Research article

Factors moderating the link between early childhood non-parental care and ADHD symptoms

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ABSTRACT

Introduction: There is little known about the association between non-parental care in early childhood and attention-deficit/hyperactivity disorder (ADHD) symptoms in preschoolers. Therefore, we examined the association between childcare from grandparents/babysitters during infancy/preschool and ADHD symptoms in preschoolers.

Methods: Using stratified random sampling, we developed a sample comprising 1597 parents of children aged 1.6–7 years who were enrolled in preschool in rural and urban areas of China. Parental reports of ADHD symptoms were assessed using the preschool version of the ADHD Rating scale-IV. A regression analysis was used to examine the association between childcare from grandparents/babysitters and ADHD symptoms.

Results: Childcare from grandparents during infancy was associated with ADHD symptoms in childhood ($\beta = 1.03$, $P < 0.0001$). Significant associations between grandparental care and ADHD symptoms were also observed in children from families with more than one child ($\beta = 0.64$, $P = 0.0035$) and children living in rural areas ($\beta = -0.78$, $P = 0.0032$). A babysitter as the primary child caregiver in preschool was especially strongly correlated with ADHD symptoms in girls ($\beta = 7.95$, $P = 0.0042$). Moreover, region was strong factor associated with ADHD symptoms without adjustment for the non-parental caregivers' age and education, whereas family income was not strongly associated with ADHD symptoms.

Conclusion: Non-parental caregiving (i.e., from grandparents or babysitters) in early childhood was associated with more ADHD symptoms in children. Certain characteristics in children, such as female gender and the existence of siblings, were stronger moderating factors than were family income and region.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD), one of the most common childhood brain disorders, is characterized by a persistent pattern of inattention, and impulsivity and hyperactivity [1]. The disorder affects approximately 7% of children worldwide [2], and the prevalence in preschoolers ranges from 3.3% to 5.4% [3, 4, 5]. Both genetic and environmental factors are believed to contribute to ADHD. Among the contributing environmental factors, multiple indicators of psychosocial adversity have been implicated, including poor parenting quality, a poor general home environment, and a low socioeconomic status (SES) [6, 7, 8].

Negative early childcare experiences are a risk and a likely causal risk factor for the development of ADHD [10]. A hospital-based case-control study conducted in South Africa found that early traumatic life events

and non-maternal childcare, included care received at daycare centers and from grandparents, were associated with ADHD symptoms [11]. Quasi-experimental studies (based in orphanages) suggested that extreme forms of early deprivation can result in ADHD-type symptoms as well as autism-like symptoms among English and Romanian adoptees [12, 13, 14]. However, it remains unclear whether more common types of early experiences, such as non-parental childcare during infancy, are associated with a risk of developing ADHD symptoms.

The non-parental childcare in the present study was narrowly focused on grandparental care and babysitter care at children's personal homes, which are the most common childcare arrangements due to the absence of early childcare systems in China. Our argument of the effect of non-parental care on children's development focused on types of care, quality and quantity of non-parental care, and on the exposure period in early childhood. The present study sought to examine the associations between

grandparental/babysitter care in different periods of early childhood and ADHD symptoms.

Grandparental care is associated with a number of children's outcomes, including lower cognitive development, lower executive function, lower emotional self-regulation, and an increased incidence of mental health problems [15, 16], which are all highly associated with ADHD symptoms. It should be noted that grandparents are involved in childcare to different degrees in sociocultural contexts, which may have different links with children's outcomes. It is estimated that between 23–40% of grandparents take care of their grandchildren in the U.S. and in European countries [17, 18, 19]. Due to cultural traditions and the absence of early childcare systems for children under three years of age, grandparental care is much more common in China than in other countries. Infant care services are exceedingly rare, especially in rural areas. One study found that 60–70% of children younger than two years of age were cared for by their grandparents. Another found that nearly 40% of children over three years of age were still primarily cared for by their grandparents [20, 21]. As a point of comparison, the prevalence of childcare in the home by a non-relative has been reported to be about 14% in the U.S [22]. More than 30% of grandchildren were found to be cared for at grandparents' homes in China, which was different from other countries where part-time care is generally a preferred option [23]. Hours spent in non-parental care have also been shown to be associated with behavioral problems in the results of a longitudinal study of 17,000 children in the U.S [24]. In addition, the most powerful finding from that National Institute of Child Health and Human Development Early Child Care (NICHD) study indicated that the quantity rather than the quality of childcare was associated with children's development [25]. The impact of grandparental and babysitter care on children in China is even important given that Chinese grandparents and babysitters are usually engaged in childcare at a very high level by living at children's homes and serve as primary caregivers.

The contribution of family socioeconomic status (SES) requires separate consideration. A recent systematic review examined the associations between parental socioeconomic disadvantages and childhood ADHD [9]. According to the meta-analysis, children from low SES backgrounds were on average 1.9–2.2 times more likely to exhibit ADHD symptoms compared to peers from high SES backgrounds [9]. The family SES is a crucial factor in predicting non-parental care quality and patterns because grandparents are regular providers of free childcare. Households with lower incomes have been found to be more likely to use grandparental care [17]. Mothers using grandparental childcare tended to be the most disadvantaged groups [26].

From the perspective of those providing rather than using grandparental care, differences in socioeconomic status were also evident. A prior study showed that working class grandmothers with low incomes was the group most likely to give up work or reduce their paid hours to care for grandchildren [27]. By contrast, families with higher incomes tended to use paid babysitter care. In parallel with the growing labor force participation of women and rising household incomes, increasing numbers of children in China have been cared for by babysitters in large cities in recent years.

The interaction between the impact of grandparental care on children's outcomes and family SES were observed in previous studies. Data from a cohort study showed that children who were cared for in an informal childcare setting (75 percent having been cared for by grandparents) between the ages of nine months and three years were more likely to be overweight than those cared for only by a parent. This relationship only held true for children from more advantaged families (mothers with a higher educational level, from a professional background, and living with a partner) [28]. Compared with children cared for in a formal childcare center, children cared for by grandparents were better at naming objects, but worse at problem-solving, mathematical concepts and construction ability. However, these results hid strong heterogeneities. On the one hand, the positive association between family care and child outcomes was stronger for children from more

advantaged households; on the other hand, the negative association was significant only for children from more disadvantaged households. However, whether there was an interactive effect on children's ADHD symptoms remains unknown.

Besides household SES, the children's personal characteristics, such as sex and birth order, have also been found to play an important role in the association between grandparental care and children's outcomes. It has been suggested that grandparental care is more strongly associated with emotional problems in girls and with externalizing behaviors in boys [29, 30]. Another study using large-scale, representative U.S.-based sample found that maternal employment in the first year of life was associated with behavioral problems for boys but not girls [31]. Some studies showed that birth order did not affect ADHD risk [32, 33], but one study indicated that first-born children had nearly twice the ADHD risk of children lower in the birth order [34]. Before the implementation of the new universal two-child policy in 2016, China maintained a one-child policy for several decades, which, when combined with a strong cultural preference for sons (stemming from traditional Confucian norms about who takes care of aging parents), resulted in a gender imbalance [35]. Furthermore, even under the one-child policy, families in some rural areas were allowed to have a second child if their first-born was a girl or disabled. This resulted in more families in rural areas having two children than families in urban areas did. However, little is known about the moderating influence of SES, the child's sex, and number of siblings on the association between non-parental care and ADHD symptoms.

The hypotheses of this study were: 1) Two types of non-parental care (i.e., from grandparents and babysitters) in early childhood increase children's ADHD symptoms later; 2) This association is different according to children's personal characteristics; and 3) Family SES plays a moderating role in the association, e.g., low family income and rural areas.

2. Materials and methods

2.1. Participants

We conducted cluster sampling on 1597 parents of children aged 1.6–7 years (Mean = 4.8, SD = 1.1) who were enrolled in preschools in rural and urban areas of China after stratifying the regions by level of economic development. Specially, two cities with a different economic developmental level in Anhui, a large agricultural province, were selected, and then 461 parents were sampled from two public and two private preschools in the rural area of these two cities. For children from urban areas, one public preschool located in the metropolitan center of Shanghai, and two public preschools in the second-tier city of Xuzhou in the Jiangsu province, were selected. All children and their parents in each selected preschool were recruited, and the average response rate for the study was 95%. Preschools in urban areas of China usually recruited children aged 3–6 years. However, the age limit for preschool admission can be different in rural areas. Finally, 1136 parents from these three schools in urban areas were enrolled. More than half of the children were boys (53.2%), and 46.8% of the children were girls. Moreover, 60.1% of the children were the only child, and 39.9% of children had siblings (Table 1). In addition, 39.7% of the children lived in a nuclear family with two parents, 59.2% of the children lived in extended families with their parents and grandparents, and only 1.1% of children lived with a single parent.

2.2. Procedure

Participating parents were required to fill out a questionnaire anonymously, which included information about their age, education level, work status, family structure, annual household income, early childcare arrangements, and ADHD rating scales for their children. A school-based survey was conducted in this cross-sectional study. The questionnaires were distributed to parents during parent/teacher meetings at the

Table 1. Differences in sociodemographic characteristics and type of childcare between rural and urban areas.

	Total N (%)	Rural area N (%)	Urban area N (%)	χ^2	P
Children's sex (Missing value/M = 2)					
Boys	848 (53.2)	237 (14.9)	611 (38.3)	0.8	0.3702
Girls	747 (46.8)	224 (14.0)	523 (32.8)		
Only Child (M = 5)					
Yes	964 (60.1)	200 (12.6)	764 (48.0)	80.1	<.0001
No	628 (39.9)	261 (16.4)	367 (23.0)		
Family structure (M = 4)					
Nuclear family	633 (39.7)	119 (7.5)	514 (32.3)	60.2	<.0001
Extended family	943 (59.2)	342 (21.5)	601 (37.7)		
Single parent	17 (1.1)	1 (0.06)	16 (1.0)		
Family annual income (USD) (M = 10)					
<7,500	132 (8.3)	103 (6.5)	29 (1.8)	711.0	<.0001
7,500–15,000	434 (27.3)	281 (17.7)	153 (9.6)		
20,000–25,000	304 (19.2)	73 (4.6)	231 (14.5)		
25,000–30,000	183 (11.5)	3 (0.2)	180 (11.3)		
30,000–40,000	193 (12.2)	0 (0)	193 (12.2)		
>40,000	341 (21.5)	0 (0)	341 (21.5)		
Mother works (M = 7)					
Yes	1278 (75.6)	352 (22.1)	926 (58.2)	6.7	0.0099
No	312 (24.4)	109 (6.9)	203 (12.8)		
Father works (M = 13)					
Yes	1577 (99.6)	458 (28.9)	1119 (70.6)	0.0008	0.9781
No	7 (0.4)	2 (0.3)	5 (0.3)		
Mother's education level (M = 5)					
Elementary school	27 (1.7)	25 (1.6)	2 (0.1)	1066.9	<.0001
Middle school	357 (22.4)	319 (20.0)	38 (2.4)		
High school	200 (12.6)	94 (5.9)	106 (6.7)		
Undergraduate	882 (55.4)	23 (1.4)	859 (54.0)		
Graduate	126 (7.9)	0 (0)	126 (7.9)		
Father's education level (M = 8)					
Elementary school	18 (1.1)	16 (1.0)	2 (0.1)	1060.9	<.0001
Middle school	318 (20.0)	294 (18.5)	24 (1.5)		
High school	224 (14.1)	120 (7.6)	104 (6.5)		
Undergraduate	848 (53.4)	30 (1.9)	818 (51.5)		
Graduate	181 (11.4)	0 (0)	181 (11.4)		
Mother's age (M = 6)					
≤30	481 (30.2)	296 (18.8)	185 (11.8)	356.5	<.0001
30-35	787 (49.5)	124 (7.9)	663 (42.2)		
35-40	265 (16.7)	32 (2.0)	233 (14.8)		
>40	58 (3.6)	9 (0.6)	49 (3.2)		
Father's age (M = 19)					
≤30	340 (21.5)	241 (15.3)	99 (6.3)	388.6	<.0001
30-35	754 (47.8)	166 (10.5)	588 (37.3)		
35-40	334 (21.2)	42 (2.7)	301 (19.1)		
>40	150 (9.5)	11 (0.7)	139 (8.8)		
Non-parent caregiver's education[a] (N = 455; M = 1142)					
Elementary school	140 (27.9)	84 (15.2)	56 (10.1)	138.5	<.0001
Middle school	162 (32.3)	37 (6.7)	125 (22.6)		
High school	146 (42.5)	5 (0.9)	141 (25.5)		
Undergraduate	52 (10.4)	2 (0.4)	50 (9.0)		
Graduate	2 (0.4)	1 (0.2)	1 (0.2)		
ADHD symptoms					
Yes	112 (7.0)	36 (2.3)	76 (4.8)	0.6	0.4275
No	1485 (93.0)	425 (26.6)	1060 (66.3)		
Primary caregiver in infancy (M = 11)					
Parents	1176 (74.1)	412 (26.0)	764 (48.2)	81.0	<.0001
Grandparents	377 (23.8)	49 (3.1)	328 (20.7)		
Babysitter	33 (2.1)	0 (0)	33 (2.1)		

Table 1 (*continued*)

	Total N (%)	Rural area N (%)	Urban area N (%)	χ^2	P
Primary caregiver in toddlerhood (M = 14)					
Parents	971 (61.4)	295 (18.3)	676 (42.7)	2.6	0.2703
Grandparents	591 (37.3)	162 (10.2)	429 (27.1)		
Babysitter	21 (1.3)	4 (0.3)	17 (1.1)		
Primary caregiver during preschool (M = 66)					
Parents	1068 (69.8)	332 (21.7)	736 (48.1)	2.5	0.1742
Grandparents	451 (29.5)	127 (8.3)	324 (21.2)		
Babysitter	12 (0.7)	2 (0.1)	10 (0.6)		

[a] The grandparent's and babysitter's education level were inquired about only if they were the primary caregivers. The education indicator had five levels, including illiteracy and primary school, middle school, high school, college, and graduate school.

preschools in cities, and these were brought back about a week later. For preschools in rural areas, caregivers were required to fill out the questionnaire during parent/teacher meetings. The questions were read aloud to grandparents with low reading levels in their native language. If families had more than one young child, the parents were asked to select one child to rate. The study protocol was formally reviewed and approved by the Medical Ethics Committee at Fudan University in China (Ethical approval number: IRB#2016-05-0590). The author confirms that this study was performed under the approved social experimentation guidelines and regulations. Informed consent was obtained from all the individual participants included in the study.

2.3. Measures

The ADHD symptoms were assessed by the parent-reported preschool version of the ADHD Rating scale-IV [36], an 18-item ADHD assessment scale consisting of two subscales: inattention and hyperactivity-impulsivity. Each of these subscales contained nine items, and each item was mapped to one of the 18 symptoms of ADHD given in the Diagnostic and Statistical Manual of Mental Disorders - IV (DSM-IV). Parents were required to rate the frequency of occurrence of each of the ADHD symptoms over the past six months on a four-point Likert scale, with 0 representing never or rarely occurring, 1 for sometimes occurring, 2 for often occurring, and 3 for very often occurring. The values for the 18 items were then summed to obtain an overall score. The internal consistency reliability (Cronbach's alpha) of the preschool version of ADHD Rating Scale-IV (ADHDRS-IV) was 89. A score in the 93rd percentile was suggested as the cut-off point to distinguish between children with or without ADHD symptoms [37]. Parents were required to answer the following questions to assess non-parental care practices: Who was the primary caregiver during your children's infancy (0–12 months), toddlerhood (1–2 years old), and preschool stage (3–6 years old)? There were five options for each question: mother, father, father's parents, mother's parents, and babysitter. The grandparents mentioned in this study included both the father and mother's parents. The primary caregiver was defined as someone who cared for the child for the most amount of time in a day. For preschoolers who attended preschool during the daytime, the primary caregiver was someone who picked up and dropped off kids every day, as well as took care of them after school. Children usually spend a consistent 8 h a day in preschool, whereas relatively few preschools offer half-day or extended services in China. The ages of children were given as guidelines for parents to delineate caregiving during each period of infancy (0–12 months), toddlerhood (1–2 years old), and preschool (3–6 years old).

2.4. Analyses

The data were analyzed using the Statistic Analysis System (SAS) version 9.3 (Institute Inc., Cary, NC, USA). The chi-square test was used to examine differences between rural and urban areas in the demographic background of parents, non-parental childcare practices, and ADHD symptoms. Both a univariate and a multivariate regression

analysis were used to examine the associations between demographic characteristics, non-parental care practices, and ADHD symptoms. A continuous variable of the ADHD total score was put into the regression model as the dependent variable. In the regression analysis, each type of non-parental care was coded as a dummy variable. The variables for producing the interaction term were then standardized to avoid potential multicollinearity between the interaction term and component variables [38]. For the regression analysis, the bivariate association analysis between socio-demographic characteristics, childcare practices, and children's ADHD symptoms was first conducted (Table 2). Then, a multiple regression analysis with interactive effects was conducted (Table 3). Similarly, since a grandparent's or babysitter's education level and age are influential factors in predicting parenting quality and practices, these variables were adjusted in model 2 (Table 3).

3. Results

There were significant differences between rural and urban areas in family structure, household income, parental education, and early childcare practices (Table 1). As expected, urban families were more likely to report an only child (67.6%) compared with rural areas (43.4%; $\chi^2 = 80.1$, P < 0.0001). Nearly half of the children in urban areas lived in nuclear families (45.5%) in contrast to rural areas where 70% of children lived in extended families ($\chi^2 = 60.2$, P < 0.0001). The results also

Table 2. Bivariate associations between sociodemographic characteristics, childcare practices, and children's ADHD symptoms.

	β	P
Child's age	-0.07	0.7053
Child's sex	-1.07	<0.0001
Only child	-0.43	0.0386
Region	-0.30	0.1425
Family annual income	-0.41	0.0493
Family structure	0.24	0.5539
Mother's education level	-0.30	0.1443
Father's education level	-0.47	0.0220
Mother's age	-0.67	0.0013
Father's age	-0.76	0.0003
Mother has a job	0.19	0.7155
Father has a job	1.05	0.7341
Age of non-parental caregiver	-0.53	0.1778
Education level of non-parental caregiver	-0.72	0.0689
Primarily grandparental care in infancy	0.63	0.0022
Primarily grandparental care in toddlerhood	0.25	0.2358
Primarily grandparental care in preschool	0.41	0.0495
Primarily babysitter care in infancy	-0.25	0.2437
Primarily babysitter care in toddlerhood	0.15	0.4805
Primarily babysitter care in preschool	0.28	0.1778

Table 3. Multiple regression analysis examining the associations between children's characteristics, family socioeconomic status, childcare practices, and children's ADHD symptoms.

	Model 1		Model 2[a]	
	β	P	β	P
Child's age	-0.03	0.8731	-0.06	0.8726
Child's sex	-1.12	<.0001	-1.23	0.0023
Only child	-0.24	0.5793	0.54	0.5394
Father's education	-0.59	0.1501	-1.51	0.0658
Mother's education	-0.73	0.0447	-0.92	0.2035
Father's age	0.26	0.4742	0.92	0.2102
Mother's age	-0.33	0.1306	-0.35	0.4518
Family annual income	-0.16	0.5769	2.89	0.1214
Region	0.21	0.5869	1.11	0.1528
Grandparental care in infancy	1.03	<.0001	1.23	0.0007
Babysitter care in infancy	-0.06	0.7965	-0.71	0.1463
Grandparental care in preschool	0.39	0.43	3.66	0.3500
Babysitter care in preschool	0.92	0.81	8.79	0.1900
Child's sex × Grandparental care in infancy	-0.18	0.4214	-0.42	0.2306
Child's sex × Grandparental care in preschool	-0.14	0.7788	0.36	0.8679
Child's sex × Babysitter care in infancy	0.42	0.0709	0.89	0.1129
Child' s sex × Babysitter care in preschool	4.74	0.0706	7.95	0.0042
Only child × Grandparental care in infancy	0.64	0.0035	1.34	0.0003
Only child × Grandparental care in preschool	0.49	0.3322	1.63	0.5408
Only child × Babysitter care in infancy	0.01	0.9713	-0.17	0.7703
Only child × Babysitter care in preschool	3.38	0.231	5.13	0.0874
Region × Grandparental care in infancy	-0.78	0.0032	-0.87	0.0741
Region × grandparental care in preschool	1.06	0.081	-1.60	0.7324
Region × Babysitter care in infancy	0.87	0.2437	0.95	0.2464
Region × Babysitter care in preschool	0.38	0.9253	1.04	0.4148
Income × Grandparental care in infancy	-0.24	0.3895	0.21	0.6372
Income × Grandparental care in preschool	-0.65	0.295	-3.78	0.0527
Income × Babysitter care in infancy	0.03	0.9213	0.64	0.4037
Income × Babysitter care in preschool	0.39	0.9214	-6.09	0.2890
Non-parent caregiver's age			-0.28	0.5672
Non-parent caregiver's education level			-0.47	0.3152
R^2	0.0548		0.1025	

[a] Two more variables of the non-parent caregivers' education levels and ages were adjusted in Model 2.

showed the substantial gap in household incomes between families in rural and urban areas ($\chi^2 = 711.0$, P < 0.0001). The median annual income in the urban areas was around 30,000 USD, whereas all the families in the rural areas reported incomes below that level. The education level of parents and non-parental caregivers in urban areas was much higher than that of parents in rural areas ($\chi^2 = 1066.9$, P < 0.0001; $\chi^2 = 1060.9$, P < 0.0001; $\chi^2 = 138.5$, P < 0.0001). In general, 75.6% of mothers and 99.6% of fathers worked. Overall 99.6% fathers were employed, and this did not change based on area. However, the proportion of working mothers in urban areas (82.0%) was slightly higher than that in rural areas (76.4%; $\chi^2 = 6.7$, P = 0.0099). This was related to the higher proportion of grandparental care in urban areas (10.6%) than in rural areas (29.2%) during children's infancy.

As expected, 25.9% of children were cared for by grandparents and babysitters during infancy, and this percentage rose to 38.6% in toddlerhood. Moreover, 29.2% of children were cared for by their grandparents during infancy in urban areas, whereas only 10.6% of children received grandparental care in rural areas. In addition, 2.9% of

urban children were cared for during infancy by babysitters, but none were in rural areas. No significant difference was found in ADHD symptoms when comparing children in urban with rural areas ($\chi^2 = 0.6$, P = 0.4275).

Table 2, which shows the comparison of boys to girls (β = -1.07, P <. 0001) and only children compared to children with siblings (β = -0.43 P = 0.0386), indicated that boys and only children had more ADHD symptoms. Moreover, while there were no regional differences in the ADHD symptom scores (β = -0.30, P = 0.1425), children from low-income households exhibited more ADHD symptoms compared with children from high-income backgrounds (β = -0.41 P = 0.0493). In addition, a higher paternal education level was associated with less ADHD symptoms (β = -0.47 P = 0.0220). Compared with younger parents, the presence of an older mother (β = -0.67 P = 0.0013) or father (β = -0.76 P = 0.0003) was linked with less ADHD symptoms in children. As we hypothesized, children who were raised by their grandparents during infancy (β = 0.63, P = 0.0022) and preschool (β = 0.41, P = 0.0495) exhibited more ADHD symptoms in preschool.

Table 3 shows the multivariable-adjusted regression results. Model 1 shows the results of multiple regression analysis after accounting for children's characteristics and family socioeconomic status (see Table 3). Children cared for primarily by grandparents in infancy had more ADHD symptoms in later years (β = 1.03, P < 0.0001). Grandparental care during infancy was more strongly predictive of ADHD symptoms in children with siblings than in only children (β = 0.64, P = 0.0035). Rurality also played a role in the association between grandparental care and children's ADHD symptoms (β = -0.78, P = 0.0032).

After adjusting for the grandparents' and babysitters' age and education level in Model 2, the associations found in Model 1 remained significant. Furthermore, a babysitter as the primary caregiver during preschool appeared to be especially harmful for girls (β = 7.95, P = 0.0042). The R square improved from 5.5% in model 1–10.3% in model 2 after adjusting the non-parental caregivers' education levels and ages. There was also an association between family income and the type of childcare. In conclusion, girls, children with siblings, children from low-income families, and rural-based children were more susceptible to ADHD symptoms as a result of receiving non-parental care.

4. Discussion

In conclusion, we found that children who were primarily cared for by grandparents during infancy exhibited more ADHD symptoms in preschool. This association was especially marked for children with siblings and children living in rural areas. Infancy appeared to be a critical period for children's psycho-behavioral development. Previous studies found that a low quality of care characterized by less sensitivity and response in the first year of life was especially predictive of externalized behavioral problems during childhood and adolescence [39]. Grandparental care, in combination with an overprotective parenting strategy, has been found to result in less responsiveness in children [40, 41]. In addition, children who experienced extensive non-maternal childcare during infancy were found to be less likely to form secure emotional attachments later in life [42, 43, 44].

A previous study suggested that grandparental care was the most beneficial arrangement for the cognitive development of children in poverty [45]. However, the findings in the current study suggested the opposite, i.e., grandparental care was more strongly associated with ADHD symptoms in children from low-income backgrounds. A possible reason for this discrepancy is that in Chinese families in rural areas, mothers who are younger and less educated are more likely to use grandparental care. Compared with non-caregivers, grandparents who raised grandchildren have been found to experience significantly more health problems, including depression, coronary heart disease, chronic

health conditions, and physical disabilities, that may limit activity and affect the quality of childcare they deliver [15, 23, 46]. However, these associations also likely reflected some degree of selection bias, i.e. parents might choose to "outsource" the care of children with early signs of developmental disorder to others to provide respite for the primary caregiver. The association may be also causal, e.g., grandparents and babysitters may engage in fewer social interactions with children. Babysitter care also increased parental inconsistency, which has been associated with developmental delay in preschoolers [47].

In addition, there is an interesting theory about a link between lack of crawling and ADHD. It all has to do with a reflex we are born with, called the Symmetric Tonic Neck Reflex (STNR). If reflex does not integrate, some of the symptoms will be caused, including poor attention, poor eye-hand coordination. A retained STNR is often accompanied with ADHD symptoms and causes problems with copying from the board and vertical tracking [48]. The STNR is often active in children who have not crawled. Infants' experience of reaching and crawling also boost their cognitive and social development [49, 50]. For these reasons, grandparent care may potentially increase children's ADHD symptoms. In China, grandparent care often is complained with overprotection and inhibition of children's physical movement for some reasons of safety and hygiene.

Another interesting finding in this study was that only children, as compared with those with siblings, exhibited more ADHD symptoms. However, the opposite was true for families with grandparents as primary caregivers. We found that grandparental care during infancy was more strongly associated with more ADHD symptoms in children with siblings compared with only children. An obvious explanation for this is that parents are able to devote more time, energy, and money to only children, and that these resources are diluted among siblings as family size increases [51]. Only children are also able to access more family resources and a higher quality of care. In particular, only children are often considered more precious for grandparents. Generally speaking, family size has been found to exert the strongest influence on parental investment in each child, even in wealthy or well-educated families [52]. However, it would also be relevant to acknowledge the actual dynamics between children and siblings in the household.

Beyond the issue of single-child families, the present study also found that gender moderated the association between babysitter care and ADHD symptoms. A previous study suggested that maternal care was the most beneficial for boys, whereas babysitter care was the most beneficial for girls [45]. However, the current study found that babysitter care, either during infancy or in childhood, was associated with more ADHD symptoms in girls than in boys. The relationship between early attachment deprivation and ADHD may explain why girls were found to be more vulnerable to babysitter care. It has been suggested that girls have more difficulty in developing secure attachments with non-parental caregivers than boys do [53].

Finally, the duration of paid maternity leave in China is currently at 14 weeks (98 days) in accordance with labor law, which barely meets the minimum maternity leave period stipulated by the International Labor Organization (ILO). The amount of paid parental leave given in China is considerably lower than that in several European countries and some Asian countries. The results of our study suggested that improving the Chinese family leave policy so that mothers (and fathers) of young infants can take time off to care for their children would potentially improve the quality of early childcare. Along with the roll-out of the two-child policy in 2016, it is imperative to increase childcare services for children younger than three years of age, in particular in low-income families who cannot afford existing childcare services.

5. Limitations

There were some limitations to our study. First, the cross-sectional study design limited our ability to draw causal inferences. In particular, we could not exclude some degree of reverse causation and selection, i.e., children who exhibited early behavioral difficulties were more likely to be cared for by non-parents. Second, this study used a questionnaire rather than interview-based assessments to assess ADHD symptoms.

Declarations

References

[1] American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, fifth ed., American Psychiatric Publishing, Arlington, VA, 2013.

[2] R. Thomas, S. Sanders, J. Doust, E. Beller, P. Glasziou, Prevalence of attention-deficit/hyperactivity disorder: a systematic review and meta-analysis, Pediatrics 135 (4) (2015) 1093–1106.

[3] H.L. Egger, A. Angold, Common emotional and behavioral disorders in preschool children: presentation, nosology, and epidemiology, JCPP (J. Child Psychol. Psychiatry) 47 (3-4) (2006) 313–337.

[4] S.J. Bufferd, L.R. Dougherty, G.A. Carlson, S. Rose, D.N. Klein, Psychiatric disorders in preschoolers: continuity from ages 3 to 6, Am. J. Psychiatr. 169 (2012) 1157–1164.

[5] J. Canals, P. Moraleshidalgo, M.C. Jané, E. Domènech, ADHD prevalence in Spanish preschoolers: comorbidity, socio-demographic factors, and functional consequences, J. Atten. Disord. (2016) 1–11.

[6] L. Keown, Predictors of boys' ADHD symptoms from early to middle childhood: the role of father-child and mother-child interactions, J. Abnorm. Child Psychol. 40 (2012) 569–581.

[7] A. Mulligan, R. Anney, L. Butler, M. O'Regan, T. Richardson, E.M. Tulewicz, et al., Home environment: association with hyperactivity/impulsivity in children with ADHD and their non ADHD siblings, Child Care Health Dev. 39 (2) (2013) 202–212.

[8] G. Russell, T. Ford, R. Rosenberg, S. Kelly, The association of attention deficit hyperactivity disorder with socioeconomic disadvantage: alternative explanations and evidence, JCPP (J. Child Psychol. Psychiatry) 55 (5) (2013) 436–445.

[9] A.E. Russell, T. Ford, R. Williams, G. Russell, The association between socioeconomic disadvantage and attention deficit/hyperactivity disorder (ADHD): a systematic review, Child Psychiatr. Hum. Dev. 47 (3) (2016) 440–458.

[10] A. Thapar, M. Cooper, O. Eyre, K. Langley, What have we learnt about the causes of ADHD? JCPP (J. Child Psychol. Psychiatry) 54 (1) (2013) 3–16.

[11] D.L. Van, P. Springer, M. Kidd, N. Steyn, R. Solomons, T.R. Van, Familial-environmental risk factors in South African children with attention-deficit hyperactivity disorder (ADHD): a case-control study, J. Child Neurol. 30 (10) (2014) 1327–1332.

[12] J.M. Kreppner, T.G. O'Connor, M. Rutter, the English and Romanian Adoptees Study Team, Can inattention/overactivity be an institutional deprivation syndrome? J. Abnorm. Child Psychol. 29 (2001) 513–528.

[13] M. Rutter, C. Beckett, J. Castle, E. Colvert, J. Kreppner, M. Mehta, et al., Effects of profound early institutional deprivation: an overview of findings from a UK longitudinal study of Romanian adoptees, Eur. J. Dev. Psychol. 4 (2007) 332–350.

[14] M. Rutter, J. Kreppner, C. Croft, M. Murin, E. Colvert, C. Beckett, et al., Early adolescent outcomes of institutionally deprived and non-deprived adoptees. III. Quasi-autism, JCPP (J. Child Psychol. Psychiatry) 48 (2007) 1200–1207.

[15] J.M. Augustine, R.L. Crosnoe, R. Gordon, Early child care and illness among preschoolers, J. Health Soc. Behav. 54 (3) (2013) 315–334.

[16] X.L. Guo, The influence of grandparenting on cognitive development among children: a longitudinal study, Chin. J. Clin. Psychol. 22 (6) (2014) 1072–1076.

[17] K. Smith, Who' S Minding the Kids? Child Care Arrangements: Spring 1997. Current Populations Reports P70–86, U.S. Census Bureau, Washington, DC, 2002.

[18] K. Hank, I. Buber, Grandparents caring for their grandchildren: findings from the 2004 survey of health, ageing, and retirement in Europe, J. Fam. Issues 30 (1) (2009) 53–73.

[19] A. Aassve, E. Meroni, C. Pronzato, Grandparenting and childbearing in the extended family, Eur. J. Popul. 24 (4) (2012) 499–518.

[20] P.C. Ko, K. Hank, Grandparents caring for grandchildren in China and Korea: findings from charls and klosa, J. Gerontol. B Psychol. Sci. Social Sci. 69 (4) (2014) 646–651.

[21] H.H. Liu, Review on grandparent care for children aged 0 to 3 years, China Family Edu. 3 (2006) 67–71.

[22] US census, Child Care Arrangements of Preschoolers under 5 Years Old Living with Mother, by Employment Status of Mother and Selected Characteristics: 2011. Who's Minding the Kids? Child Care Arrangements, Spring, 2011. Retrieved from, http://www.census.gov/data/tables/2008/demo/2011-tables.html. (Accessed 29 December 2016).

[23] J. Goodfellow, J. Laverty, Grandparents supporting working families: satisfaction and choice in the provision of childcare, Fam. Matters 66 (2003) 14–19.

[24] G.W. Ritter, R.C. Turner, The impact of daycare on school readiness; using new data to examine the controversy, in: Paper Presented at the 2003 Biennial Meeting of the Society for Research in Child Development, 2003. Tampa, FL.

[25] A. Bell, N. Finch, I. La Valle, R. Sainsbury, C. Skinner, A Question of Balance: Lone Parents, Childcare and Work, Department for Work and Pensions, 2005. Research Report No.2 30, 1-192. Retrieved on March, 2019 from, https://www.york.ac.uk/inst/spru/pubs/pdf/rrep230.pdf.

[26] P. Leach, J. Barnes, L. Malmberg, K. Sylva, A. Stein, the FCCC team, The quality of different types of child care at 10 and 18 months: a comparison between types and factors related to quality, Early Child. Dev. Care 178 (2) (2008) 177–209.

[27] Grandparents Plus, The Poor Relation: Interim Report, Grandparents Plus, London, 2009. Retrieved on March, 2019 from, https://www.grandparentsplus.org.uk/wp-content/uploads/2011/03.

[28] A. Pearce, L. Li, J. Abbas, B. Ferguson, H. Grahamm, C. Law, Millennium Cohort Study Child Health Group, Is childcare associated with the risk of overweight and obesity in the early years? Findings from the UK Millennium Cohort Study, Int. J. Obes. 34 (7) (2010) 1160–1168.

[29] H.S. Kleiner, J. Hertzog, D.B. Targ, Grandparents Acting as Parents: Background Information for Educators, 1998 http//www.nnfr.org/igen/gaap.html. (Accessed 18 October 2002).

[30] L.F. Wang, Investigation on the mental health of preschoolers reared by their grandparents, China Mental Health J. 1 (10) (2007) 672–674.

[31] L M, Peer and teacher ratings of third- and fourth-grade children's social behavior as a function of early maternal employment, JCPP (J. Child Psychol. Psychiatry) 44 (2003) 477–488.

[32] I. Berger, N. Felsenthal-Berger, Attention-deficit hyperactivity disorder (ADHD) and birth order, J. Child Neurol. 24 (6) (2009) 692–696.

[33] M.A. Masana, S.F. López, S.S. Martí, G.S. Acosta, Correspondence on "attention-deficit hyperactivity disorder (adhd) and birth order, J. Child Neurol. 26 (3) (2011) 395–396.

[34] A.M. Marín, F.L. Seco, S.M. Serrano, S.A. García, A.M. Gaviria Gómez, I. Ney, Do firstborn children have an increased risk of adhd? J. Atten. Disord. 18 (7) (2014) 594.

[35] B.J. Lu, The Effect of Fertility Policy on the Rural Sex Ratio Imbalance: Based on the Analysis of CHNS Data 2017, 2015. Nanjing Agricultural University (Master's thesis), Retrieved from China National Knowledge Internet.

[36] K.E. McGoey, G.J. DuPaul, E. Haley, T.L. Shelton, Parent and teacher ratings of attention-deficit/hyperactivity disorder in preschool: the ADHD rating scale IV preschool version, J. Psychopathol. Behav. Assess. 29 (4) (2007) 269–276.

[37] G.J. DuPaul, A.D. Anastopoulos, T.J. Power, R. Reid, M.J. Ikeda, K.E. McGoey, Parent ratings of ADHD symptoms: factor structure, normative data, and psychometric properties, J. Psychopathol. Behav. Assess. 20 (1) (1998) 83–102.

[38] P.A. Frazier, A.P. Tix, K.E. Barron, Testing moderator and mediator effects in counseling psychology research, J. Counsel. Psychol. 51 (1) (2004) 115–134.

[39] D. Berry, K. Deaterdeckard, K. Mccartney, Z. Wang, S.A. Petrill, Gene-environment interaction between dopamine receptor d4 7-repeat polymorphism and early maternal sensitivity predicts inattention trajectories across middle childhood, Dev. Psychopathol. 25 (2) (2013) 291–306.

[40] Y.Y. Huang, Grandparents care and children's psychological development, Econ. Soc. Dev. 4 (4) (2006) 203–205.

[41] B. Haslip Jr., R. Goldbert-Glen (Eds.), Grandparents Raising Grandchildren: Theoretical, Empirical, and Clinical Perspectives, Springer, New York, N.Y., 2000.

[42] N.L. Hazen, S.D. Allen, C.H. Christopher, T. Umemura, D.B. Jacobvitz, Very extensive nonmaternal care predicts mother-infant attachment disorganization: convergent evidence from two samples, Dev. Psychopathol. 27 (3) (2015) 1–13.

[43] P.M. Crittenden, G.R. Kulbotten, Familial contributions to ADHD: an attachment perspective, Tidsskrift Norsk Psykologforening 44 (10) (2007) 1220–1229.

[44] H. Niederhofer, Attachment as a component of attention deficit hyperactivity disorder, Psychol. Rep. 104 (2) (2009) 645–648.

[45] N. Baydar, J. Brooksgunn, Effects of maternal employment and child-care arrangements on preschoolers' cognitive and behavioral outcomes: evidence from the children of the national longitudinal survey of youth, Dev. Psychol. 27 (6) (1991) 932–945.

[46] K. Folk, For love or money: costs of child care by relatives, J. Fam. Econ. Issues 15 (1994) 243–260.

[47] L. Tong, R. Shinohara, Y. Sugisawa, E. Tanaka, A. Maruyama, Y. Sawada, et al., Relationship of working mothers' parenting style and consistency to early childhood development: a longitudinal investigation, J. Adv. Nurs. 65 (10) (2009) 2067–2076.

[48] S. Goddard Blythe, The Well Balanced Child: Movement and Learning, Hawthorn Press, Gloucestershire, UK, 2008.

[49] E.N. Cannon, E.A. Simpson, N.A. Fox, R.E. Vanderwert, A.L. Woodward, P.F. Ferrari, Relations between infants' emerging reach-grasp competence and event-related desynchronization in EEG, Dev. Sci. 19 (2015) 50–62.

[50] S.L. Gonzalez, B.C. Reeb-Sutherland, E.L. Nelson, Quantifying motor experience in the infant brain: eeg power, coherence, and mu desynchronization, Front. Psychol. 7 (2016).

[51] D.B. Downey, Number of siblings and intellectual development. The resource dilution explanation, Am. Psychol. 56 (6-7) (2001) 497–504.

[52] D.W. Lawson, R. Mace, Trade-offs in modern parenting: a longitudinal study of sibling competition for parental care, Evol. Hum. Behav. 30 (3) (2009) 170–183.

[53] Network N. E. C. C, The effects of infant child care on infant-mother attachment security: results of the NICHD [national institute of child health and human development] study of early child care, Child Dev. 68 (5) (1997) 860–879.