**Abstract**

BACKGROUND: Evidence shows that children’s household contexts of economic pressure and home chaos may better represent children’s daily home experiences than family socioeconomic status. Still, limited research has examined the impacts of household contexts on child developmental outcomes and their underlying mechanisms. OBJECTIVE: This study examined the longitudinal associations of economic pressure and home chaos with children’s prospective word reading and school readiness and executive functioning (EF) skills of attention shifting, inhibitory control, and working memory. METHODS: Longitudinal data were collected from a socioeconomically representative sample of 523 Chinese children (mean age 5.38 years; 52.9% male) and their parents and teachers in Hong Kong. Fathers and mothers at Time 1 (start of the school year) reported their perceived economic pressure and home chaos through questionnaires. At Time 2 (end of the school year), children’s EF and Chinese word reading were directly assessed with behavioral tasks, whereas teachers rated children’s school readiness using a questionnaire. RESULTS: Controlling for child age and gender, economic pressure was associated with later working memory and attention shifting. Time 1 economic pressure was indirectly associated with time 2 word reading and school readiness via time 2 working memory. A negative direct relationship was found between home chaos and school readiness. No significant associations were observed between home chaos and later EF skills. CONCLUSIONS: Economic pressure predicts later working memory as well as word reading and school readiness. The study suggests a potential role of working memory in the links between home environment and school readiness.

Keywords: Economic Pressure, Home Chaos, Executive Functioning, Chinese Word Reading, School Readiness

The Longitudinal Associations of Household Economic Pressure and Home Chaos with Children’s Executive Functioning, Word Reading, and School Readiness

**Introduction**

Children’s literacy skills and school readiness are robust predictors of their future academic achievement (e.g., Chung & McBride-Chang, 2011; Panlilio et al., 2018). Considerable research has examined how family socioeconomic status (by the acronym “SES”) may impact the development of these capabilities (e.g., Ip et al., 2016; Liu et al., 2016; Zhang et al., 2019). Although children’s executive functioning (by the acronym “EF”) unveils the underlying mechanism (e.g., Chung et al., 2017; St. John et al., 2019), prior research examining the mediating role of EF in the relationships between children’s SES and their literacy skills and school readiness has yielded inconclusive findings (e.g., Chung et al., 2017; Dilworth-Bart, 2012; Liu et al., 2016). These findings pointed to the inadequacy of SES in reflecting children’s proximal household environments (Conger et al., 1994; Masarik & Confer, 2017). Along a similar line of research, children’s EF is a potential mediator of children’s proximal household contexts of economic pressure (i.e., household financial stresses) and home chaos (i.e., the degree of noisiness, crowdedness, lack of routine, and disorganization of the household environments) (Matheny et al., 1995) in children’s literacy and school readiness (e.g., Jeon et al., 2014; Sénéchal & LeFevre, 2014). However, most studies were cross-sectional without considering the multidimensional nature of EF (e.g., Micalizzi et al., 2019; Dilworth-Bart, 2012). The present study extended previous work by examining the direct relationships between children’s proximal household contexts (economic pressure and home chaos) and their future academic achievement (word reading skills and school readiness) and their indirect relationships (i.e., mediation models between household contexts and academic achievement with the EF components of attention shifting, inhibitory control, and working memory considered as the underlying mechanisms) in a sample of Hong Kong Chinese kindergarten children.

**SES and Household Contexts as Differential Predictors of Children’s Academic Achievement**

Children’s early academic achievement can shape their future social (Gremmen et al., 2019) and psychological development (Cvencek et al., 2018; Putwain et al., 2022), and career prospect (Negru-Subtirica & Pop, 2016). Drawing on Bronfenbrenner’s ecological model (1977), variations in the family environment may explain the disparity in children’s academic achievement. Specifically, parents who come from different socioeconomic backgrounds provide varying degrees of cognitive stimulation (Slemming et al., 2022), home literacy environment (Chow et al., 2017), and parental instructions (Chung et al., 2017) to their children. Therefore, considerable research has investigated the impact of SES, defined as a combined index of parental income, education, and occupational status, on children’s academic performance (e.g., Chung, 2015; Fung & Chung, 2020; Zhang et al., 2019).

Drawing on the Family Stress Model (FSM; Conger et al., 1994; Masarik & Confer, 2017), family SES should be distinguished from the more proximal household contexts, such as economic pressure and home chaos. Likely, household contexts may have a more direct impact on children’s learning and academic achievement. Specifically, the FSM proposes that economic pressure, defined as the psychological stress due to insufficient monetary resources to deal with everyday household expenses (Conger et al., 1994), may contribute to parents’ psychological distress. High levels of psychological distress can dampen parents’ ability to manage children’s negative emotions and behaviors (Polizzi et al., 2021). Compared to affluent parents, parents from lower SES households tend to use control strategies, which can negatively impact children’s learning and development, rather than positive emotional or behavioral socialization approaches (Campos-Gil et al., 2020). Although SES and economic pressure are intricately related, SES focuses more on monetary resources than household expenses—middle-SES parents, for example, may also be due to financial stress by large mortgage loans and private school tuition. Therefore, SES may not fully reflect the levels of psychological distress experienced by parents and their children.

Home chaos, defined as a lack of household routine and organization (Matheny et al., 1995), may inform on aspects of children’s family environment in which SES factors yet provide a complete picture concerning children from different family backgrounds. High levels of home chaos limit not only children’s exposure to quality cognitive stimulation (e.g., household learning materials and opportunities) (Sarsour et al., 2010; Vernon-Feagans et al., 2016) but also parental responsiveness in daily parent-child interaction (e.g., nurturing, contingent response, timely scaffolding) (Andrews, Dunn, et al., 2021) while these are important predictors of children’s academic achievement (e.g., Altun, 2022; Andrews, Dunn, et al., 2021; Korucu et al., 2020; Merz et al., 2017). However, low-SES children may not necessarily live in a confusing and disorganized home environment; therefore, existing research on family SES may or may not shed light on the role of home chaos in children’s academic achievement (St. John et al., 2019). Taken together, economic pressure and home chaos are variables that may better indicate parental psychological distress and household disorganization and confusion in the family environment, especially when compared to family SES, and their relationships with children’s academic achievement warrant further examination.

**The Role of Executive Functioning in Early Disparity in Academic Achievement**

Emerging evidence suggests that EF explains children’s disparity in academic achievement originating from their family environment (e.g., Barnes et al., 2022; Fitzpatrick et al., 2014; Greenfader, 2019). EF is defined as a group of top-down mental processes that are required to control thoughts, feelings, and behaviors. These processes help children concentrate, make decisions, self-regulate, solve problems, and adapt to rules and requirements (Diamond, 2012, 2013). EF develops rapidly during child development from three to five years (Carlson, 2005). In developmental research, EF is commonly conceptualized as children’s abilities to hold and manipulate information mentally (working memory), attend to the appropriate target and ignore distraction (attention shifting), and suppress non-adaptive responses (inhibitory control) (Best & Miller, 2010; Miyake et al., 2000). These three components tend to emerge as distinct factors in the early years (St. John et al., 2019).

On the one hand, prior research has revealed the relationship between family environment and children’s EF. For example, children from less affluent backgrounds tend to show lower levels of EF than their more affluent peers (e.g., Chung et al., 2017; St. John et al., 2019). Likewise, economic pressure and home chaos were negatively associated with children’s EF (Andrews, Atkinson, et al., 2021; Campos-Gil et al., 2020) and self-regulation (Dumas et al., 2005) development. Moreover, there is a theoretical framework (e.g., psychobiological model of school readiness; Blair & Raver, 2015) and empirical evidence to support that EF forms a foundation for kindergarten children’s academic achievement such as literacy skills (e.g., Chung et al., 2018; Chung & McBride-Chang, 2011; Liu et al., 2019) and school readiness (e.g., Shaul & Schwartz, 2013; Willoughby et al., 2017). There is a growing research interest in how EF may play a central role in the underlying mechanisms accounting for the early disparity in children’s academic skills and its association with SES (e.g., Barnes et al., 2022; Fitzpatrick et al., 2014; Greenfader, 2019; Ip et al., 2016; Liu et al., 2016; Zhang et al., 2019). Such research has provided evidence supporting the mediating role of EF.

Yet, studies have revealed that EF may not offer a comprehensive view of the impacts of early family environment on children’s academic achievement. For instance, Dilworth-Bart (2012) and Liu et al. (2016) reported that kindergarten children’s EF was not a significant mediator in the link between SES and word reading. Likewise, although kindergarten children from low-SES backgrounds showed lower levels of EF than their more affluent peers, the gap in their word reading was not statistically significant (Chung et al., 2017). Further, Zhang et al. (2019) reported that the indirect relationships between children’s SES, EF, and reading or mathematical skills were non-significant. Existing studies concerning the mediating role of EF on children’s disparity in early academic achievement have so far produced inconsistent findings. A possible reason is that family SES may not fully capture children’s immediate household contexts, as proposed by the FSM (Conger et al., 1994; Masarik & Confer, 2017), whereas economic pressure and home chaos may better reflect children’s proximal household contexts and explain the relationship between family environment and academic achievement.

**Research Examining the Links between Household Contexts, Executive Functioning, and Academic Achievement**

Although the FSM (Conger et al., 1994; Masarik & Confer, 2017) suggested that SES and proximal household contexts (i.e., economic pressure and home chaos) may differentially predict children’s academic achievement, minimal research has investigated their direct and indirect relationships with children’s EF considered (e.g., Dilworth-Bart, 2012; Micalizzi et al., 2019). Micalizzi and colleagues (2019) examined the concurrent associations among SES, home chaos, and school readiness of 574 kindergarten children in the United States. They investigated whether the links were mediated through children’s attention shifting and inhibitory control. Results revealed that attention shifting partially mediated the association between SES and school readiness and that both attention shifting and inhibitory control were positively associated with school readiness. Additionally, home chaos was unrelated to attention shifting and inhibitory control but negatively related to school readiness. However, Micalizzi et al. (2019) underscored that the findings were based on cross-sectional data without considering children’s working memory.

Dilworth-Bart (2012) conducted another cross-sectional study to investigate whether EF (operationalized as a composite score of working memory, attention shifting, and inhibitory control) mediated the relationships between SES, home environment (e.g., learning materials, physical environment, and academic stimulation), and academic achievement (conceptualized as children’s math skills and word reading) in a sample of 49 kindergarten children in the United States. Findings suggested that children’s EF composite score mediated the relationship between SES and their mathematical skills, but the indirect relationship among SES, EF, and word reading was non-significant.

Given the cross-sectional nature of the existing evidence (Dilworth-Bart, 2012; Micalizzi et al., 2019), a further examination of the indirect links among children’s proximal household contexts and their future EF, literacy skills, and school readiness represented a step forward to inform their directional relationships better. Moreover, since the three EF skills may develop at different paces (Miyake & Friedman, 2012) and emerge as distinct cognitive components in the kindergarten years (St. John et al., 2019), it is also important to consider them simultaneously to identify their unique contributions. Therefore, this study focuses on two aspects of proximal household contexts, namely economic pressure and home chaos, to examine their interrelationships with children’s EF, literacy skills, and school readiness across two-time points separated by one year. In particular, we extend Micalizzi and colleagues’ framework (2019) by including the three EF processes of working memory, attention shifting, and inhibitory control as potential mediators to investigate how children’s proximal household contexts would, directly and indirectly, predict their prospective Chinese word reading and school readiness.

**The Present Study**

The present research examined the relationships among economic pressure, home chaos, word reading, and school readiness across time in 523 Chinese kindergarten children. This study also investigated their indirect relationships as mediated through EF by including all three components of working memory, attention shifting, and inhibitory control. Based on previous research findings (Dilworth-Bart, 2012; Micalizzi et al., 2019), we hypothesized that economic pressure and home chaos at the start of the school year (Time 1) would have direct relationships with children’s EF, Chinese word reading, and school readiness at the end of the school year (Time 2), and that these household contexts and child developmental outcomes would have indirect relationships via the three EF skills at Time 2 (refer to Figure 1 for the conceptual model).

<Figure 1 about here>

**Methods**

**Participants**

Participants were 523 Hong Kong kindergarten children (277 boys, mean age at Time 2 5.38 years, *SD* = 0.6 years) and their parents and teachers from nine kindergartens. The nine participating kindergartens were socioeconomically representative local schools (three schools from each of the high-, middle-, and low-socioeconomic strata based on the district median household income) with whole-day and/or half-day classes, and they developed their school-based curriculum. Most Hong Kong children attend three years of kindergarten: K1 (typical age range 3-4), K2 (typical age range 4-5), and K3 (typical age range 5-6). School teachers and parents filled in a questionnaire to provide information on the types of children with special needs. Children were eligible for inclusion in the study if they studied K1 or K2 at Time 1 and had no chronic illnesses, developmental delay or special education needs as reported by their parents and teachers. For family backgrounds, 40% of the parents completed secondary school, whereas 46% completed college or above. For parental age, 61% of the parents were between 31 and 40, 20% were between 41 and 50, and 17% were between 21 and 30. All children were native Cantonese speakers with no reported intellectual or language disabilities. The attrition rate was 3.8%, representing a low dropout rate.

**Procedure**

Ethical approval was obtained from the Institutional Review Board of the respective university (approval code: 2018-2019-0175), and kindergarten principals granted permission. Informed consent has been appropriately obtained from all participants. All teachers and parents from the K1 and K2 classes of the participating kindergartens were then given consent forms with questionnaires to invite their participation. Parents who agreed to participate in this study returned their consent and questionnaire forms; the consent rate was 97%. All invited teachers agreed to participate in the current study.This study employed the longitudinal design with data collected at two time points separated by one year: at the beginning and the end of the school year. Data collection started on September 2017 and finished on July 2018. Fathers and mothers reported their perceived economic pressure and home chaos at Time 1, while teachers reported children’s school readiness at Time 2. The assessment measures of children’s working memory, attention shifting, inhibitory control, and Chinese word reading were individually administered at Time 2 by trained assistants in a quiet school area. Testing lasted approximately 40 minutes, with a short break during testing. The authors have no competing interests to declare that are relevant to the execution of the present study and the content of this article.

**Measures**

***Economic Pressure***

Following Conger et al.’s (1994) conceptualization and previous approach (Chan et al., 2018; McHale et al., 2011; Neppl et al., 2016), we asked parents to rate whether they have sufficient money to pay for their everyday family expenses items of clothing, food, housing, household goods, transportation, medical care, recreation, and child education/extracurricular activities. To reduce the self-report bias (e.g., Datta Gupta et al., 2018), we asked both the father and the mother to report their perceived economic pressure, and we also informed parents about the study method and confidentiality of information. Parents rated the extent of economic pressure on each item on a 5-point scale ranging from 1 (minimal economic pressure) to 5 (a great deal of economic pressure). Given that fathers’ and mothers’ scores were significantly correlated (*r* = .65, *p* < .001), the scores were standardized and averaged to represent economic pressure. The overall Cronbach’s alpha with all items included was 0.96, whereas the Cronbach’s alphas of fathers’ and mothers’ items were 0.95 and 0.96, respectively.

***Home Chaos***

Home chaos was assessed by the Confusion, Hubbub, and Order Scale (Matheny et al., 1995). Due to time constraints, the measure originally included 15 items, but we only used a 6-item version developed by Wang and colleagues (2013). Both parents rated the levels of confusion (e.g., “I can’t hear myself think in our home,” “The atmosphere in our house is calm”) and disorganization (e.g., “It’s a real zoo in our home,” “We have a regular routine at home”) at home on a 5-point scale ranging from 1 (strongly disagree) to 5 (strongly agree). Reverse coding was made where appropriate so that a higher score indicated a higher level of chaos. Given that fathers’ and mothers’ scores were moderately correlated (*r* = .57, *p* < .001), their scores were standardized and averaged to represent home chaos. The overall Cronbach’s alpha with all items included was 0.80, whereas the Cronbach’s alphas of fathers’ and mothers’ items were 0.73 and 0.71, respectively.

***School Readiness***

Children’s school readiness was assessed by the Chinese version of the Gumpel Readiness Inventory (GRI) (Gumpel, 1999). GRI is a validated measure of Hong Kong kindergarten children, which demonstrates good internal consistency, test-retest reliability, construct validity, and concurrent validity (Ho et al., 2013). The scale included 6 items tapping children’s academic (e.g., demonstrates an understanding of relational concepts), strategic (e.g., can break down a complex task into its constituent parts), and role-governed (e.g., pays attention during class) skills. Teachers rated each item on a 5-point scale ranging from 1 (never) to 5 (always) based on their observed frequency of the relevant behavior, and the mean score represented children’s school readiness. The Cronbach’s alpha was 0.87.

***Chinese Word Reading***

Chinese word reading was assessed by 70 one- and two-character words adopted from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-P(II)) (Ho et al., 2007), and this test was employed in previous studies (e.g., Chung et al., 2017). Children were asked to read aloud the words sorted in increasing order of difficulty, and each correct answer scored one mark. The test was ended if children failed to answer 12 consecutive words correctly. The maximum score was 70, and the Cronbach’s alpha was 0.98.

***Executive Functions***

**Working Memory** Working memory was assessed by the backward digit span task from the Wechsler Intelligence Scale for Children – 3rd (WISC–3; Wechsler, 1991), which is commonly employed in research of kindergarten children (e.g., Blair & Raver, 2014; Chung & McBride-Chang, 2011; Fung et al., 2020). Children first listened to a sequence of digits presented at a rate of one per second and then repeated that sequence in reverse order after hearing a signal. The span level ranged from two to nine digits, with two different sequences on each level. The task was ended if children failed to recall both sequences at one level. One point was given to each correct sequence, with a maximum of 16. The Cronbach’s alpha was 0.72.

**Attention Shifting** Attention shifting was assessed by 40 items from the NIH Toolbox Dimensional Change Card Sort Test (Zaitchik et al., 2014; Zelazo et al., 2014). Two target pictures were presented with two variant dimensions: color (yellow vs. blue) and shape (a ball vs. a truck). Children were asked to match a series of bivalent test pictures (e.g., yellow balls and blue trucks), first according to one dimension (e.g., color) and then, after a number of trials, according to the other dimension (e.g., shape). The reference dimension for sorting was indicated to the child by both visual (cue word of “shape” or “color”) and audio (prerecorded audio file of “shape” or “color”) means. Before the testing trials, children were given four practice trials for each dimension with feedback on the correctness of the response provided. Children could advance to practice trials for the next dimension and then to the test trials only if they got at least three out of four practice trials correct, and they could practice at most three times for each dimension. During the testing trials, children first completed five trials for the color dimension, followed by five trials for the shape dimension. The test ended if children did not get four out of five trials correct for either dimension. If children met the criteria for both dimensions, they could proceed to the mixed block, which consisted of 30 shape/color trials. One point was given for each correct answer, with a maximum of 40. The Cronbach’s alpha was 0.86.

**Inhibitory Control** Inhibitory control was assessed by the NIH Toolbox Flanker Inhibitory Control and Attention Test (Zaitchik et al., 2014; Zelazo et al., 2014). Children were asked to indicate the orientation of a target stimulus (fish or arrow) located at the center of the screen while ignoring the distracting stimuli (fish or arrows) located on both sides of the target stimulus. In the congruent trials, the target stimulus and the distracting stimuli were pointing in the same direction, whereas the target stimulus and the distracting stimuli were pointing in opposite directions in the incongruent trials. Before the testing trials, children were given four practice trials with feedback on the correctness of the response provided. Children could advance to the test trials only if they got at least three out of four practice trials correct. The testing trials consisted of 20 mixed congruent/incongruent trials with fishes as stimuli, followed by 20 mixed congruent/incongruent trials with arrows as stimuli. Each correct answer scored one mark, with a maximum of 40. The Cronbach’s alpha was 0.83.

**Data Analysis Plan**

Outlier (examining any data entry or measurement error for values exceeding 3 standard deviations), normality (skewness and kurtosis within the range of plus and minus one), and pattern of missing data (missing completely at random) were first examined to ensure the statistical assumptions were met. Correlations were then examined to understand the relationships among the variables. To address the hypotheses of this study, two separate path analytic models were tested with the lavaan package (version 0.6-1) in R (version 3.5.0; R Core Team, 2018). The multilevel nature of the data (children nested within classes) may bias the parameter estimates, and the intraclass correlations of the variables at the class level ranged between 0.134 to 0.339. Therefore, the lavaan.survey package was employed in the path analyses (Oberski, 2014). The lavaan.survey package (Oberski, 2014) corrects the parameter estimates and standard errors to account for the non-independence due to the nested sampling structure. Previous research employed this approach (e.g., Jackson & Cunningham, 2017; Stühmann et al., 2020). The path models examined if economic pressure and home chaos at Time 1, as well as working memory, attention shifting, and inhibitory control at Time 2, were directly related to Chinese word reading or school readiness at Time 2. Moreover, the models investigated whether economic pressure and home chaos at Time 1 were indirectly related to children’s Chinese word reading or school readiness at Time 2 as mediated through working memory, attention shifting, and inhibitory control at Time 2. Child age and gender were statistically controlled for Chinese word reading, school readiness, and the three components of EF.

Model fit was assessed by the Chi-square index (χ2), comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR), with a non-significant χ2, CFI and NNFI values beyond .95, and RMSEA and SRMR values under .05, indicating a good model fit (Hu & Bentler, 1999).

**Results**

**Preliminary Analyses**

Table 1 shows the descriptive statistics and the bivariate correlations among the study variables. The percentages of missing data for the study variables ranged from 6.7 (teachers-reported school readiness) to 18.9% (parent-reported home chaos). The Little’s (1998) test value was non-significant (χ2 (126) = 146.78, *p* = .10), which indicated that the data were missing completely at random. Considering the fraction of missing data was smaller than 0.3, the missingness was addressed using multiple imputation with 100 between-imputation iterations to generate 20 imputed datasets (Graham et al., 2007) that were pooled to produce point and variance estimates based on the standard Rubin (1987) formula. The maximum likelihood estimation with robust standard errors (i.e., MLM estimator) was employed in estimating the model fit (Oberski, 2014).

<Table 1 about here>

**Path Model Predicting Chinese Word Reading**

Table 2 shows the parameter estimates and model fit statistics for predicting Chinese word reading, whereas Figure 2 highlights the standardized path coefficients. The model demonstrated a good fit to the data *χ2*(*df* = 4, *N* = 523) = 3.253, *p* = .516, CFI = 1.000, NNFI = 1.009, RMSEA = .000 (90% CI: .000, .060), SRMR = .012, *R2 Chinese word reading* = .421. A negative indirect relationship via working memory at Time 2 was noted between economic pressure at Time 1 and Chinese word reading at Time 2 (indirect effect: *β* = -.036, *SE* = .313, *p* < .05). Although the direct links between economic pressure at Time 1 and attention shifting at Time 2 (*β* = -.102, *SE* = .723, *p* < .05) and between attention shifting and Chinese word reading at Time 2 (*β* =.074, *SE* = .050, *p* < .05) were both significant, the indirect effect between economic pressure at Time 1 and Chinese word reading at Time 2 via attention shifting at Time 2 was non-significant (indirect effect: *β* = -.008, *SE* = .107, *ns*). The associations among economic pressure at Time 1, inhibitory control at Time 2, and Chinese word reading at Time 2 were non-significant. Moreover, the direct links between home chaos at Time 1 and Chinese word reading or EF skills at Time 2 were all non-significant.

<Table 2 about here>

<Figure 2 about here>

**Path Model Predicting School Readiness**

Table 3 shows the parameter estimates and model fit statistics for predicting school readiness, whereas Figure 3 highlights the standardized path coefficients. The model demonstrated a good fit to the data *χ2*(*df* = 4, *N* = 523) = 3.516, *p* = .475, CFI = 1.000, NNFI = 1.007, RMSEA = .000 (90% CI: .000, .062), SRMR = .013, *R2 School readiness* = .229. A negative indirect relationship via working memory at Time 2 was noted between economic pressure at Time 1 and school readiness at Time 2 (indirect effect: *β* = -.016, *SE* = .006, *p* < .05). Economic pressure at Time 1 was negatively related to attention shifting at Time 2 (*β* = -.103, *SE* = .735, *p* < .05), but the relationships between economic pressure at Time 1 and inhibitory control or school readiness at Time 2 were non-significant. Home chaos at Time 1 was negatively associated with school readiness at Time 2 (*β* = -.112, *SE* = .033, *p* < .01), but the links between home chaos at Time 1 and the three components of EF at Time 2 were all non-significant. Moreover, inhibitory control at Time 2 was positively associated with school readiness at Time 2 (*β* = .229, *SE* = .003, *p* < .001), whereas the link between attention shifting and school readiness at Time 2 was non-significant.

<Table 3 about here>

<Figure 3 about here>

**Discussion**

This study examined the direct relationships between economic pressure, home chaos, word reading, and school readiness and their indirect relationships as mediated through children’s EF skills of working memory, attention shifting, and inhibitory control. In line with previous findings (Micalizzi et al., 2019), the present results showed that the indirect associations among children’s home chaos, EF skills, word reading, and school readiness were non-significant. More importantly, the results demonstrated that the indirect associations among economic pressure and children’s working memory, word reading, and school readiness were significant. These findings underscored that excessive household economic pressure may negatively impact kindergarten children’s working memory and, in turn, lower their Chinese word reading and school readiness. The present study extended the previous work (Dilworth-Bart, 2012; Micalizzi et al., 2019) by highlighting working memory as the specific EF skill. Working memory could potentially explain the relationships between economic pressure and Chinese kindergarten children’s word reading and school readiness across time, with all three EF components considered simultaneously.

**Indirect Associations of Economic Pressure and Working Memory with Chinese Word Reading and School Readiness**

Of specific importance are the findings that the indirect associations between economic pressure, Chinese word reading, and school readiness via children’s working memory were statistically significant. Although previous research suggested that attention shifting, but not inhibitory control, mediated the link between SES and children’s school readiness (Micalizzi et al., 2019), those results were based on cross-sectional data without considering the role of working memory. The present results underscored working memory, instead of attention shifting or inhibitory control, as the factor through which economic pressure may exert an impact in influencing children’s word reading and school readiness. A possible reason is that parents reporting high economic pressure had less time and resources to provide parental companionship or enrichment activities, such as parent-child shared book reading, to their children (Sarsour et al., 2010). These resources and opportunities may be critical to developing children’s working memory (e.g., to recollect and manipulate word patterns in mind while reading). This speculation concurs with previous findings showing that Chinese children from low-SES backgrounds performed less well in working memory tasks than their middle-SES peers (Chung et al., 2017). Still, no significant difference was found in inhibitory control (Chung et al., 2017). However, as EF skills, word reading, and school readiness were assessed at Time 2, the research design precluded inferences about temporal ordering or true longitudinal mediation, and caution should be taken when interpreting the findings. Future work is also worth validating the mediating role of working memory in the relationship between household contexts and children’s English word reading ability and school readiness in different cultural contexts.

Notably, although the total effect of the relationship among economic pressure, working memory, and Chinese word reading was significant (Table 2), the impact of the relationship among these variables on school readiness (Table 3) was non-significant. The correlation between economic pressure and school readiness was also close to zero (Table 1). The non-significance of the total effect among economic pressure, working memory, and school readiness, as well as the zero correlation between economic pressure and school readiness, may be partly attributed to the marginally positive link between economic pressure and school readiness in the path model (*β =* .077, *SE* = .032, *p* = .059). This correlation suggests that economic pressure has a lesser impact on children’s learning outcomes in Chinese society. This may be because children may endorse high social goals in their academic pursuits (e.g., being an excellent student to demonstrate children’s sense of indebtedness toward their parents) (Cheng & Fung, 2018). Apart from the indirect impact on school readiness via children’s EF, economic pressure and the contingent psychological distress experienced by the parents may also be perceived and internalized by the children, which functions as an internal motivational force that drives children to achieve academically. Taken together, economic pressure may influence children’s school readiness via different pathways, and its impacts may be in opposing directions (i.e., a positive direct effect plus a negative indirect effect). However, given the direct association between economic pressure and school readiness was only marginally significant, further research is needed to address this speculation by tapping children’s achievement motivation in school settings. Further studies are also needed to examine whether a positive relationship between economic pressure and school readiness will also be found across different cultures. Nevertheless, the results suggested working memory is a plausible target that early intervention programs fostering children’s Chinese word reading and school readiness should focus on.

**Associations of Attention Shifting and Inhibitory Control with Chinese Word Reading and School Readiness**

In addition to working memory, the present results suggested that children’s attention shifting, but not inhibitory control, may contribute to their Chinese word reading. Although a prior longitudinal study has documented that both working memory and inhibitory control were significantly predictive of kindergarten children’s Chinese word reading (Chung & McBride-Chang, 2011), the predictive ability of working memory was relatively stronger than the inhibitory control (as reflected by their standardized regression coefficients). The analyses did not include attention shifting in their study. It may be that, with increasing exposure to Chinese characters, children were trained to ignore irrelevant information effectively. In contrast, the abilities to hold and manipulate information as perceived by focusing attention on different radicals of a Chinese character were still important in determining their word reading performance. The results pointed to the need to examine further how different components of EF might influence Chinese word reading in children.

On the other hand, children’s inhibitory control, but not attention shifting, was positively related to their school readiness. As suggested by the psychobiological framework of school readiness (Blair & Raver, 2015), children’s abilities to hold impulsive responses and to regulate their behaviors adaptively (e.g., role-governed skills) are vital components of school readiness (Gumpel, 1999). Therefore, it is unsurprising that children’s inhibitory control may contribute to their school readiness. Although Micalizzi et al. (2019) revealed that attention shifting and inhibitory control were related to children’s school readiness, they assessed school readiness by employing a standardized test of five basic skills (colors, letters, number concepts, sizes, and shapes). Thus, the conceptualization of school readiness in Micalizzi et al. (2019) may rely more on children’s academic abilities, whereas school readiness in this study also tapped into children’s role-governed skills. Additionally, the inclusion of working memory in this study may also have affected the relative strength of the path coefficients among the three components of EF.

**Relationships among Home Chaos, EF, Chinese word reading, and School Readiness**

In both path models, home chaos was not significantly associated with children’s working memory, attention shifting, and inhibitory control. Nevertheless, home chaos was negatively associated with children’s school readiness over time. Findings from the present and a prior study (Micalizzi et al., 2019) reliably suggested that the potential impact of home chaos on children’s school readiness may be due to variables that were not included in this study. For example, research has documented that the associations between home chaos and kindergarten children’s learning outcomes can be mediated through parenting practices (e.g., Vernon-Feagans et al., 2012; Vernon-Feagans et al., 2016). Therefore, in addition to EF skills, it is worthwhile to examine additional mechanisms (e.g., parenting styles) underlying the potential link between home chaos and school readiness among Chinese children.

Surprisingly, home chaos was not significantly associated with children’s Chinese word reading despite its direct relationship with school readiness. Apart from EF, vocabulary knowledge is another potential construct accounting for the relationship between home chaos and Chinese word reading (e.g., Chung & McBride-Chang, 2011; Martin et al., 2012; Vernon-Feagans et al., 2012). Nevertheless, the parental reading ability may moderate the association between home chaos and vocabulary knowledge (Johnson et al., 2008). Specifically, home chaos only significantly predicted the vocabulary knowledge of children whose mothers were above-average readers (Johnson et al., 2008). Perhaps, in the present study, parental reading ability moderated and, therefore, somehow weakened the direct relationship between home chaos and Chinese word reading. Future studies, however, are needed to address this possibility.

**Limitations and Future Directions**

The present study has several limitations. First, this study was correlational in nature, and no causal relationship could be inferred from its findings. Moreover, parent-reported (economic pressure and home chaos), teacher-reported (school readiness), and behaviorally assessed (EF and Chinese word reading) data were not collected at both Time 1 and Time 2, and thus these variables were not covaried. The mediators and the dependent variables of the indirect tests were assessed contemporaneously is a major limitation as the present design did not preserve the temporal ordering of variables. This design may lead to biased estimates of model fit (Cole & Maxwell, 2003). Therefore, future researchers should retest our hypotheses using randomized experimental or multi-wave cross-lagged panel designs. Second, to have a more comprehensive understanding of children’s reading development across time points, reading performance should include reading comprehension and word reading.

Third, this study investigated how parent-reported economic pressure and home chaos were related to EF, school readiness, and word reading in Chinese children. In particular, self-reporting of family economic status without more objective measurements may be the potential sources of selection and survey bias influencing the results of the study. Even though parents are knowledgeable informants of household contexts (Micalizzi et al., 2019; Neppl et al., 2016), direct measures, for example, the ratios between actual family incomes and actual household expenses and observations of the household organization (e.g., Dilworth-Bart, 2012) may provide a comprehensive picture of economic pressure and home chaos. Further studies may consider using both subjective and objective measures to triangulate such complex household contexts as economic pressure and home chaos.

Fourth, the present results were based on data collected from a socioeconomically representative sample of Chinese kindergarten children in Hong Kong. Nevertheless, the generalizability of the findings to other social and cultural contexts remains an open question. Future work may validate the present results in different Chinese societies (e.g., Taiwanese, Singaporean, and Malaysian Chinese) and cultural contexts.

Finally, although the conceptualization of EF as working memory, attention shifting, and inhibitory control (Miyake et al., 2000) is common in developmental research of kindergarten children (Best & Miller, 2010), there is a theoretical debate in relation to the idea of whether EF skills are a unitary construct in early childhood (e.g., Wiebe et al., 2008; Wiebe et al., 2011). The modest correlations among the three dimensions of EF and the distinctive patterns of indirect relationships, as demonstrated in the present findings, agree with the suggestion that EF skills exhibit both unity (relying on common ability) and diversity (are separable) (Miyake & Friedman, 2012). However, caution should still be taken in interpreting the present results.

**Conclusions and Implications**

Despite these limitations, the present study provides theoretical insights by suggesting how economic pressure may influence children’s academic outcomes. Specifically, the results highlighted the indirect associations between economic pressure and the development of prospective working memory, Chinese word reading, and school readiness in children. The findings of this study suggest working memory as a possible target of intervention (e.g., Cogmed computer-based training; Diamond, 2012) to facilitate kindergarten children, especially those from families facing high economic pressure, to read Chinese characters and prepare for their formal school transition.

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Table 1

*Descriptive statistics and bivariate correlations of various variables.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  | Correlations | | | | | |
| Variables | *M* | *SD* | Skewness | Kurtosis | Range |  | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
| 1. T1 Home Chaos (Z-score) | -0.01 | 0.88 | 0.05 | 0.01 | -2.40 – 2.43 |  | -- |  |  |  |  |  |  |
| Father Home Chaos | 2.25 | 0.53 | 0.16 | 0.19 | 1.00-4.00 |  |  |  |  |  |  |  |  |
| Mother Home Chaos | 2.23 | 0.50 | 0.24 | 0.19 | 1.00-4.00 |  |  |  |  |  |  |  |  |
| 2. T1 Economic Pressure (Z-score) | -0.03 | 0.89 | 0.61 | 0.56 | -1.54 – 2.99 |  | .42\*\* | -- |  |  |  |  |  |
| Father Economic Pressure | 3.94 | 0.69 | -0.55 | 0.84 | 1.00-5.00 |  |  |  |  |  |  |  |  |
| Mother Economic Pressure | 3.89 | 0.72 | -0.56 | 0.42 | 1.00-5.00 |  |  |  |  |  |  |  |  |
| 3. T2 Working Memory | 2.21 | 1.49 | -0.04 | -0.57 | 0.00 – 6.00 |  | -.13\*\* | -.14\*\* | -- |  |  |  |  |
| 4. T2 Attention Shifting | 27.41 | 13.33 | -0.80 | -0.91 | 2.00 – 40.00 |  | -.12\* | -.14\*\* | .18\*\* | -- |  |  |  |
| 5. T2 Inhibitory Control | 32.33 | 11.12 | -0.95 | -0.44 | 6.00 – 40.00 |  | -.08 | -.07 | .30\*\* | .24\*\* | -- |  |  |
| 6. T2 Chinese Word Reading | 33.97 | 19.53 | 0.13 | -0.82 | 0.00 – 70.00 |  | -.14\*\* | -.15\*\* | .49\*\* | .19\*\* | .33\*\* | -- |  |
| 7. T2 School Readiness | 3.82 | 0.72 | -0.54 | 0.31 | 1.00 – 5.00 |  | -.11\* | .00 | .30\*\* | .17\*\* | .36\*\* | .46\*\* | -- |
| 8. T2 Child Age | 5.38 | 0.60 | 0.04 | -.1.12 | 52.00 – 82.00 |  | -.05 | .00 | .37\*\* | .08 | .37\*\* | .52\*\* | .32\*\* |
| *Note:* \* *p* < .05; \*\* *p* < .01. T1 = Time 1; T2 = Time 2. | | | | | | | | | | | | | |

Table 2

*Parameter estimates (unstandardized regression coefficients (b), standardized regression coefficients (β), standard errors (SE), and p-value (p)) and model fit statistics (Chi-square index (χ2), comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR)) for the path model predicting Chinese word reading.*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Path |  | Parameter Estimates | | | | |
|  |  | *b* | *β* | *SE* | *p* |
| Direct effects |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM |  | -.191 | -.116 | .069 | .006 |
| T1 Economic Pressure -> T2 AS |  | -1.519 | -.102 | .723 | .036 |
| T1 Economic Pressure -> T2 IC |  | -.777 | -.063 | .616 | .207 |
| T1 Home Chaos -> T2 WM |  | -.121 | -.074 | .075 | .105 |
| T1 Home Chaos -> T2 AS |  | -.872 | -.059 | .782 | .265 |
| T1 Home Chaos -> T2 IC |  | -.417 | -.034 | .539 | .439 |
| T1 Economic Pressure -> T2 CWR |  | -1.520 | -.068 | .912 | .096 |
| T1 Home Chaos -> T2 CWR |  | -.739 | -.034 | .827 | .371 |
| T2 WM -> T2 CWR |  | 4.142 | .307 | .596 | < .001 |
| T2 AS -> T2 CWR |  | .110 | .074 | .050 | .028 |
| T2 IC -> T2 CWR |  | .127 | .071 | .068 | .061 |
|  |  |  |  |  |  |
| Indirect effects |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM -> T2 CWR |  | -.792 | -.036 | .313 | .012 |
| T1 Economic Pressure -> T2 AS -> T2 CWR |  | -.167 | -.008 | .107 | .117 |
| T1 Economic Pressure -> T2 IC -> T2 CWR |  | -.099 | -.004 | .099 | .316 |
| T1 Home Chaos -> T2 WM -> T2 CWR |  | -.503 | -.023 | .322 | .118 |
| T1 Home Chaos -> T2 AS -> T2 CWR |  | -.096 | -.004 | .095 | .310 |
| T1 Home Chaos -> T2 IC -> T2 CWR |  | -.053 | -.002 | .073 | .464 |
|  |  |  |  |  |  |
| Total effect |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM -> T2 CWR |  | -2.312 | -.104 | .900 | .010 |
| *Note:* T1 = Time 1; T2 = Time 2; WM = working memory; AS = attention shifting; IC = inhibitory control; CWR = Chinese word reading. Control variables included child age and gender. Model fit statistics *χ2*(*df* = 4, *N* = 523) = 3.253, *p* = .516, CFI = 1.000, NNFI = 1.009, RMSEA = .000 (90% CI: .000, .060), SRMR = .012, *R2 Chinese word reading* = .421. | | | | | |

Table 3

*Parameter estimates (unstandardized regression coefficients (b), standardized regression coefficients (β), standard errors (SE), and p-value (p)) and model fit statistics (Chi-square index (χ2), comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR)) for the path model predicting school readiness.*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Path |  | Parameter Estimates | | | |
|  |  | *b* | *β* | *SE* | *p* |
| Direct effects |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM |  | -.186 | -.113 | .071 | .009 |
| T1 Economic Pressure -> T2 AS |  | -1.521 | -.103 | .735 | .039 |
| T1 Economic Pressure -> T2 IC |  | -.671 | -.055 | .600 | .263 |
| T1 Home Chaos -> T2 WM |  | -.137 | -.085 | .077 | .076 |
| T1 Home Chaos -> T2 AS |  | -.788 | -.054 | .782 | .313 |
| T1 Home Chaos -> T2 IC |  | -.499 | -.041 | .521 | .338 |
| T1 Economic Pressure -> T2 SR |  | .060 | .077 | .032 | .059 |
| T1 Home Chaos -> T2 SR |  | -.088 | -.112 | .033 | .007 |
| T2 WM -> T2 SR |  | .070 | .146 | .021 | < .001 |
| T2 AS -> T2 SR |  | .002 | .043 | .002 | .275 |
| T2 IC -> T2 SR |  | .015 | .229 | .003 | < .001 |
|  |  |  |  |  |  |
| Indirect effects |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM -> T2 SR |  | -.013 | -.016 | .006 | .033 |
| T1 Economic Pressure -> T2 AS -> T2 SR |  | -.003 | -.004 | .004 | .353 |
| T1 Economic Pressure -> T2 IC -> T2 SR |  | -.010 | -.013 | .009 | .280 |
| T1 Home Chaos -> T2 WM -> T2 SR |  | -.010 | -.012 | .006 | .095 |
| T1 Home Chaos -> T2 AS -> T2 SR |  | -.002 | -.002 | .002 | .464 |
| T1 Home Chaos -> T2 IC -> T2 SR |  | -.007 | -.009 | .008 | .359 |
|  |  |  |  |  |  |
| Total effect |  |  |  |  |  |
| T1 Economic Pressure -> T2 WM -> T2 SR |  | .047 | .060 | .033 | .150 |
| *Note:* T1 = Time 1; T2 = Time 2; WM = working memory; AS = attention shifting; IC = inhibitory control; SR = school readiness. Control variables included child age and gender. Model fit statistics *χ2*(*df* = 4, *N* = 523) = 3.516, *p* = .475, CFI = 1.000, NNFI = 1.007, RMSEA = .000 (90% CI: .000, .062), SRMR = .013, *R2 School readiness* = .229. | | | | | |

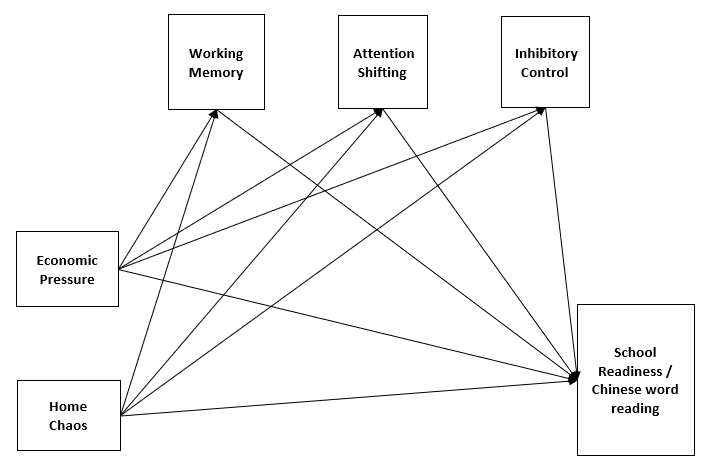
Figure Legends

**Figure 1**. Conceptual model showing the direct and indirect relationships of economic pressure and home chaos with children’s working memory, attention shifting, inhibitory control, Chinese word reading, and school readiness.

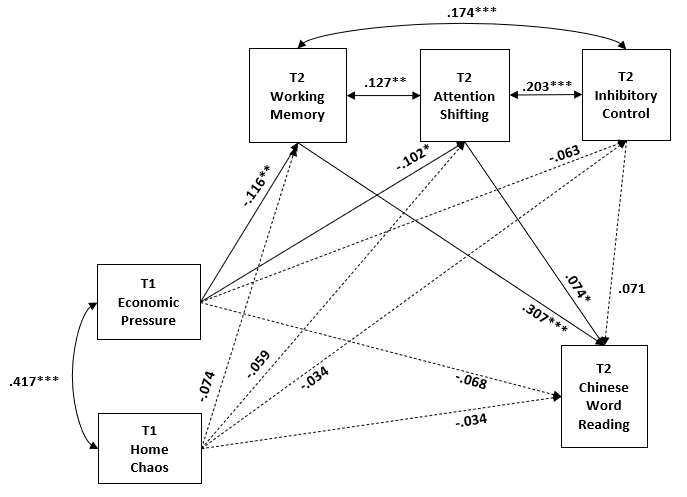
**Figure 2.** Path model for predicting children’s Chinese word reading from economic pressure, home chaos, working memory, attention shifting, and inhibitory control controlling for child age and gender. Standardized coefficients are reported. All solid paths are significant, whereas dashed paths are non-significant. T1 = Time 1; T2 = Time 2. \* *p* < .05; \*\* *p* < .01; \*\*\* *p* < .001. Model fit statistics *χ2*(*df* = 4, *N* = 523) = 3.253, *p* = .516, CFI = 1.000, NNFI = 1.009, RMSEA = .000 (90% CI: .000, .060), SRMR = .012, *R2 Chinese word reading* = .421.

**Figure 3.** Path model for predicting children’s school readiness from economic pressure, home chaos, working memory, attention shifting, and inhibitory control controlling for child age and gender. Standardized coefficients are reported. All solid paths are significant, whereas dashed paths are non-significant. T1 = Time 1; T2 = Time 2. \* *p* < .05; \*\* *p* < .01; \*\*\* *p* < .001. Model fit statistics *χ2*(*df* = 4, *N* = 523) = 3.516, *p* = .475, CFI = 1.000, NNFI = 1.007, RMSEA = .000 (90% CI: .000, .062), SRMR = .013, *R2 School readiness* = .229.

**Figure 1.**

****

**Figure 2.**



**Figure 3.**

