



## Height deficit in early adulthood following substantiated childhood maltreatment: A birth cohort study

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### ABSTRACT

Early life stress including childhood maltreatment has been associated with reduced head circumference and/or brain size, cognitive, and academic deficits in children and adolescents. However, little is known about the effect of childhood maltreatment on height, especially in early adulthood. This study was designed to examine the association between confirmed cases of multiple or subtypes of childhood maltreatment and stunted growth in young adulthood controlling for perinatal and familial confounding factors. A total of 2661 (48.4% female) young adults from the Mater Hospital–University Study of Pregnancy (MUSP) had data on standardised height-for-age score measurement as part of physical assessment at the 21-year follow-up. Prospectively substantiated cases of childhood maltreatment, 0–14 years of age, were linked to the MUSP dataset. Ethical approval was obtained from the Human Ethics Review Committee of The University of Queensland and the Mater Hospital. Multiple regression analyses were performed to determine the effects of childhood maltreatment on height in young adults. Childhood physical or emotional abuse and neglect were significantly associated with a deficit in height in young adulthood after controlling for perinatal and familial confounders. Multiple incidents of childhood maltreatment also were associated with a deficit in height.

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## 1. Introduction

Early life stress including childhood maltreatment has the potential to adversely affect long-term health and physical development, possibly through neurobiological and epigenetic mechanisms (Shonkoff et al., 2012). For instance, the number and type (Pears & Fisher, 2005) of childhood maltreatment (Brooks et al., 2014), particularly neglect (Font & Berger, 2015; Hildyard & Wolfe, 2002; Mehta et al., 2009; Mills et al., 2011; Oliván, 2003; Strathearn, Gray, O'Callaghan, & Wood, 2001), has been associated with a smaller head circumference (Oliván, 2003; Pears & Fisher, 2005; Strathearn et al., 2001) and reduced

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brain size (Brooks et al., 2014; Mehta et al., 2009), as well as cognitive and academic deficits (Brooks et al., 2014; Font & Berger, 2015; Hildyard & Wolfe, 2002; Strathearn et al., 2001). Environmental stress including psychosocial stress (Batty et al., 2009) such as family conflict, poor housing, low social class (Montgomery, Bartley, & Wilkinson, 1997), and being an orphan child (Finlay et al., 2016) may also affect physical growth (i.e., length or height) (Batty et al., 2009). However, little is known about the long-term effect of childhood maltreatment on height, especially into early adulthood.

In the short-term, childhood maltreatment including substantiated physical abuse or neglect has been associated with short height-for-age in early childhood (Wales, Herber, & Taitz, 1992). In the few longitudinal studies to date, foster care placement for neglect, emotional, and physical abuse was associated with height deficit in early childhood period (Oliván, 2003; Pears & Fisher, 2005; Taitz & King, 1988). It also appears that maltreated children attain lower levels of physical growth than their non-maltreated counterparts. However, these findings may have been limited by a short follow-up period that precluded “catch-up growth” (Iwaniec, 1997). As such, the findings may not reveal long-term growth deficits that persist into young adulthood or beyond. In a rare long-term study that extended its follow-up up to 45 years, childhood neglect at 7 years was associated with shorter height throughout childhood in both genders with modest but also significant deficits in adulthood (Denholm, Power, & Li, 2013). Shorter leg length accounted for the majority of the deficits in males. This study, however, reported no association between sexual abuse, physical abuse, or emotional abuse and shortened stature.

The relation between childhood maltreatment and physical and cognitive growth may be complicated. For instance, children with developmental delay have higher rates of childhood maltreatment (Skuse, Gill, Reilly, Wolke, & Lynch, 1995). In addition, some of the perinatal factors associated with lower child growth are also associated with childhood maltreatment (Skuse et al., 1995). These include gender at birth (Strathearn et al., 2001), low birth weight (Cole & Lanham, 2011; Strathearn et al., 2001), small for gestational age, “nonorganic failure to thrive” (Cole & Lanham, 2011), and cognitive delay (Strathearn et al., 2001). It is also possible that children who are small for gestational age or experienced growth restriction in utero may never reach the height of normal children, so contributing to the disparity in adult height. Also, “failure to thrive” can be the stated reason for hospital admission for childhood maltreatment (Cole & Lanham, 2011).

The interaction of gender and environmental stress, including childhood maltreatment, on long-term growth consequences is less studied. For instance, it has been suggested that males and females may experience differing patterns of exposure and response to prenatal or postnatal stresses, partly due to different responses to intervention, gender-selective treatment and “catch-up growth” (e.g., faster in females) (Stinson, 1985). However, few of the available studies consider gender while examining the association between childhood maltreatment and height deficit, especially in young adulthood. In terms of other relevant factors, breastfeeding protects against both childhood maltreatment (Strathearn, Mamun, Najman, & O’Callaghan, 2009; Walker et al., 2011) and growth deficit (Bhandari et al., 2003), possibly as a marker of greater commitment to the child. On the other hand, early cognitive deficit may lead to childhood maltreatment (Font & Berger, 2015) while institutionalization for childhood maltreatment is reported to be a risk factor for developmental delay (Walker et al., 2011). In keeping with these findings, children with a history of both childhood maltreatment and “failure to thrive” have more developmental problems including worse cognitive performance and school functioning (Kerr, Black, & Krishnakumar, 2000).

Parental factors are also relevant in the development of “nonorganic failure to thrive” (Emond, Drewett, Blair, & Emmett, 2007; Skuse et al., 1995), as well as cognitive (Strathearn et al., 2001), length (Skuse et al., 1995), height (Howe et al., 2012), or growth deficits in infancy (Skuse et al., 1995) and adulthood (Denholm et al., 2013). These include maternal or parental short stature (<160 cm) (Emond et al., 2007; Li, Manor, & Power, 2004), younger age (<20 years) (Skuse et al., 1995; Strathearn et al., 2001), lower education level, marital status (Strathearn et al., 2001), and prenatal smoking (Denholm et al., 2013). These children also have higher rates of agency-recorded childhood maltreatment (Skuse et al., 1995; Strathearn et al., 2001). This may imply that abuse and “failure to thrive” share common risk factors such as family impoverishment (Dubowitz, Zuckerman, Bithoney, & Newberger, 1989) and socioeconomic disadvantage (Li et al., 2004; Stith et al., 2009), which also have been associated with childhood maltreatment (Stith et al., 2009) and substantial deficits in height growth (Li et al., 2004).

One limitation of the existing literature is that any association between maltreatment and height deficits in childhood may reflect an acute or temporary growth failure that may not persist into adulthood. This study was therefore designed to examine the association between confirmed cases of multiple or subtypes of childhood maltreatment and reduced growth in young adulthood controlling for gender-childhood maltreatment interaction, perinatal, and familial confounding factors.

## 2. Methods

### 2.1. Data sources

Data for this study were taken from an Australian prospective birth cohort study—the Mater Hospital-University of Queensland Study of Pregnancy (MUSP). The MUSP recruited pregnant women visiting Brisbane’s Mater Hospital for prenatal care from 1981 to 1983. The cohort comprised a total of 7223 singleton mother-child pairs. Data were collected from mothers’ reports at 3–5 days postpartum and again when the child was 6 months and 5 years. Data were also collected from mothers and adolescents/young adults at 14 and 21 years (Najman et al., 2015). At the 21-year follow-up, 2661 (48.4% female) young adults provided data on their height measurement as part of physical assessment. Government agency substantiated cases of childhood maltreatment between the age of 0 and 14 years were linked to the MUSP dataset. The MUSP has been

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