Child Physical Abuse, Non-anemic Iron Deficiency and Behavior Problems

Naixue Cui [a,b], Xiaopeng Ji [a,c], Jianghong Liu [a,*]

[a] School of Nursing, University of Pennsylvania, 418 Curie Blvd, Philadelphia, PA 19104, USA
[b] School of Nursing, Shandong University, No. 44 Wenhua Xi Road, Jinan, Shandong Province 250012, China
[c] School of Nursing, University of Delaware, 369 McDowell Hall, 25 North College, Newark, DE 19716, USA

ABSTRACT

Purpose: Child abuse is regarded as a life-course social determinant of health problems. However, little is known about the nutritional status of physically abused children and their cumulative effect on child behavior. The present study aimed to examine the non-anemic iron deficiency status of abused children and the combined effect of physical abuse and non-anemic iron deficiency on child behavior in China.

Methods: This cross-sectional study comprised 314 children aged 11–14 (12.30 ± 0.57) years old from Jintan, China. Children self-reported their physical abuse experiences and behavior problems. Blood iron and hemoglobin concentrations were also measured.

Results: Thirty-eight percent of children reported physical abuse experience, 17.5% had non-anemic iron deficiency, and the two risk factors co-occurred in 8.0% children. Physically abused children were more likely to be affected by non-anemic iron deficiency than their non-abused counterparts. Children who had experienced both physical abuse and non-anemic iron deficiency reported more behavior problems than children with neither or either risk factors.

Conclusions: Physically abused children are more likely to have non-anemic iron deficiency. Children with the presence of both physical abuse experience and non-anemic iron deficiency have more behavior problems. There is a need to prevent both child abuse and non-anemic iron deficiency simultaneously to maintain normal child behavior development.

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Introduction

Child abuse, especially physical abuse, was long regarded as an acceptable disciplinary strategy and widely practiced in the Chinese societies (Fang et al., 2015; K. Ji & Finkelhor, 2015; Stoltenborgh, Bakermans-Kranenburg, van IJzendoorn, & Alink, 2013). However, it has been recognized as a life-course social determinant of many health problems across the world. Of them, behavioral problems are of particular concern for school children. Research shows that child abuse experiences are associated with internalizing and externalizing behavioral problems in children and adolescents, such as depression, anxiety, aggressive and violent behaviors (Gilbert et al., 2009; Heim, Shugart, Craighead, & Nemeroff, 2010). Childhood and adolescent behavioral problems can cause difficulties in school adaptation (Masten et al., 2005), increase the risk for suicidal attempts (Perez, Jennings, Piquero, & Baglivio, 2016) in children and predict risky health behavior in emerging adulthood (Sentse, Kretschmer, Haan, & Prinzie, 2016). Despite the potential detrimental effects in childhood and beyond, evidence-based

programs that target child abuse remain largely underexplored in Mainland China (Man, Barth, Li, & Wang, 2017).

Many prevention programs have been launched in other countries (Chen & Chan, 2016) However, a recent meta-analysis suggested that the present child abuse prevention programs did not significantly improve behaviors of abused children (Casillas, Fauchier, Derkash, & Garrido, 2016), indicating that some other factors may exist and affect abuse-related behavior problems. The nutritional factor may be one of the factors that could influence the relationship between child abuse and behavior. Prior studies show that abused children are more likely to experience childhood malnutrition (Yount, DiGirolamo, & Ramakrishnan, 2011), thus posing additional risk for emotional and behavioral impairments Specifically, studies in western countries found that 25–35% of maltreated children showed malnutrition and consequent growth retardation (Birrell & Birrell, 1968; Oates, Peacock, & Forrest, 1984). Children with suspected abuse had significantly lower dietary micronutrient intake in the US (Harper, Ekvall, Ekvall, & Pan, 2014). Similar to child abuse, malnutrition, especially iron deficiency, is highly prevalent in China (Global Burden of Disease Pediatrics Collaboration, 2016), and has exhibited both short- and long-term effects on emotional and behavioral problems (Liu et al., 2014). However, few Chinese studies have specifically investigated the nutritional status

* Corresponding author at: Room 426 Fagin Hall, 418 Curie Blvd, Philadelphia, PA 19104, USA.

E-mail address: jhliu@nursing.upenn.edu (J. Liu).

of abused children and their combined contribution to behavioral problems.

The aim of this study is twofold: to examine the association between non-anemic iron deficiency and child physical abuse in a community sample of Chinese school-aged children; and whether child physical abuse and non-anemic iron deficiency have an accumulative effect on behavioral problems. The findings from our study will inform future preventions and interventions for the interrelated public issues of child abuse, malnutrition and behavioral problems in children, and eventually shed light on health consequences in adulthood.

Methods

Design and Sample

The present study used secondary data collected during the Wave II of China Jintan Child Cohort Study. The cohort study is an ongoing prospective-designed longitudinal project with the main purpose to investigate the neural mechanism of lead exposure and child neurobehavioral outcomes. In 2004, the China Jintan Child Cohort Study used a multiple-stage sampling method and enrolled 1656 Chinese children (55.5% boys, 44.5% girls), aged 3–5 years, in Jintan City (Jintan City became the Jintan District of Changzhou City, Jiangsu Province, China on June 1, 2015). The research team first set up a stratified sampling process to select four preschools across different types of location: rural (2 preschools), suburban (1 preschool) and urban (1 preschool), and then recruited all preschoolers in each preschool using a cluster sampling strategy. These preschoolers were regarded as representative of children aged 3–6 years old in Jintan city in China in terms of sex, age and ethnicity. Details of the cohort study design were described elsewhere (Liu et al., 2010; Liu et al., 2011; Liu et al., 2015).

During 2005–2007, 1385 out of the 1656 preschoolers and their parents and teachers participated in the Wave I of data collection (Liu et al., 2010; Liu et al., 2015). About 80.1% of these children were followed up with for the Wave II data collection during 2011–2013 (Liu et al., 2010; Liu et al., 2014). Child behavior problems, blood iron level and hemoglobin were measured twice at both Wave I and II. Child physical abuse was measured in 2013 at Wave II. For the purpose of the study, we included 414 children who had cross-sectional information of child physical abuse, the blood level of micronutrients and hemoglobin, as well as behaviors collected in 2013. The majority of them were 6th graders aged 11 and 12 years old (range 11–14, mean age 11.80 ± 0.67 years old).

Written informed consent was obtained from parents and oral informed assent was obtained from children prior to data collection. Data of child abuse were collected by distributing the questionnaire in the classroom during the regularly scheduled class time. Children's fasting blood samples were collected by nurses in Jintan Hospital and then stored and analyzed per protocol. Children self-reported their behavior problems using an established questionnaire in a quiet waiting room in Jintan Hospital. The participating children were instructed that they could skip any questions or withdraw from the study anytime. After the questionnaire survey, information about psychological and social service resources, such as information about the Jintan Maternal Health Center and Jintan Hospital and materials about parenting and child development were provided to all children, parents and teachers in case they needed help. The study was approved by the Institutional Review Board of the University of Pennsylvania and the Ethics Committee of the Jintan Hospital.

Measures

Child Physical Abuse

The Chinese Version of The Parent-Child Conflict Tactics Scale (Straus, Hamby, Finkelhor, Moore, & Runyan, 1998) was used to assess physical abuse by mother and father abusers in the previous 12 months using the severe and very severe physical assault subscale (7 items, in which two example items are listed: "[Mother/Father] hit me with a fist or kicked me hard" and "[Mother/Father] beat me up"). Children were asked to provide information regarding whether their parents (mother and father separately) displayed these behaviors (0 = "No", 1 = "Yes"). Non-abused children were those with zeros on all items in the subscales for both mother and father abusers. Otherwise, they were labeled as physically abused survivors. The CTSPC is one of the most widely used tool to assess child abuse among children aged 10 years or older. The Chinese version of CTSPC showed satisfactory to good reliabilities (Chan, 2012; Cui, Xue, Connolly, & Liu, 2016). Out of the 414 children, 350 children filled out the questionnaire.

Serum Iron and Hemoglobin Level

Trained pediatric nurses collected approximately two tubes of 0.5 mL of venous blood from 329 children at fasting. One tube of blood was used to assess the serum iron and other trace elements in the Research Center for Environmental Medicine of Children at Shanghai Jiaotong University using inductively coupled plasma mass spectrometry. The other tube was used to measure blood hemoglobin concentrations by the 7–22 photoelectric colorimeter at the Jintan Maternal Child Health Center. The detailed analytical procedure was reported elsewhere (X. Ji & Liu, 2015; Zhao et al., 2009). Iron deficiency was defined as blood iron level below 7.5 μg/dL (Liu et al., 2014). Hemoglobin concentrations higher than 115 g/L were considered as non-anemic.

Child Behavior

Children ($n = 339$) self-reported their behaviors using the Chinese version of the 112-item Youth Self-Report (YSR, Achenbach & Rescorla, 2001) that is designed for adolescents aged 11–18 years. The YSR is a widely used tool for assessing adolescent behavioral problems including internalizing (i.e., anxiety, depression, somatic complaints and suicide) and externalizing behaviors (i.e., aggression, delinquency, and hyperactivity) over the last 6 months. Participants were asked to rate on a 3-point Likert scale, ranging from 0 (not true) to 2 (often true). The YSR has shown good psychometric properties among the youth in different countries (Ivanova et al., 2007; Leung et al., 2006; Verhulst et al., 2003). The Chinese version of the YSR is also reported to have satisfactory reliability and validly (Liu et al., 1997). In the preliminary analysis of the study, we calculated the normalized T scores from the raw scores of total behavior problems (combining both internalizing and externalizing problems). Higher T scores indicate more behavioral problems.

Covariates

Covariates included child sex, age, family location in preschool (i.e. urban, suburban, or rural), socioeconomic status (SES), hemoglobin concentrations and body mass index (BMI). SES was generated according to the procedure described elsewhere (Straus, 2004). It was the standardized z score of the sum of z scores of children's father's and mothers' years of education and monthly wage. Missing values of mothers' and fathers' years of education and monthly wages were replaced by the sample means of respective variables. BMI was calculated by using weight in kilograms divided by the square of height in meters.

Statistical Analysis

Sample characteristics were summarized by descriptive statistics. Bivariate analysis including *t*-tests, ANOVA, chi-square test and *Pearson* correlation were used to examine the differences in demographic characteristics and physical abuse between children with and without non-anemic iron deficiency, as well as bivariate associations with behavior problems. The generalized linear model (GLM) with *logit* link was used to analyze the relationship between non-anemic iron deficiency and physical abuse controlling for covariates. Then, two generalized