. *Early Child Development and Care*, 173(2–3), 175–183. <http://dx.doi.org/10.1080/03004430303095>
- Sammons, P. (2010). Does preschool make a difference? In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford, & B. Taggart (Eds.), *Early childhood matters: evidence from the effective pre-school and primary education project*. London: Routledge.
- Shonkoff, J. P., & Phillips, D. A. (2000). *From neurons to neighborhoods: the science of early childhood development*. Washington, D.C.: National Academy Press.
- Selden, S. C., Sowa, J. E., & Sandfort, J. (2006). The impact of nonprofit collaboration in early child care and education on management and program outcomes. *Public Administration Review*, May/June, 412–425. <http://dx.doi.org/10.1111/j.1540-6210.2006.00598.x>
- Siraj-Blatchford, I. (2010). The EPPE settings in the context of English pre-schools. In K. Sylva, E. Melhuish, P. Sammons, I. Siraj-Blatchford, & B. Taggart (Eds.), *Early childhood matters: evidence from the effective pre-school and primary education project*. London: Routledge.
- Spoth, R. L., & Redmond, C. (2000). Research on family engagement in preventive interventions: toward improved use of scientific findings in primary prevention practice. *Journal of Primary Prevention*, 21(2), 267–284. <http://dx.doi.org/10.1023/A:1007039421026>
- St. Pierre, R. G., Layzer, J. I., & Barnes, H. V. (1995). Two-generation programs: design, cost, and short-term effectiveness. *The Future of Children*, 5(3), 76–93. <http://dx.doi.org/10.2307/1602368>
- Sylva, K., Melhuish, E., Sammons, P., Siraj-Blatchford, I., & Taggart, B. (2004). *The effective provision of pre-school education (EPPE) project: final report*. Great Britain: Department for Education and Skills.
- Toronto District School Board. (2005). *TDSB learning opportunities index*. Author.
- Toronto District School Board. (2007). *TDSB Learning Opportunities Index*. Author.
- Toronto District School Board (2009). 2008 Parent census, kindergarten–grade 6: system overview and detailed findings. Retrieved from Toronto District School Board website: <http://www.tdsb.on.ca/Portals/0/AboutUs/Research/2008ParentCensusK-6SystemOverviewAndDetailedFindings.pdf>

Toronto First Duty Research Team (2005). First duty indicators of change.

Retrieved from City of Toronto website: <http://www1.toronto.ca/City%20of%20Toronto/Children's%20Services/Divisional%20Profile/Past%20Projects/firstduty/indicators.oct2005.pdf>.

Warren, S. F., Fey, M. E., & Yoder, P. J. (2007). Differential treatment intensity research: a missing link to creating optimally effective communication

interventions. *Mental Retardation and Developmental Disabilities Research Reviews*, 13(1), 70–77. <http://dx.doi.org/10.1002/mrdd.20139>

Zigler, E., & Finn-Stevenson, M. (2007). From research to policy and practice: the school of the 21st century. *American Journal of Orthopsychiatry*, 77(2), 175–181. <http://dx.doi.org/10.1037/0002-9432.77.2.175>