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The Impact of a Preventive Intervention on Persistent, Cross-Situational Early Onset Externalizing Problems

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Abstract

The Nurse-Family Partnership (NFP) home visiting intervention for low-income first-time mothers was evaluated for its preventive impact on persistent, cross-situational early-onset externalizing problems (EXT). Seven hundred thirty-five women in the Denver, CO, area were randomly assigned into one of two active conditions (nurse or paraprofessional home visiting from pregnancy through child age 2) or a control group in which children were screened and referred for behavioral and developmental problems. Externalizing behavior was assessed by parent report when the children were 2, 4, 6, and 9 years old; teachers provided reports at ages 6 and 9. Latent profile analyses suggested the presence of persistent, cross-situational early onset EXT in approximately 6 to 7% of girls and boys. The intervention deflected girls away from these EXT and toward a pattern marked by a persistent moderate elevation of externalizing behavior that was evident at home and not at school. This finding should be interpreted cautiously given the small number of girls with the elevated EXT. Surprisingly, the intervention also moved girls away from stable low level externalizing behavior toward the moderately elevated pattern. Both of the significant effects on girls' externalizing behavior were modest. No statistically significant effects were found for boys' externalizing behaviors, which exhibited a somewhat different patterning across time and reporter. Effect sizes were generally similar for the nurse and paraprofessional-visited groups. The results are discussed in the context of prior efforts to prevent early EXT and emerging evidence on the normative development of externalizing behavior.

Keywords Prevention · Externalizing · Infancy · Toddlerhood · RCT

Persistent early-onset child externalizing problems (EXT)—characterized by high levels of aggression, destruction, defiance, and negative affect—are a significant public health concern. Early externalizing behaviors appear to be highly stable, with 2-year stability correlations exceeding 0.5 by as early as age 2 (e.g., O'Leary et al. 1999). Moreover, there are replicated findings to suggest that children who will exhibit a pattern of persistent early EXT for years to come are already elevated relative to their peers by age 2 (NICHD Early Child Care Research Network 2004; Shaw et al. 2003). Further, persistent early EXT confer risk for a multitude of negative outcomes in childhood and adulthood, including depression, substance dependence, financial and work problems, crime, and the perpetration of violence against family members (e.g., Moffitt et al. 2002). In sum, persistent early EXT are costly to individuals, families, and society. Accordingly, their prevention is a national public health priority (NIMH National Advisory Mental Health Council Workgroup on Mental Disorders Prevention Research 2001).

If persistent early EXT are established by age 2, primary prevention programs for early EXT must begin prior to age 2. Several interventions have been designed for that purpose (see the comprehensive review of Matjasko et al. 2012). One such intervention is the Nurse-Family Partnership (NFP) intervention developed by Olds and colleagues (Olds et al. 2007a). NFP is a broad intervention designed to impact multiple child and family outcomes, engaging high-risk mothers in a

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program of regular nurse home visiting beginning in pregnancy and continuing through child age 2. In three randomized controlled trials, NFP has been shown to consistently impact several risk factors for child psychopathology (e.g., reduced rates of abusive parenting; Donelan-McCall et al. 2009) and has also shown benefits to child functioning (e.g., superior performance on cognitive tests; Olds et al. 2004b). A description of additional intervention effects can be found in Olds et al. (2007a).

Although NFP has shown replicable preventive effects on early to late childhood internalizing and/or total child behavior problems, summed across the internalizing and externalizing spectra (e.g., Kitzman et al. 2010; Olds et al. 2014; Olds et al. 2004b), its record in specifically preventing EXT is more complicated. NFP was first tested in a sample primarily composed of European American families in Elmira, NY. Children of nurse visited mothers in Elmira exhibited decreased rates of antisocial outcomes such as arrests and convictions at ages 15 and 19, effects at age 19 that were limited to girls (Eckenrode et al. 2010; Olds et al. 1998a). Yet, initial published reports from the second trial of NFP (Memphis, TN) indicated that the intervention failed to produce significant main effects on externalizing behavior measured at ages 2, 6, 9, and 12 in a sample heavily populated by African Americans (Kitzman et al. 2010; Olds et al. 2004b; Olds et al. 2007b; Sidora-Arcoleo et al. 2010). Notwithstanding the lack of main effects on early-onset EXT, analyses of the Memphis trial suggest that program effects are conditioned by child gender and mothers' baseline psychological resources (a composite reflecting intelligence, mental health, and self-efficacy). Sidora-Arcoleo et al. (2010) reported significant preventive effects for toddler girls' physical aggression and for elementary school age physical aggression in children born to higher functioning mothers.

In the most recent trial (Denver, CO), the NFP intervention has thus far failed to produce significant main effects on age 4, 6, or 9 externalizing behavior in a sample primarily composed of Latinos, European Americans, and African Americans (Olds et al. 2004a; Olds et al. 2014). Earlier externalizing measures were not available in the Elmira trial, nor are age 15 measures of EXT yet available for the two replication trials, preventing fully parallel comparisons across all three trials. However, considered together, the published findings from the Memphis and Denver trials suggest that the NFP intervention does not have a significant preventive main effect on early onset EXT, although it may have effects for girls or children of mothers with higher than average psychological resources.

The Present Investigation

The present report describes the results of new analyses of additional waves of assessment in the Denver trial (ages 2 through 9), conducted to determine if NFP home visiting prevents persistent early onset EXT exhibited at both school and home. As described above, persistent early-onset EXT—in contrast to time-limited EXT that emerge in toddlerhood and soon dissipate—are associated with significantly more negative outcomes. Moreover, children who show problematic behavior both at home and school (i.e., cross-situationally) may be at particularly high risk for compromised future outcomes (Robins 2006). Accordingly, determining if the NFP intervention is capable of preventing stable, cross-situational early EXT, rather than "snapshots" of child EXT at one time and/or in one setting, is of substantial interest. NFP targets several environmental risk factors for early EXT, such as prenatal maternal smoking and alcohol use (Loukas et al. 2003; Wakschlag et al. 2006), rapid repeat births (Crowne et al. 2012), negative or otherwise insensitive parenting during infancy and toddlerhood (Lorber and Egeland 2011), and early child abuse (Aguilar et al. 2000). Thus, notwithstanding genetically driven variance in externalizing behavior (Silberg et al. 2015), NFP could potentially prevent stable, cross-situational early EXT.

Taking cues from Sidora-Arcoleo et al.'s (2010) finding that aggression was prevented among girls born to mothers with higher psychological resources, we also examined moderated impacts in the Denver trial. If the NFP intervention reliably prevents cross-situational, persistent early onset EXT in at least some segments of the population, a potential benefit to public health is indicated. Just as importantly, the identification of population groups for whom the intervention does not appear to be especially effective can suggest areas for improvement. From an empirical stance, child gender and maternal psychological resources are potential moderators of program impact on early EXT per Sidora-Arcoleo et al. (2010). It may be girls and/or children born to high resource mothers who benefit the most from intervention. These findings are especially in need of replication and extension given that parenting practices are more strongly associated with preadolescent boys' vs. girls' externalizing behavior (e.g., Rothbaum and Weisz 1994), although such patterns are not universal (e.g., Lorber and Egeland 2011). Parenting is a major target of NFP, and if parenting is indeed more strongly associated with boys' early EXT, it follows that NFP may have greater impacts on boys' EXT.

With respect to the potential moderating impact of mothers' psychological resources, it may be that high resource mothers have a level of functioning that enables them to make better use of the NFP intervention, leading to greater prevention of EXT in this group as in Sidora-Arcoleo et al. (2010). Conversely, the children of low resource mothers may enjoy the most benefit. Children of low-resource mothers may be at especially high risk for the development of EXT, as maternal characteristics such as intelligence and psychopathology are known correlates of EXT (Mesman et al. 2009; Whitley et al. 2011). Program effects may be greater for this low maternal resources group because there is putatively more to prevent.

The benefits of NFP on parenting, children's injuries, and child cognitive-related outcomes are consistently concentrated among low resource mothers, providing additional support for this hypothesis (Olds et al. 2007a).

In sum, there is a need to evaluate the impact of NFP home visiting on stable, cross-situational early EXT. It was hypothesized that intervention would deflect children away from a trajectory marked by early EXT noted by both parents and teachers. Given empirical and theoretical considerations, the influence of child gender and maternal psychological resources as moderators of the impact of NFP on persistent early EXT was also investigated. Given conflicting indications outlined above, it was hypothesized that both child gender and maternal psychological resources would moderate the impact of the intervention on EXT, but no specific predictions were offered regarding the nature of these interactions.

Method

Participants

As more fully described in Olds et al. (2002), participants were 735 women pregnant with their first child who qualified for Medicaid or did not have private insurance. The resulting study sample had large groups of Latino (48.71%), African American (16.33%), and European American (35.64%) women. The women were 19.79 years old on average ($SD = 4.00$), and 14.01% of them were married or cohabiting with a partner. Analyses are restricted to an N of 706; 29 cases were excluded from the analyses due to missing gender data due to death, adoption, or missing birth record information in the medical chart. Missing data were handled via full information maximum likelihood estimation. All available data were used for each model estimated; Ns per variable are reported in Table 1.

Procedures

Questionnaire assessments pertaining to this report were conducted with participating mothers at baseline (prior to randomization) and at child ages 2, 4, 6, and 9 years. Teachers completed assessments at child ages 6 and 9 years. The descriptions of these assessments are provided below.

Intervention

After completion of a baseline interview conducted during the mothers' pregnancy, they were randomized into one of three conditions: nurse home visiting, paraprofessional home visiting (visits by clinicians with no formal training in the helping professions), or no intervention control. Control women ($n = 243$) were offered developmental screening and referral to services for their children at multiple points between child ages 6 and 24 months. Mothers in the nurse ($n = 225$) and paraprofessional ($n = 238$) groups received home visiting that began in pregnancy and continued at regular intervals through child age 2, for up to 64 total sessions. Both nurses and paraprofessionals were charged with three major goals: (1) to improve the outcomes of pregnancy by helping women improve their prenatal health, (2) to improve children's subsequent health and development by helping parents provide more competent care of the child, and (3) to improve maternal life-course by helping women articulate a vision for their

Table 1 Sample characteristics

	Mothers and girls					Mothers and boys				
	N	*M*	*SD*	Min	Max	*N*	*M*	*SD*	Min	Max
Mother age[a]	344	19.68	3.72	12.00	34.00	362	19.84	4.22	13.00	39.00
Mother education[a]	344	11.24	1.91	6.00	20.00	361	11.06	1.92	3.00	17.00
Household income (tens of thousands)[a]	312	12.76	12.11	1.50	50.00	331	13.31	12.61	1.50	50.00
Maternal psychological resources[a]	344	100.83	9.76	75.41	125.94	362	99.37	10.11	68.95	124.33
Conflict with the mother[a]	344	1.18	2.09	0.00	14.00	362	1.19	2.15	0.00	14.00
CBCL externalizing—age 2	299	0.64	0.31	0.00	1.54	319	0.65	0.30	0.00	1.54
CBCL externalizing—age 4	303	0.34	0.20	0.00	1.03	324	0.38	0.23	0.00	1.46
CBCL externalizing—age 6	290	0.18	0.18	0.00	0.97	302	0.20	0.18	0.00	0.94
CBCL externalizing—age 9	265	0.20	0.17	0.00	0.88	289	0.22	0.19	0.00	1.30
TRF externalizing—age 6	255	0.18	0.23	0.00	1.19	267	0.27	0.31	0.00	1.31
TRF externalizing—age 9	229	0.17	0.23	0.00	1.25	241	0.26	0.31	0.00	1.59

CBCL = mother completed Child Behavior Checklist; TRF = Teacher Report Form; CBCL and TRF are reported in their raw metric as item averages

[a] Measured at intake

future and to engage in behaviors consistent with those values (e.g., completing their educations, finding work, and planning subsequent pregnancies). Nurses helped parents achieve these goals by engaging fathers and other family members and friends in the program, by helping parents address environmental health factors such as environmental lead exposure, and linking mothers with other needed health and human services. The NFP intervention has been described in detail in Olds et al. 1998

Measures

Externalizing Behavior Mothers' reports of externalizing behavior were measured by their responses on the broadband Externalizing scale of the Child Behavior Checklist at ages 2 (CBCL/2–3), 4, 6, and 9 (CBCL/4–17) (Achenbach 2009). Teachers' reports of externalizing behavior were measured via their responses on the Externalizing scale of the Teacher Report Form at ages 6 and 9 (TRF; Achenbach 2009). The Externalizing scale items tap aggression, rule breaking/defiance, and moodiness/tantrums. The scores analyzed were averages of Externalizing scale items at each assessment. All Cronbach's alphas exceeded 0.85. T-scores based on normative reference samples were also calculated.

Maternal Psychological Resources Mothers' psychological resources were measured upon registration to the study, during their pregnancies. To be consistent with previous evaluations of the NFP program (Olds et al. 2004a), it was operationalized as a composite of z-scores of mothers' intelligence, mental health, and sense of mastery, standardized to have a *M* and *SD* of approximately 100 and 10, respectively. It is an index score that does not make assumptions about the relations among its components (Streiner 2003). The measures of the above constructs were, respectively, the Shipley–Hartford IQ scale (Shipley 1940), RAND mental health assessment (Ware et al. 1985), and Pearlin and Schooler's (1978) sense of mastery measure. The psychological resources score was used as a covariate in testing intervention effects and was also examined as a moderator of intervention effects.

Conflict with the Mother Mothers' frequency of conflict with their own mothers was measured as a baseline characteristic to use as a covariate. Mothers were asked to indicate the number of days in the last 2 weeks each of the following events occurred: (1) their own mothers criticized something they did or said, (2) they had an unpleasant disagreement with their own mothers, and (3) their own mothers talked to them in a cruel or mean way (Olds et al. 1983). To be consistent with previous evaluations of the NFP program (Olds et al. 2004a), an item average was calculated across these three items. It too is an index score that does not make assumptions about the relations among its components (Streiner 2003).

Results

Descriptive statistics for study variables and demographic characteristics are presented in Table 1. Hypothesis tests were conducted with Mplus version 8.0 software (Muthén and Muthén 1998-2017).

Identification of Latent Externalizing Behavior Profiles

Latent profile analyses (LPAs) were used to identify subgroups among the children by jointly using mothers' and teachers' continuous reports of externalizing behavior between ages 2 and 9. Persistently high, medium, and low externalizing classes emerged for girls and boys (Fig. 1). Based on CBCL and TRF Externalizing scale means, the high and low externalizing classes were generally well separated across time and reporter. The medium externalizing classes were not as consistently distinguished from the high and low externalizing classes. Model details and results, as well as additional analyses to evaluate the criterion-related validity of the LPA-derived classes, are reported in the supplement to this article, available online.

Intervention Effects on Girls

Main Effects The effect of the intervention on externalizing class membership was evaluated in the LPA context with a series of latent multinomial regression tests. The first set of analyses addressed whether home visiting as performed by either nurses or paraprofessionals significantly affected which externalizing class a girl would eventually be in. Externalizing class was regressed on a dummy variable with nurse or paraprofessional conditions coded 1 and control coded 0. To control for possible confounds, maternal psychological resources, age, and maternal conflict with their own mothers—all measured prior to the intervention—were entered as covariates due to group nonequivalencies on these measures (reported in Olds et al. 2004a) and because they were each associated with externalizing behavior. The results of these analyses are reported in the first section of Table 2. Coefficients corresponding to covariates are not reported for the sake of parsimony but are available from the first author. Because there were three categories of the dependent variable (latent externalizing class), the multinomial regression is expressed as two contrasts. Thus, two runs of each multinomial regression model were conducted, shifting the reference category to allow the comparison of all three externalizing classes. Class indicators' means were fixed to the values obtained in the model selection phase.

Results indicated that intervention decreased the odds of girls' ($n = 344$) being in the high externalizing group relative to the medium externalizing group. However, intervention did not significantly alter their chances of being in the high,

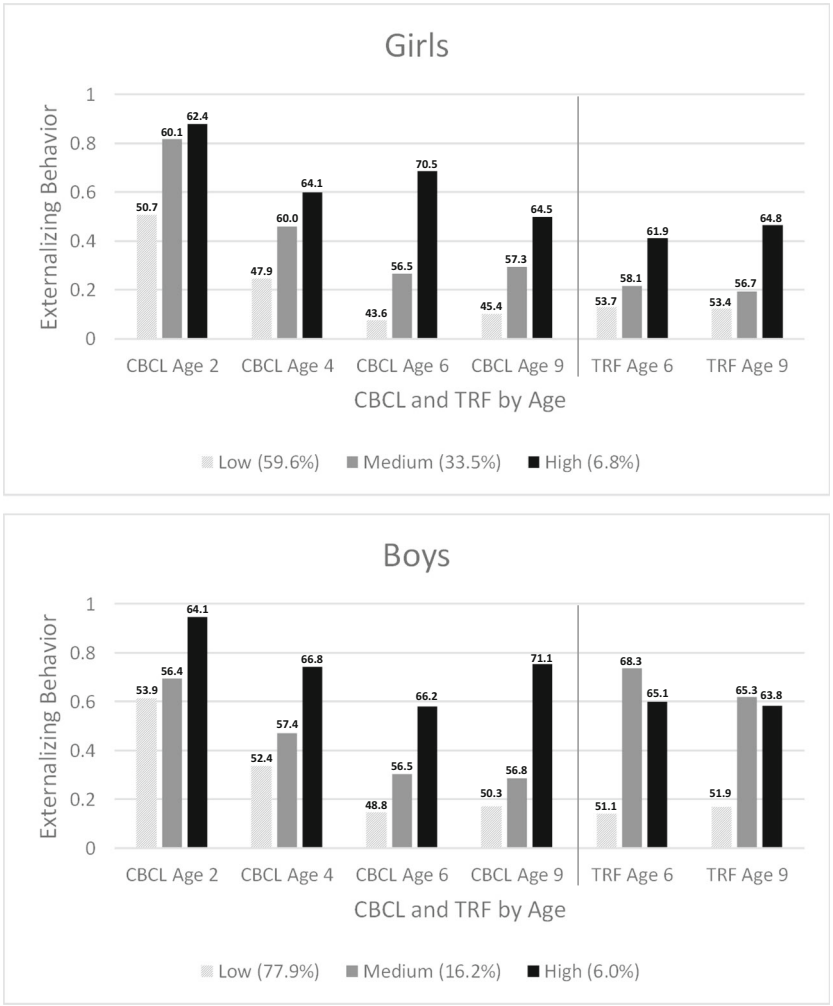

Fig. 1 Latent externalizing behavior classes. Numbers above bars are mean T-scores, relative to age and gender, based on posterior class assignments

relative to the low, externalizing group. Additionally, intervention significantly increased girls' odds of being in the medium externalizing group, relative to the low externalizing group. To further describe the intervention effects, predicted probabilities of membership in each class for girls in the combine intervention and control groups, and assuming mean levels of the three covariates, were computed. In the combined intervention group, 4.1% of the girls were in the high externalizing class, 39.9% were in the medium externalizing class, and 56.0% were in the low externalizing class. In control group girls, the corresponding rates were 7.4%, 24.1%, and 68.5%, respectively. See Table S2 of the online supplement for predicted probabilities reported separately for the two intervention groups.

The second set of analyses decomposed the intervention group into its constituent conditions: nurse and paraprofessional home visiting. Latent externalizing class was simultaneously regressed on dummy variables representing nurse visiting vs. control (coded 1 and 0, respectively), paraprofessional home visiting vs. control (coded 1 and 0, respectively), as well as the same three covariates used above. Results from these analyses are presented in the second and third sections of Table 2. The effects of nurse and paraprofessional visiting were in the same direction as in the previous regression analyses, effect sizes were similar, but the findings were not as consistent. Nurse visiting did not significantly decrease the odds of being in the high vs. medium externalizing groups. But, as above, it did significantly increase girls' odds of being in the medium externalizing group, as compared to the low externalizing group. Also, consistent with the previous analyses, nurse visiting did not alter the odds of girls belonging to the high vs. low externalizing group. The effects of paraprofessional visiting were similar to those of nurse visiting in terms of the effect size and direction, but were statistically nonsignificant.

Moderation by Maternal Psychological Resources Hypotheses concerning the moderation of intervention effects by maternal psychological resources were tested by conducting additional latent multinomial regression analyses in the context of LPA models. Intervention × Psychological Resources interaction terms were added to the regression equations specified above.

Table 2 Intervention effects on girls' externalizing behavior class

	B	*SE*	*p*	95% CI		OR	RR[a]
				Low	High		
Nurse/paraprofessional intervention vs. control							
High vs. low externalizing	− 0.40	0.51	.439	− 1.40	0.61	0.67	0.70
High vs. medium externalizing	− 1.10	0.55	.046	− 2.18	− 0.02	0.33	0.39
Medium vs. low externalizing	0.70	0.31	.023	0.10	1.31	2.02	1.60
Nurse intervention vs. control							
High vs. low xternalizing	− 0.36	0.63	.570	− 1.59	0.88	0.70	0.72
High vs. medium externalizing	− 1.09	0.69	.115	− 2.43	0.26	0.34	0.40
Medium vs. low externalizing	0.73	0.36	.044	0.02	1.43	2.06	1.61
Paraprofessional intervention vs. control							
High vs. low externalizing	− 0.43	0.62	.486	− 1.65	0.78	0.65	0.67
High vs. medium externalizing	− 1.11	0.65	.087	− 2.38	0.16	0.33	0.39
Medium vs. low externalizing	0.68	0.36	.059	− 0.03	1.38	1.97	1.57

Coefficients represent intervention effects on latent externalizing behavior class; mothers' age, psychological resources, and conflict with their own mothers entered as covariates for all analyses

[a] Risk ratio calculated from model implied predicted probabilities

In no case were these interaction terms significant. Thus, there was no evidence that intervention effects were moderated by mothers' psychological resources.

Intervention Effects on Boys

Boys' data ($n = 362$) were analyzed in an identical manner to girls' data (Table 3). Intervention had no significant main or moderated effects on externalizing class. Based on predicted probabilities, among the combined intervention group boys, 4.7% were in the high externalizing class, 13.4% were in the medium externalizing class, and 81.5% were in the low externalizing class. In control group boys, the parallel rates were 4.3%, 22.6%, and 72.7%, respectively.

Gender Moderation

Gender moderation could not be examined within a single statistical model because it was necessary to conduct the LPAs separately for boys and girls. Accordingly, gender

Table 3 Intervention effects on boys' externalizing behavior class

	B	*SE*	*p*	95% CI		OR	RR[a]
				Low	High		
Nurse/paraprofessional intervention vs. control							
High vs. low externalizing	− 0.04	0.60	0.946	− 1.21	1.13	0.96	0.96
High vs. medium externalizing	0.60	0.67	0.366	− 0.70	1.91	1.83	1.60
Medium vs. low externalizing	− 0.64	0.37	0.080	− 1.36	0.08	0.53	0.59
Nurse intervention vs. control							
High vs. low externalizing	− 0.85	0.81	0.295	− 2.44	0.74	0.43	0.44
High vs. medium externalizing	− 0.21	0.90	0.819	− 1.98	1.56	0.81	0.84
Medium vs. low externalizing	− 0.64	0.46	0.161	− 1.54	0.26	0.53	0.59
Paraprofessional intervention vs. control							
High vs. low externalizing	0.39	0.65	0.547	− 0.88	1.66	1.48	1.44
High vs. medium externalizing	1.03	0.74	0.167	− 0.43	2.48	2.79	2.14
Medium vs. low externalizing	− 0.64	0.43	0.136	− 1.47	0.20	0.53	0.59

Coefficients represent intervention effects on latent externalizing behavior class; mothers' age, psychological resources, and conflict with their own mothers entered as covariates for all analyses

[a] Risk ratio calculated from model implied predicted probabilities

moderation was examined descriptively by comparing the above results concerning girls and boys, as well as by comparing their respective CIs. The intervention effects observed for girls' externalizing behavior did not replicate in the sample of boys. Moreover, the 95% CI for the combined nurse/paraprofessional intervention effect on children's membership in medium vs. low externalizing behavior classes was more positive, and zero exclusive, for girls (0.10 to 1.31) than for boys (− 1.36 to 0.08). Notwithstanding the complications of comparing treatment effects on classes that are not strictly equivalent in boys and girls (see online supplement), this finding suggests the possibility of some degree of gender moderation. Yet, all other CIs around the intervention effect estimates overlapped for boys and girls; it is thus difficult to conclude that these intervention effects are different for boys and girls.

Discussion

The primary aim in the present article was to study the efficacy of NFP home visiting in preventing children's membership in groups with persistent, cross-situational early onset EXT. Latent classes of girls and boys were identified based on mothers' and teachers' reports of child externalizing behavior between ages 2 and 9. Consistent with developmental theory and previous findings, approximately 6–7% of boys and girls showed persistently elevated externalizing behavior across time and situation. Larger intermediate and low level externalizing groups were also identified, although the intermediate externalizing groups were not consistently distinct from their high and low level externalizing counterparts at all times and according to all reporters. Moreover, the nature of the classes somewhat differed by gender, most evident in teachers' ratings of children in the intermediate externalizing classes. Intermediate externalizing boys, but not girls, were seen by their teachers as highly problematic.

The findings suggest that the NFP intervention has modest effects on girls' externalizing behavior that are not enjoyed by boys. Home visiting decreased girls' risk of being in a class of children who showed highly elevated externalizing behavior across time and situation, in favor of membership in a group marked by moderately elevated externalizing behavior at home and relatively normative externalizing behavior at school. Girls whose mothers received home visiting (either nurse- or paraprofessional-delivered) were about 55% as likely as controls to exhibit the stable cross-situational EXT pattern. Thus, NFP home visiting deflected girls away from a highly problematic outcome. Underscoring the severity of this behavioral pattern, validation analyses revealed that these girls were more likely than other girls to have received treatment for emotional/behavior problems or ADHD symptoms (see online supplement). Statistical and clinical significance notwithstanding, a degree of caution is warranted in interpreting this finding, as we describe in the "Limitations" section.

At the same time, NFP home visiting appeared to deflect girls away from low and toward intermediate levels of externalizing behavior, although their problem behavior was not as evident at school. Girls whose mothers received home visiting were about 65% more likely than controls to be members of the moderately elevated externalizing class; they were also about 18% less likely to be in the low externalizing class. Thus, home visiting appeared to "push girls toward the middle," away from both low and high levels of externalizing behaviors. Although not as severely troubled as the high externalizing girls, girls in the moderately elevated externalizing class received treatment for emotional/behavior problems or ADHD symptoms at a higher rate than did their low externalizing peers (see online supplement). Thus, the effect may be clinically significant. In contrast to the findings of Sidora-Arcoleo et al. (2010), intervention effects on girls did not depend on mothers' baseline psychological resources, as jointly indicated by their IQ, mental health, and sense of mastery.

Whatever impacts NFP home visiting had were of modest magnitude and restricted to altering the probability of girls' membership in adjacent externalizing behavior classes (e.g., high vs. medium). In no case did home visiting have a large effect or deflect girls away from stable high level externalizing behavior toward stable low level externalizing behavior. Thus, the intervention appears to have an incremental impact in the outcomes of girls. The protective impact of NFP on girls' EXT, however, retains clinical relevance, although qualified by the small number of girls who exhibited the persistent high EXT pattern. Home visiting significantly decreased the odds of a very serious pattern of early antisocial behavior. Some girls who might have assumed this pattern of behavior were instead part of a group of girls who showed moderately and situationally specific elevated externalizing behavior as a result of their mothers' participation in the NFP program. This clear preventive benefit for the highest risk girls is balanced against the increased likelihood of mildly but consistently elevated externalizing behavior in other girls at home, although perhaps not at school.

How can NFP home visiting push girls away from both high level and low level externalizing behavior? NFP seeks to modify several risk factors for child psychopathology, including biological and social factors implicated in the development of externalizing behaviors, such as maternal smoking during pregnancy and abusive parenting practices (Olds et al. 2007a). Reductions in these and other risk factors may explain why NFP home visiting is able to deflect girls away from high levels of externalizing behaviors. At the same time, it is possible that some intervention strategies "backfire" to a certain extent. In emphasizing maternal responsiveness and deemphasizing harsh parenting practices, NFP practitioners

may inadvertently discourage parents from using firm discipline techniques in the face of the normative contests of will between child and parent that characterize toddlerhood. Ineffective discipline practices may not be independently sufficient to cause high level externalizing behaviors, but may turn what would otherwise be normative toddler limited challenges into stable, situationally specific, moderately elevated externalizing behavior in girls.

An alternative explanation for the nonlinear effects is that NFP home visiting changes mothers' views of their girls' behavior and that these views are reflected in how they complete study questionnaires. The medium externalizing girls significantly differed from the low externalizing girls on parent- but not teacher-reported behavior. In contrast, high and low externalizing girls' behavior was statistically distinguishable irrespective of reporter. Intervention group mothers of girls in the medium externalizing class may have been more sensitive to or overreported slight elevations in their daughters' externalizing behaviors that were not detected or reported by teachers. Medium externalizing girls were also more likely to have received treatment for psychological problems, perhaps because of their mothers' increased sensitivities to their girls' externalizing behaviors. Increased sensitivity in maternal reports was found in the Elmira trial of NFP. Intervention mothers were (a) more accurate in predicting how their children would perform on IQ tests relative to controls (Olds et al. 1986a), and (b) more accurate in their self-reports of tobacco use when compared to serum cotinine than controls (Olds et al. 1986b).

We note that the contrasting effects on girls' externalizing behavior were unanticipated. Thus, the above explanations are necessarily post hoc and must be interpreted with caution. Future research is required to substantiate these preliminary suggestions.

Findings for boys followed a different pattern. NFP home visiting did not reliably alter boys' early externalizing behavior, nor did they depend on mothers' psychological resources. Despite the apparent gender differences in intervention effects, it is important to note that in only one case did the confidence intervals for intervention effects reliably differ between boys and girls. Thus, it is not safe to broadly conclude that NFP home visiting has different effects on stable, cross-situational variation in girls' and boys' early externalizing behavior. Moreover, because the nature of the intermediate externalizing class differed in boys and girls, direct comparisons are not straightforward. Yet, parallels are found in the findings of Sidora-Arcoleo et al. (2010; Memphis trial) in which NFP nurse home visiting was found to have a stronger impact on girls' aggression at age 2, and girls' arrests and convictions in the second half of adolescence (Eckenrode et al. 2010; Elmira trial). In sum, results from all three trials of NFP suggest that, where externalizing behaviors are concerned, girls are disproportionately likely to benefit from the intervention.

Integration with Prior Findings and Indications for Future Research

The preventive effect for girls' persistent, cross-situational early onset EXT partly substantiates and extends our prior research on the prevention of EXT by the NFP program (e.g., Sidora-Arcoleo et al. 2010). Yet, the bifurcated effects in girls and the lack of reliable preventive effects in boys—if they prove to be replicable—suggest the need to refine and/or supplement at least some of content of the NFP intervention, without sacrificing its many documented preventive effects. More generally, the efficacy of infancy interventions in preventing early EXT is quite limited. Many of these interventions have been shown to positively affect risk factors for EXT, such as insecure attachment, child maltreatment, and emotionally unsupportive parenting (e.g., Bugental et al. 2002; Love et al. 2005; Van Zeijl et al. 2006). Critically, however, where early onset EXT themselves are concerned, these interventions have often shown null effects (e.g., St. Pierre and Layzer 1999), small effects (e.g., Love et al. 2005), or effects limited to subpopulations and narrow aspects of behavioral adjustment (e.g., Sidora-Arcoleo et al. 2010; Van Zeijl et al. 2006).

The limited efficacy of infancy preventive interventions for early onset EXT may be due to a mismatch between the timing and content of intervention activities with the natural developmental course of externalizing behaviors. Emerging literature suggests that physical aggression and defiance are present and consequential considerably earlier than had been previously suspected. Alink et al. (2006) found approximate 50% prevalence of and substantial 1-year stability of 12-month-old aggression. Two other recent findings, push the envelope even further in suggesting that physical aggression and defiance appear in the majority of children by 6 or 8 months, exhibit theoretically interpretable correlations with other factors in their nomological network (e.g., parenting), and show significant rank-order stability (Hay et al. 2010; Lorber et al. 2015). These findings represent an advance in our understanding of the normative developmental course of externalizing behavior in the first year of life—one that has yet to be translated to preventive interventions. Perhaps interventions that improve parents' management of externalizing behaviors when they are first developing, and prior to when they are engrained "externalizing problems," will yield enhanced preventive efficacy.

Limitations

Statistical power was the primary limitation of the present study. Intervention effects were most consistently observed when the nurse and paraprofessional home visiting conditions were combined into a single intervention vs. control contrast, despite similar magnitude nurse, and paraprofessional group

effects considered separately. Furthermore, persistent, cross-situational early onset EXT occurred in only about 6 to 7% of this at risk sample. Thus, despite the inclusion of more than 700 families, a small number of children exhibited this pattern. Although significant preventive effects were obtained, they were modest, and the small number of girls with persistent, cross-situational early onset EXT raises the specter of sampling error. Interpretive caution is therefore advised, particularly in the separate comparisons of nurse and paraprofessional home visiting group vs. control comparisons involving the high EXT group, in which the girls with high EXT behavior are subdivided further (likely fewer than 10 girls per group). Replication is thus crucial.

The reliance on maternal report on externalizing behavior prior to age 6 is an additional limitation. This may be of special concern if parents hold different standards of child behavior as a result of the intervention—a possibility we describe above. The inclusion of teacher reports was one of the strengths of the design, allowing us to test hypotheses about cross-situational child behavior. The design would have been further strengthened by collecting data from key informants in other settings (e.g., child care) prior to elementary school, which would have allowed for more certain inferences about intervention effects on cross-situational EXT.

The increasing rate of missing data over time is another limitation (e.g., response rates of 78% for mothers and 67% for teachers by age 9), reflecting a classic attrition effect. Our approach allowed us to retain all cases in the analyses. However, the missing data undoubtedly harmed precision of the EXT class membership estimates, thus increasing measurement error in our dependent variable, and making the detection of intervention effects more difficult.

Finally, we noted the statistical impossibility of examining gender moderation due to our decision to conduct LPAs separately for boys and girls. An apples-to-apples statistical comparison is not possible given the nonequivalence of the dependent variable (EXT class structure). Even though, *descriptively*, the intervention effects appear to be different for boys and girls, a firm conclusion is not warranted.

Conclusion

The NFP home visiting intervention modestly deflected the highest risk girls away from persistent, cross-situational early onset EXT from age 2 to 9 and toward a pattern of moderately elevated externalizing behavior that was evident at home and not at school. However, the small number of girls in the persistent, cross-situational early onset EXT group should qualify one's interpretation of this finding. Surprisingly, the intervention also deflected girls away from stable low levels of externalizing behavior and toward the middle, a pattern for which we offer competing explanations. No statistically significant effects were detected on boys' externalizing behavior. The preventive effect of the NFP intervention for girls' EXT is encouraging. Notwithstanding, the push of low-risk girls toward moderately elevated externalizing behavior and the non-significant impact on boys' externalizing behavior suggests the need for further innovation. This need is particularly evident when considered in the larger context of the uneven record of infancy preventive interventions for EXT and recent evidence suggesting that externalizing behaviors begin to develop in the first year of infancy.

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Compliance with Ethical Standards

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Colorado Multiple Institutional Review Board and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Conflict of Interest Michael Lorber and Nancy Donelan-McCall declare that they have no conflicts of interest. The Prevention Research Center for Family and Child Health (PRC), directed by David Olds, receives fees and travel expenses from governments and entities outside of the United States to implement the Nurse-Family Partnership©. Licensing fees are charged to international entities for implementing the program. The fees are used to support program implementation in international contexts and research on testing and improving the NFP and its implementation. In the US, the program is replicated by the NFP National Service Office, which provides funding to the PRC to conduct research aimed at improving the NFP model and its implementation. None of these fees are used to augment Dr. Olds's university salary. Professor Olds does receive honoraria for writing and speaking about the NFP.

References

Achenbach, T. M. (2009). Achenbach system of empirically based assessment (ASEBA): Development, findings, theory, and applications. Burlington, VT: Author.

Aguilar, B., Sroufe, L. A., Egeland, B., & Carlson, E. (2000). Distinguishing the early-onset/persistent and adolescence-onset antisocial behavior types: From birth to 16 years. *Development and Psychopathology, 12*, 109–132. https://doi.org/10.1017/S0954579400002017.

Alink, L. R. A., Mesman, J., Van Zeijl, J., Stolk, M. N., Juffer, F., Koot, H. M., et al. (2006). The early childhood aggression curve: Development of physical aggression in 10 to 50 month-old children. *Child Development, 77*, 954–966. https://doi.org/10.1111/j.1467-8624.2006.00912.x.

Bugental, D. B., Ellerson, P. C., Lin, E. K., Rainey, B., Kokotovic, A., & O'Hara, N. (2002). A cognitive approach to child abuse prevention. *Journal of Family Psychology, 16*, 243–258. https://doi.org/10.1037//0893-3200.16.3.243.

Crowne, S. S., Gonsalves, K., Burrell, L., McFarlane, E., & Duggan, A. (2012). Relationship between birth spacing, child maltreatment, and child behavior and development outcomes among at-risk families. *Maternal and Child Health Journal, 16*, 1413–1420. https://doi.org/10.1007/s10995-011-0909-3.

Donelan-McCall, N., Eckenrode, J., & Olds, D. L. (2009). Home visiting for the prevention of child maltreatment: Lessons learned during the past 20 years. *Pediatric Clinics of North America, 56*, 389–403. https://doi.org/10.1016/j.pcl.2009.01.002.

Eckenrode, J., Campa, M., Luckey, D. W., Henderson, C. R., Jr., Cole, R., Kitzman, H., et al. (2010). Long-term effects of prenatal and infancy nurse home visitation on the life course of youths: 19-year follow-up of a randomized trial. *Archives of Pediatrics and Adolescent Medicine, 164*, 9–15. https://doi.org/10.1001/archpediatrics.2009.240.

Hay, D. F., Perra, O., Hudson, K., Waters, C. S., Mundy, L., Phillips, R., et al. (2010). Identifying early signs of aggression: Psychometric properties of the Cardiff infant contentiousness scale. *Aggressive Behavior, 36*, 351–357. https://doi.org/10.1002/ab.20363.

Kitzman, H. J., Olds, D. L., Cole, R. E., Hanks, C. A., Anson, E. A., Arcoleo, K. J., et al. (2010). Enduring effects of prenatal and infancy home visiting by nurses on children: Follow-up of a randomized trial among children at age 12 years. *Archives of Pediatrics and Adolescent Medicine, 164*, 412–418. https://doi.org/10.1001/archpediatrics.2010.76.

Lorber, M. F., & Egeland, B. (2011). Parenting and temperament in infancy: Testing a mutual exacerbation hypothesis to predict conduct problems. *Child Development, 82*, 2006–2020. https://doi.org/10.1111/j.1467-8624.2011.01652.x.

Lorber, M. F., Del Vecchio, T., & Slep, A. M. S. (2015). The emergence and evolution of infant externalizing behavior. *Development and Psychopathology, 27*, 663–680. https://doi.org/10.1017/S0954579414000923.

Loukas, A., Zucker, R. A., Fitzgerald, H. E., & Krull, J. L. (2003). Developmental trajectories of disruptive behavior problems among sons of alcoholics: Effects of parent psychopathology, family conflict, and child undercontrol. *Journal of Abnormal Psychology, 112*, 119–131. https://doi.org/10.1037/0021-843X.112.1.119.

Love, J. M., Kisker, E. E., Ross, C., Raikes, H., Constantine, J., Boller, K., et al. (2005). The effectiveness of Early Head Start for 3-year-old children and their parents: Lessons for policy and programs. *Developmental Psychology, 41*, 885–901. https://doi.org/10.1037/0012-1649.41.6.885.

Matjasko, J. L., Vivolo-Kantor, A. M., Massetti, G. M., Holland, K. M., Holt, M. K., & Dela Cruz, J. (2012). A systematic meta-review of evaluations of youth violence prevention programs: Common and divergent findings from 25 years of meta-analyses and systematic reviews. *Aggression and Violent Behavior, 17*, 540–552. https://doi.org/10.1016/j.avb.2012.06.006.

Mesman, J., Stoel, R., Bakermans-Kranenburg, M. J., van IJzendoorn, M. H., Juffer, F., Koot, H. M., & Alink, L. R. (2009). Predicting growth curves of early childhood externalizing problems: Differential susceptibility of children with difficult temperament. *Journal of Abnormal Child Psychology, 37*, 625–636. https://doi.org/10.1007/s10802-009-9298-0.

Moffitt, T. E., Caspi, A., Harrington, H., & Milne, B. J. (2002). Males on the life-course-persistent and adolescence-limited antisocial pathways: Follow-up at age 26 years. *Development and Psychopathology, 14*, 179–207 http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=100937.

Muthén, L. K., & Muthén, B. O. (1998-2017). *Mplus user's guide* (8th ed.). Los Angeles, CA: Muthén & Muthén.

NICHD Early Child Care Research Network, & Arsenio, W. F. (2004). Trajectories of physical aggression from toddlerhood to middle childhood: Predictors, correlates, and outcomes. *Monographs of the Society for Research in Child Development, 69*, 1–129. https://doi.org/10.1111/j.0037-976X.2004.00312.x.

NIMH National Advisory Mental Health Council Workgroup on Mental Disorders Prevention Research (2001). *Prevention and Treatment, Volume 4, Article 17.* Retrieved May 15, 2005 from http://www.journals.apa.org/prevention/volume4/pre0040027c.html

Olds, D. L., Henderson, C. R., Chamberlin, R., & Tatelbaum, R. (1986a). Preventing child abuse and neglect: A randomized trial of nurse home visitation. *Pediatrics, 78*, 65–78 http://pediatrics.aappublications.org.

Olds, D. L., Henderson, C. R., Tatelbaum, R., & Chamberlin, R. (1986b). Improving the delivery of prenatal care and outcomes of pregnancy: A randomized trial of nurse home visitation. *Pediatrics, 77*, 16–28 http://pediatrics.aappublications.org.

Olds, D. L., Holmberg, J. R., Donelan-McCall, N., Luckey, D. W., Knudtson, M. D., & Robinson, J. (2014). Effects of home visits by paraprofessionals and by nurses on children: Follow-up of a randomized trial at ages 6 and 9 years. *JAMA Pediatrics, 168*, 114–121. https://doi.org/10.1001/jamapediatrics.2013.3817.

Olds, D. L., Kitzman, H., Cole, R., Robinson, J., Sidora, K., Luckey, D. W., et al. (2004b). Effects of nurse home-visiting on maternal life course and child development: Age 6 follow-up results of a randomized trial. *Pediatrics, 114*, 1550–1559. https://doi.org/10.1542/peds.2004-0962.

Olds, D. L., Kitzman, H., Hanks, C., Cole, R., Anson, E., Sidora-Arcoleo, K., et al. (2007b). Effects of nurse home visiting on maternal and child functioning: Age-9 follow-up of a randomized trial. *Pediatrics, 120*, e832–e845. https://doi.org/10.1542/peds.2006-2111.

Olds, D. L., Robinson, J., O'Brien, R., Luckey, D. W., Pettitt, L. M., Henderson, C. R., et al. (2002). Home visiting by paraprofessionals and by nurses: A randomized, controlled trial. *Pediatrics, 110*, 486–496. https://doi.org/10.1542/peds.110.3.486.

Olds, D. L., Robinson, J., Pettitt, L., Luckey, D. W., Holmberg, J., Ng, R. K., et al. (2004a). Effects of home visits by paraprofessionals and by nurses: Age 4 follow-up results of a randomized trial. *Pediatrics, 114*, 1560–1568. https://doi.org/10.1542/peds.2004-0961.

Olds, D. L., Sadler, L., & Kitzman, H. (2007a). Programs for parents of infants and toddlers: Recent evidence from randomized trials. *Journal of Child Psychology and Psychiatry, 48*, 355–391. https://doi.org/10.1111/j.1469-7610.2006.01702.x.

Olds, D., Henderson, C. R., Jr., Cole, R., Eckenrode, J., Kitzman, H., Luckey, D., et al. (1998a). Long-term effects of nurse home visitation on children's criminal and antisocial behavior. *Journal of the American Medical Association, 280*, 1238–1244. https://doi.org/10.1001/jama.280.14.1238.

Olds, D., Henderson, C., Birmingham, M., et al. (1983). Final report to the Maternal and Child Health and Crippled Children's Services Research Grants Program, Bureau of Community Health Services, Health Services Administration, Public Health Service, Department of Health and Human Services, grant MCJ-36040307. *November*, 1983.

Olds, D. L., Henderson, C. R., Kitzman, H., Eckenrode, J., Tatelbaum, R., Robinson, et al. (1998). Prenatal and infancy home visitation by nurses: a program of research. In C. Rovee-Collier, L. P. Lipsitt, & H. Hayne (Eds.), *Advances in infancy research (Vol. 12)* (pp. 79–130). Stamford: Ablex Publishing Corp.

O'Leary, S. G., Slep, A. M. S., & Reid, J. (1999). A longitudinal study of mothers' overreactive discipline and toddlers' externalizing behavior. *Journal of Abnormal Child Psychology, 27*, 331–341. https://doi.org/10.1023/A:1021919716586.

Pearlin, L. I., & Schooler, C. (1978). The structure of coping. *Journal of Health and Social Behavior, 19*, 2–21. https://doi.org/10.2307/2136319.

Robins, L. N. (2006). Conduct disorder. *Journal of Child Psychology and Psychiatry, 32*, 193–212. https://doi.org/10.1111/j.1469-7610.1991.tb00008.x.

Rothbaum, F., & Weisz, J. R. (1994). Parental caregiving and child externalizing behavior in nonclinical samples: A meta-analysis. *Psychological Bulletin, 116*, 55–74. https://doi.org/10.1037/0033-2909.116.1.55.

Shaw, D. S., Gilliom, M., Ingoldsby, E. M., & Nagin, D. S. (2003). Trajectories leading to school-age conduct problems. *Developmental Psychology, 39*, 189–200. https://doi.org/10.1037/0012-1649.39.2.189.

Shipley, W. (1940). A self-administered scale for measuring intellectual impairment and deterioration. *Journal of Psychology, 9*, 371–377. https://doi.org/10.1080/00223980.1940.9917704.

Sidora-Arcoleo, K., Anson, E., Lorber, M., Cole, R., Olds, D., & Kitzman, H. (2010). Differential effects of a nurse home-visiting intervention on physically aggressive behavior in children. *Journal of Pediatric Nursing, 25*, 35–45. https://doi.org/10.1016/j.pedn.2008.07.011.

Silberg, J., Moore, A. A., & Rutter, M. (2015). Age of onset and the subclassification of conduct/dissocial disorder. *Journal of Child Psychology and Psychiatry, 56*, 826–833. https://doi.org/10.1111/jcpp.12353.

St. Pierre, R. G., & Layzer, J. I. (1999). Using home visits for multiple purposes: The comprehensive child development program. *Future of Children, 9*, 134–151 http://futureofchildren.org/futureofchildren/publications/docs/09_01_06.pdf.

Streiner, D. L. (2003). Being inconsistent about consistency: Whencoefficient alpha does and doesn't matter. *Journal of Personality Assessment, 80*, 217–222. https://doi.org/10.1207/s15327752jpa8003_01.

Van Zeijl, J., Mesman, J., van IJzendoorn, M. H., Bakermans-Kranenburg, M. J., Juffer, F., Stolk, M. N., et al. (2006). Attachment-based intervention for enhancing sensitive discipline in mothers of 1- to 3-year-old children at risk for externalizing behavior problems: A randomized controlled trial. *Journal of Consulting and Clinical Psychology, 74*, 994–1005. https://doi.org/10.1037/0022-006X.74.6.994.

Wakschlag, L. S., Pickett, K. E., Kasza, K. E., & Loeber, R. (2006). Is prenatal smoking associated with a developmental pattern of conduct problems in young boys? *Journal of the American Academy of Child and Adolescent Psychiatry, 45*, 461–467. https://doi.org/10.1097/01.chi.0000198597.53572.3e.

Ware, J. E., Veit, C. T., Donald, C. A. (1985). *Refinements in the Measurement of Mental Health for Adults in the Health Insurance Study*. Santa Monica, CA: RAND Corp.

Whitley, E., Gale, C. R., Deary, I. J., Kivimaki, M., & Batty, G. D. (2011). Association of maternal and paternal IQ with offspring conduct, emotional, and attention problem scores: Transgenerational evidence from the 1958 British birth cohort study. *Archives of General Psychiatry, 68*, 1032–1038. https://doi.org/10.1001/archgenpsychiatry.2011.111.