



Child labour and health: a systematic review

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Abstract

Objectives This study aimed to synthesise the available knowledge, identify unexplored areas and discuss general limits of the published evidence. We focused on outcomes commonly hypothesised to be affected by child labour: nutritional status, harmful exposures and injuries.

Methods Four electronic databases (EMBASE, MEDLINE, Scopus, ISI Web of Science) were searched in November 2017. All articles published since 1996, without restrictions on language, were considered for inclusion.

Results Out of the 1090 abstracts initially identified by the search, 78 articles were selected for inclusion and reviewed. Most of the studies were conducted in Asia and South America, and only a third of them compared working children to a control group of non-working children. Child labour appears to be associated with poor nutritional status, diseases due to harmful exposures, and a higher prevalence of injuries.

Conclusions Despite evidence for a negative relation between child work and health, the cross-sectional design of most studies limits the causal interpretation of existing findings. More rigorous observational studies are needed to confirm and better quantify these associations.

Keywords Child labour · Child employment · Child welfare · Injury · Safety · Underweight · Harmful exposure

Introduction

The abolition of child labour is one of the four categories of rights adopted in 1998 by the International Labour Organization Declaration on Fundamental Principles and Rights at Work (Convention 2005; International Labour Office 2017). Although member states are committed to respect and promote these rights, even if they have not ratified the relevant conventions, hundreds of millions of children worldwide are still involved in various types of labour (Council 2016; Office 2011). In addition, ending child

labour in all its forms by 2025 is one of the targets of Sustainable Development Goal 8, to “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” (Boothe 2016).

Children are known to be especially vulnerable to both harmful workplace exposures (ergonomic, chemical exposure hazards) and injuries (Fassa et al. 2000). In addition, labour imposes physical and mental strain, which the working child is likely ill-equipped to handle—the increased caloric requirements for strenuous labour, for example, may cause malnourishment to a child. These stresses and the loss of developmental opportunities could adversely impact children into adulthood and over the life-course (Cigno and Rosati 2005). Finally, time spent working severely constrains learning and playing time (Nishijima et al. 2015; Shendell et al. 2016).

However, it may be argued that work also has some positive effects on the working child. Working children might learn adaptation strategies that increase their resilience, which can help them cope better with adverse situations (Blair 1992). The skills they acquire in the work place may also give them an advantage over non-working

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children in later life. Additionally, the income from a working child may improve his or her nutritional status and overall health and may confer health benefits to other family members as well (Genicot 2005). Finally, work and schooling are not mutually exclusive. Some policies allow certain types and quantities of work (Center 2017). Therefore, there is a lack of clarity in the overall relation between child labour and health.

Considering that child labour is more prevalent in developing countries (Council EaS 2016) and that an expected health dividend from the elimination of child work is one of the major drivers of international efforts to intervene at the policy level, there is the need for a clearer understanding of how child work relates to health. This review synthesises the available knowledge from the past two decades of research into the relationship between child labour and health in low- and middle-income countries (LMICs) and identifies unexplored areas and discusses general limits of published evidence. The selected health outcomes are injuries (work-related and otherwise), nutritional outcomes (anaemia, wasting and stunting) and conditions due to workplace toxic exposures (including exposure to loud noise, dust, extreme cold or heat, chemical, biological and radiation exposures). These outcomes are most commonly hypothesised to be the immediate (injuries and harmful exposures) and the long-term effects (nutritional status) of child labour (Parker 1997).

Methods

The study protocol was registered in PROSPERO and it is available at (http://www.crd.york.ac.uk/PROSPERO/display_record.asp?ID=CRD42016041317). We completed a systematic review following a registered protocol and PRISMA guidelines (appendix 1) (Moher et al. 2009). The search strategy was designed with the help of a professional librarian to favour sensitivity over specificity in an effort to be as comprehensive as possible (appendix 2). Four indexing and abstracting services (EMBASE, MEDLINE, Scopus, and ISI Web of Science) were searched in November 2017. All articles, without restrictions on language, were considered for inclusion. Manual searches for additional eligible studies were performed by reviewing the reference lists of included studies. Figure 1 summarises our literature search.

The population of interest for this review was all children under 18 years in LMICs, classified according to the World Bank Data Catalogue (WorldBank 2016).

The exposure was child labour, defined as paid or unpaid economic activity by children under 18 years of age either for family or outside the home (ILO 2011). The outcomes included were: injuries, nutritional outcomes

(e.g. anaemia, malnutrition, wasting, stunting, weight-for height) and harmful workplace exposures (e.g. chemical toxins, excessive heat/cold, physical risks such as working with heavy machinery without adequate protective measures). We included studies published since January 1996 that (1) described the incidence or prevalence of these outcomes among working children or (2) examined the association between child labour and these outcomes by including an unexposed control group. Studies were excluded if entirely qualitative, or if they only examined the prevalence of child work.

Data extraction

Two investigators (BLBK and OO) independently reviewed titles and abstracts and applied the inclusion and exclusion criteria to select studies for full-text review. Discrepancies were resolved by consensus between all research collaborators. The following information was extracted for each study included during the full-text review: reference, country of study, study design, description of study, year of study, sample size, age range, exposure (including nature of child work studied), outcome (including details of units of measurement), covariates adjusted for, effect measures for each outcome as reported (captured separately for each outcome of interest) and subgroup analyses. Study quality was assessed using the Newcastle–Ottawa Scale, which provides a quantitative measure of study quality based on study characteristics (Wells et al. 2011).

Results

A total of 1090 citations were initially identified by the search strategy. Among the 153 articles selected for full text review, 64 satisfied our inclusion criteria. An additional 14 articles were added after reviewing the references of included articles. In total, 78 articles were extracted (Fig. 1).

Most studies were conducted in Asia and South America, with a fifth coming from India alone. 74 studies were conducted in individual countries (Fig. 2) and four studies included more than one country. 38% of studies estimated the prevalence of at least one of the health outcomes (Amiri et al. 2014; Ansari et al. 2015; Ayelo et al. 2013; Baig et al. 2005; Banerjee et al. 2008; Baron 2005; Beegle et al. 2009; Caglayan et al. 2010; Chandrashree 2014; Dalal et al. 2016; Satpathy and Sahu 2005; El-Gilany et al. 2007; Elci et al. 2007; Gol 2016; Hawamdeh and Spencer 2001, 2003a, b; Javed et al. 2013; Kana et al. 2007, 2010; Miquilin Ide et al. 2015; Nicolella et al. 2008; Oviedo-Trespalacios et al. 2013; Pinzon-Rondon et al. 2009;

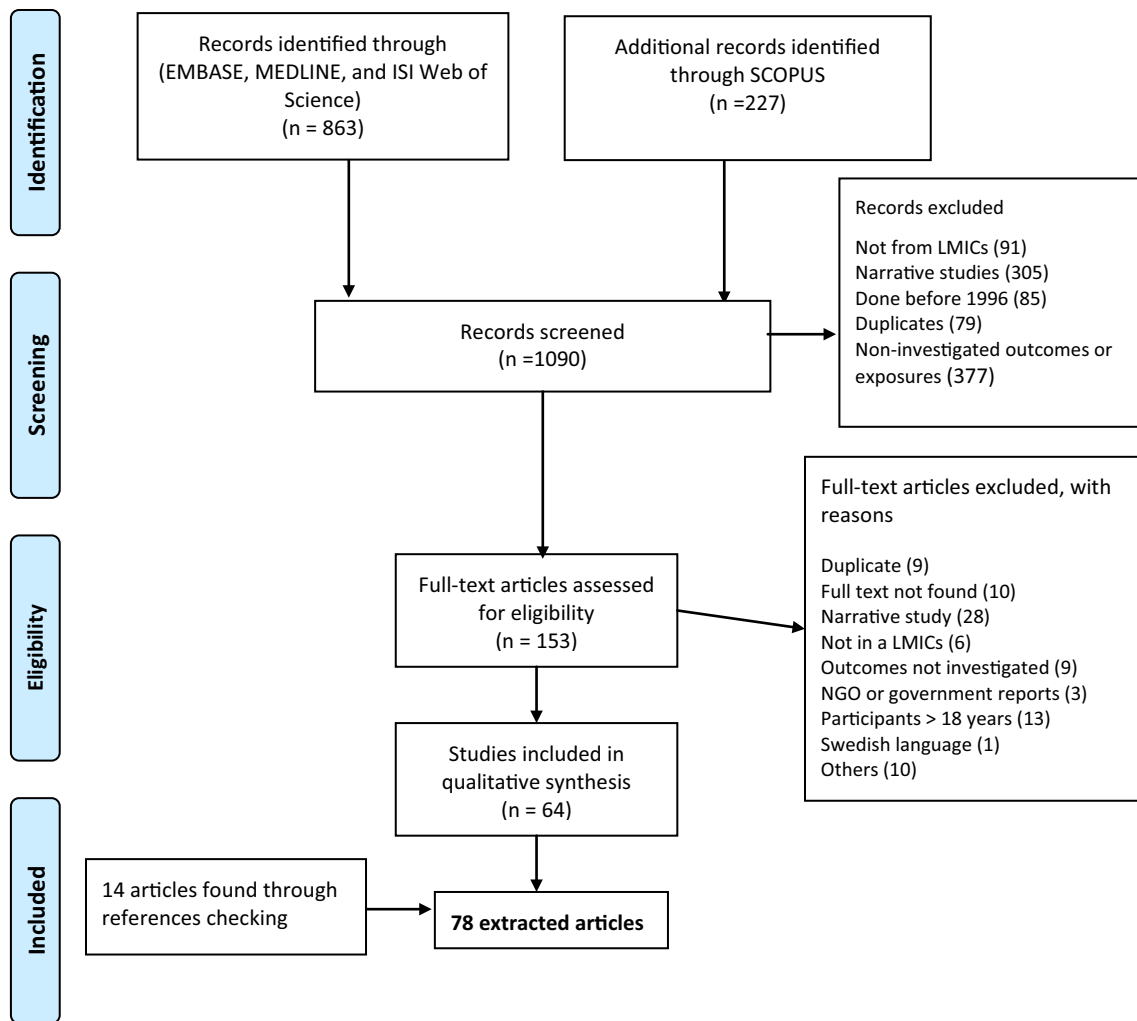
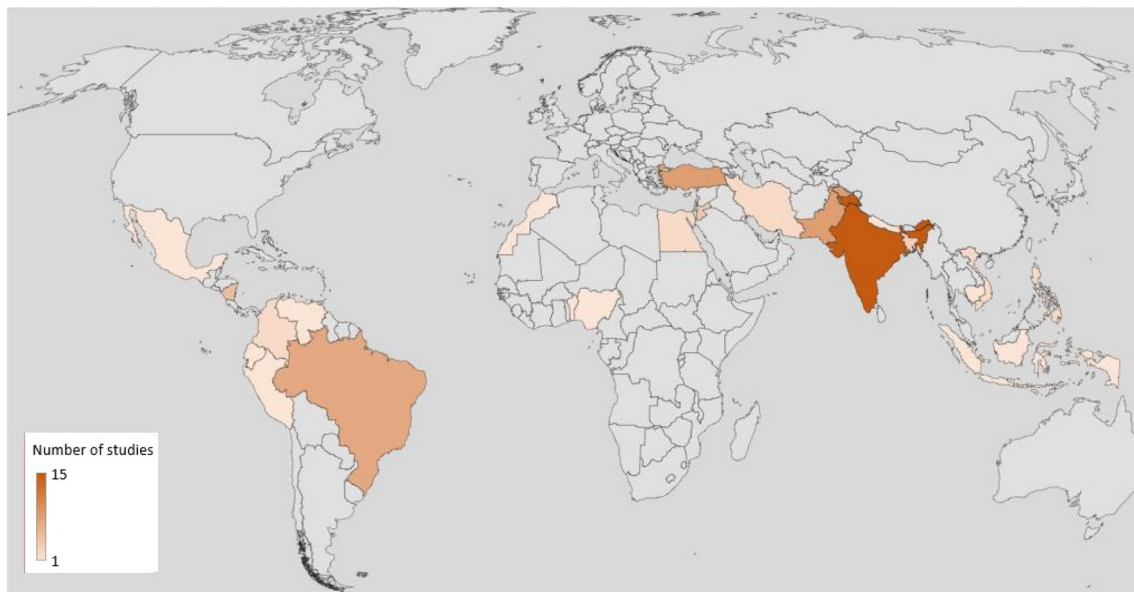


Fig. 1 Flow chart

Roggero et al. 2007; Saha and Sadhu 2014; Tiwari et al. 2004; Vasconcelos et al. 2010; Zainab and Kadir 2016; Zaki et al. 1998), 42% had at least one control group of non-working children and examined the association between child labour and health (Ahmed and Ray 2014; Ambadekar et al. 1999; Athanasiadou et al. 2008; Awan et al. 2010; Basema et al. 2003; Bose-O'Reilly et al. 2008; Cortez et al. 2007; Cuadra et al. 2006, 2007a, b, 2009; Daga 2000; Das et al. 2011, 2013; Doocy et al. 2007; Duyar and Ozener 2005; Etiler et al. 2011; Fassa et al. 2005; Furman and Laleli 2000; Graves et al. 2014; Hawamdeh and Spencer 2002; Hincapie 2007; Joshi et al. 1996; Junaid et al. 2017; Laraqui et al. 2000; Nuwayhid et al. 2005; Omokhodion and Omokhodion 2004; Saddik et al. 2005; Singhal et al. 2006; Sughis et al. 2012, 2014; Tiwari et al. 2009, 2013), and 20% compared outcomes across different types of work (Aktas and Esin 2016; Carmen et al. 2003; Castro et al. 2005; Castro and Hunting 2013; Dey 2008; Esin et al. 2005; Fischer et al. 2003; French 2010; Gargy et al. 2011; Harari et al. 1997; Jildeh

et al. 2014; Mohan et al. 2015; O'Donnell et al. 2005; Schlick et al. 2014). A roughly equal proportion of studies examined each of the health outcome categories: 26% for nutritional status (Ambadekar et al. 1999; Ansari et al. 2015; Banerjee et al. 2008; Beegle et al. 2009; Chandrashree 2014; Cortez et al. 2007; Daga 2000; Duyar and Ozener 2005; Etiler et al. 2011; Gross et al. 1996; Hawamdeh et al. 2001, 2002, 2003a, b; Hincapie 2007; Kana et al. 2010; Mohan et al. 2015; Nicoletta et al. 2008; O'Donnell et al. 2005; Roggero et al. 2007), 28% for injuries (Ahmed and Ray 2014; Amiri et al. 2014; Ayelo et al. 2013; Baron 2005; Carmen et al. 2003; Castro et al. 2005, 2013; Cuadra et al. 2007b; Dalal et al. 2016; Dey 2008; El-Gilany et al. 2007; Fassa et al. 2005; Fischer et al. 2003; Graves et al. 2014; Javed et al. 2013; Jildeh et al. 2014; Khan et al. 2007; Pinzon-Rondon et al. 2009; Saha and Sadhu 2014; Schlick et al. 2014; Tiwari et al. 2004; De Vasconcelos et al. 2010) and 30% for harmful exposures (Aktas and Esin 2016; Athanasiadou et al. 2008; Baig et al. 2005; Basema et al. 2003; Bose-O'Reilly et al. 2008;



*24 countries covered by studies conducted in a single country are represented.

Overall, the 78 studies included four cross-national studies. Among these studies, (Bose-O'Reilly et al. 2008), (Pinzon-Rondon et al. 2009), and (Gargy et al. 2011) covered 9 countries (with Afghanistan and Zimbabwe being the countries not represented in this map) and one study (Roggero et al. 2007) combined data from all developing countries.

15 studies were conducted solely in India. Turkey and Pakistan were the second most represented with 8 studies each.

Fig. 2 Location of included studies ($N = 74^*$)

Cuadra et al. 2006, 2007b, 2009; Das et al. 2011; Elci et al. 2007; Esin et al. 2005; French 2010; Furman and Laleli 2000; Gargy et al. 2011; Harari et al. 1997; Junaid et al. 2017; Oviedo-Trespalacios et al. 2013; Saddik et al. 2005; Singhal et al. 2006; Sughis et al. 2012, 2014; Tiwari et al. 2009, 2013; Zaki et al. 1998). The remaining studies (Awan et al. 2010; Caglayan et al. 2010; Das et al. 2013; Satpathy and Sahu 2005; Doocy et al. 2007; Gol 2016; Joshi et al. 1996; Laraqui et al. 2000; Miquilin Ide et al. 2015; Nuwayhid et al. 2005; Omokhodion and Omokhodion 2004; Zainab and Kadir 2016) examined more than one of the three outcome categories (Table 1).

Nutritional outcomes

Nutritional status was mostly assessed by height for age, weight for age, presence of anaemia and body mass index (BMI). Fourteen studies had a control group of non-working children (Ambadekar et al. 1999; Awan et al. 2010; Das et al. 2013; Doocy et al. 2007; Duyar and Ozener 2005; Etiler et al. 2011; Hawamdeh and Spencer 2002, 2003b; Hincapie 2007; Joshi et al. 1996; Laraqui et al. 2000; Miquilin Ide et al. 2015; Nicolella et al. 2008; O'Donnell et al. 2005; Omokhodion and Omokhodion 2004) and examined the relation between child work and nutrition. Only four studies had a longitudinal design

(Beegle et al. 2009; Laraqui et al. 2000; Nicolella et al. 2008; O'Donnell et al. 2005).

Generally, studies found associations between child labour and poorer nutritional status. On average, child workers had lower weight and height for age (Ambadekar et al. 1999; Chandrashree 2014; Cortez et al. 2007; Duyar and Ozener 2005; Gross et al. 1996; Hawamdeh and Spencer 2003a; Roggero et al. 2007), compared to non-working children or a reference population (commonly those of the United Kingdom or the National Center for Health Statistics in the United States). Packed cell volume was found to be below the threshold of anaemia (35%) in Jordanian working boys (Hawamdeh et al. 2001, 2003a), with working boys having lower values than their non-working siblings (Hawamdeh and Spencer 2002).

The relation between child work and nutrition may be non-linear; in a study from rural Cambodia, there was an inverse *U*-shaped association between the numbers of hours of labour and nutritional status (Kana et al. 2010). This suggests that health status improves if the working hours of children is shorter than the turning point, which was around 18 h/week. One study in rural Vietnam found that children engaged in paid work were heavier than their peers either working only for the household or not at all (O'Donnell et al. 2005). The association may also vary depending on the type of work; a study from Durg District in India showed that children engaged in sedentary work

Table 1 Study characteristics

Characteristics	N (%)
Type of study ^a	
Prevalence	30 (38)
Associational	33 (42)
Hybrid (compared different types of work or to a reference population)	15 (20)
Type of outcome	
Nutritional	20 (26)
Injury	22 (28)
Harmful exposure	24 (30)
Injury and harmful exposure	2 (3)
Injury and nutritional	8 (10)
Nutritional and harmful exposure	2 (3)
Studies with longitudinal design ^b	7 (9)

^aStudies only estimating the prevalence of at least one the health outcomes were classified as “prevalence”; those having a group of non-working children as control were classified as “associational”; finally, those comparing the association between child labour and health outcomes across different types of work were classified as “hybrid”

^bInclude 3 two-round surveys, 2 prospectives, and 2 retrospective cohort studies

were significantly taller than children engaged in heavy work (Mohan et al. 2015). Few studies reported a relation between child labour and BMI (appendix 3).

The cross-sectional design, small sample size and lack of covariates adjustment in half of the studies included were the major limitations to the interpretation of these findings.

Injuries

Almost all studies investigated nonfatal injuries. One-half of studies described the prevalence or incidence of injuries among working children (Amiri et al. 2014; Ayelo et al. 2013; Baron 2005; Caglayan et al. 2010; Dalal et al. 2016; Satpathy and Sahu 2005; El-Gilany et al. 2007; Javed et al. 2013; Khan et al. 2007; Miquilin Ide et al. 2015; Pinzon-Rondon et al. 2009; Saha and Sadhu 2014; Tiwari et al. 2004) and the other half compared injury rates among different types of working activities (Carmen et al. 2003; Castro et al. 2005, 2013; Dey 2008; Fischer et al. 2003; Jildeh et al. 2014; Schlick et al. 2014) or between working and non-working children (Ahmed and Ray 2014; Awan et al. 2010; Cuadra et al. 2007b; Das et al. 2013; Doocy et al. 2007; Fassa et al. 2005; Graves et al. 2014; Nuwayhid et al. 2005).

An elevated prevalence of diverse types of injuries including work accidents, fractures, burns, cuts, falls, sprains and musculoskeletal pain was observed among working children. Agricultural activities appear to be the most hazardous forms of child labour, with working children showing a prevalence of work-related injuries 4–5 times higher than those working in the non-agricultural

sector (Castro et al. 2005, 2013; Jildeh et al. 2014). Those working in manufacturing and domestic services had a higher prevalence of back pain (Fassa et al. 2005). A prospective study among child labourers in rural communities in Bangladesh (Dalal et al. 2016) showed that younger age (< 10 years) is associated with an increased incidence of injury-related illness. A retrospective study in Iran found that among construction workers, the accident rate among teenagers (15–19 years) was almost six times higher than that of young adults (20–24 years) (Amiri et al. 2014). Boys seem to sustain more severe injuries than girls (Ahmed and Ray 2014; Baron 2005; Fischer et al. 2003; Jildeh et al. 2014; De Vasconcelos et al. 2010). As with nutritional status, injuries seem to increase steadily with the number of hours worked after a certain threshold of around 19 h/week (Ahmed and Ray 2014; Amiri et al. 2014) (appendix 3). However, 26 of the 29 studies had a non-longitudinal design, limiting the interpretation of these results.

Harmful exposures

Many types of harmful exposures were explored: chemicals, including polybrominated diphenyl ethers (PBDEs), 2,5hexanedione, cosmetics and shampoo; environmental toxins (lipid hydroperoxide in serum); and organic and inorganic solvents.

Only five of the 28 studies with harmful exposures as outcomes (Baig et al. 2005; Elci et al. 2007; Gol 2016; Oviedo-Trespalacios et al. 2013; Zaki et al. 1998) did not have a comparison group. The working environment of most working children was considered below the

acceptable standards for proper arrangement of ventilation, light, garbage disposal, temperature, level of noise and minimal appropriate safety standards (Baig et al. 2005; Esin et al. 2005; Gol 2016; Oviedo-Trespalacios et al. 2013).

Five studies (four in Nicaragua and one in Bangladesh) investigated child labour in waste disposal sites (Athanasidou et al. 2008; Cuadra et al. 2006, 2007a, 2009; Gargy et al. 2011). Of those, two studies found that serum levels of PBDEs among working children (Athanasidou et al. 2008; Cuadra et al. 2007a) were 20–50 times the serum level of non-working children. These serum concentrations among children working and living at the waste disposal site were among the highest ever reported. Higher levels of several polychlorinated biphenyl congeners were observed among the children who lived and worked at a Managua-waste-disposal site (Cuadra et al. 2006). In addition, one study in the same site (Cuadra et al. 2009) found that children working at the waste disposal site showed higher blood levels of lead, mercury and cadmium, 28% having lead levels higher than 100 g/l, the level that the United States Centers for Disease Control (CDC) considers as actionable. Finally, a study in Dhaka, Bangladesh found that working in garbage dumping sites was also associated with DNA damage (Gargy et al. 2011). Compared to a non-working control group, working children had higher levels of protein carbonyl, a well-known marker of protein damage and a longer tail moment, a commonly used marker of DNA damage.

Children working in agricultural, construction and gem polishing sectors had a lower Peak Expiratory Flow (PEFR) compared to non-working children (Das et al. 2011, 2013; Joshi et al. 1996; Singhal et al. 2006). Child labour was also associated with lead and mercury toxicity (Harari et al. 1997; Nuwayhid et al. 2005; Zaki et al. 1998). Children working in automotive spray painting, mechanical repair, searching for gold-amalgam and furniture painting workshops who were exposed to solvents (e.g. mercury, lead) showed poorer performance in various tests (choice reaction time test, hand–eye coordination tests, symbol-digit test, spatial memory tests, matchbox test and the pencil tapping test) when compared to both working non-exposed children and non-working children (Basema et al. 2003; Bose-O'Reilly et al. 2008; Saddik et al. 2005). Exposed working children also complained significantly more about excessive salivation and a metallic taste in the mouth (appendix 3) (Bose-O'Reilly et al. 2008).

Discussion

This systematic review suggests that child labour in LMICs is negatively associated with some aspects of nutritional status, increased prevalence of injuries and harmful exposures.

Concerning harmful exposures, working children had high serum levels of many harmful elements, such as PBDEs, which are known to be associated with thyroid hormone disruption, memory impairment, impaired neurobehavioral development, iron deficiency and impaired hearing (Amler and Smith 2001; Calderón et al. 2001; Siddiqi et al. 2003). In addition, working children exposed to solvents (e.g. mercury, lead) showed poorer performance in various memory tests. However, an overview of the extent of hazardous lead exposure in child labourers published in 2005 concluded that the potential magnitude of the hazard of lead exposure in child labourers is unclear (Ide and Parker 2005). Concerning nutritional status, working in non-sedentary sectors (e.g. agricultural, construction) was associated with lower height and weight, but not with differential BMI. This might be the result of child labour affecting height and weight in the same direction and magnitude. A high prevalence of non-fatal injuries and musculoskeletal pain was found in working children. The latter can lead to perceived thermoregulation, hypervigilance and hypersensitivity (Clinch and Eccleston 2009).

Our findings build on a recent review by (Shendell et al. 2016). That review focused on lead and chemical exposure hazards, missed education and health of street children who are quite distinct from the general population of child workers. In addition, it only included references available in the English language and excluded many nutritional outcomes, which is a potential long-term consequence of child labour.

Our first observation on the state of the science is the poor methodological quality of most studies. For example, many papers reported odds ratios (OR) as measures of association, even if the outcome frequency was common, which exaggerates the relative risk (Rothman et al. 2008). Sampling was sometimes done in a non-representative fashion and almost all studies failed to report the proportion of missing data. In addition, only one-third of studies having at least one control (non-working children) group adjusted for potential confounders in their analyses. This lack of adjustment for potential confounding factors added to the possibility that frail children might be less likely to find work at baseline (i.e. reverse causality), might tend to underestimate the adverse effects of child labour observed, seriously limiting the causal interpretation of associations reported in these studies.

Second, there was no study conducted solely in China (China appears in one study including all developing countries) and only five in Africa were included. This regional imbalance was also present in the (Shendell et al. 2016) review. This imbalance needs to be explored, since no restriction on language was applied. Articles in Spanish, Portuguese, French, English and Turkish were included in our review. Therefore, it does appear that many regions are

severely understudied. One possible explanation for the paucity of reports from China might be that few Chinese journals are indexed in databases such as PUBMED, EMBASE and Scopus (Fan et al. 2008; Xia et al. 2008). Concerning Africa, one study has shown that Sub-Saharan Africa lags in scientific and technical publications due to lack of a congenial political and academic environment in some countries, shortage of trained personnel to pursue academic research due to heavy teaching loads and inadequate financial support (Atuahene 2011). However, our review covers 26 LMICs which is fairly comprehensive.

Third, there might also be a high likelihood of publication bias in this review. Only three studies reported non-significant associations between child labour and health outcomes among all studies having a non-working control group. Finally, other aspects of child labour were not captured in this review, particularly, children involved in illicit activities such as prostitution and drug trafficking, which may be considerably more hazardous.

With over 170 million children involved in child labour, the limited peer-reviewed work identified in LMICs is clearly an indication that more research with longitudinal quantitative measures on child labour and health outcomes is urgently needed. Current evidence comes mostly from cross-sectional studies, which are vulnerable to reverse causality and unmeasured confounding. We lack data from many parts of the developing world, particularly in China and Africa.

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Compliance with ethical standards

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

References

- Ahmed S, Ray R (2014) Health consequences of child labour in Bangladesh. *Demogr Res* 30:111–150
- Aktas E, Esin MN (2016) Skin disease symptoms and related risk factors among young workers in high-risk jobs. *Contact Dermat* 75:96–105
- Ambadekar NN, Wahab SN, Zodpey SP, Khandait DW (1999) Effect of child labour on growth of children. *Public Health* 113:303–306. [https://doi.org/10.1016/s0033-3506\(99\)00185-7](https://doi.org/10.1016/s0033-3506(99)00185-7)
- Amiri M, Ardeshir A, Zarandi MHF (2014) Risk-based analysis of construction accidents in Iran during 2007–2011-meta analyze study. *Iran J Public Health* 43:507–522
- Amler RW, Smith L (2001) Achievements in children’s environmental health. (US Department of Health and Human Services, Public Health Service), Agency for Toxic Substances and Disease Registry, Office of Children’s Health
- Ansari H, Moghaddam AA, Mohammadi M, Peyvand M, Gorgij A, Sanavi FS (2015) Health status and life situation of street children in zahedan southeast of Iran. *Health Scope* 4:e31077
- Athanasiadou M, Cuadra SN, Marsh G, Bergman A, Jakobsson K (2008) Polybrominated diphenyl ethers (PBDEs) and bioaccumulative hydroxylated PBDE metabolites in young humans from Managua. *Nicaragua Environ Health Perspect* 116:400–408. <https://doi.org/10.1289/ehp.10713>
- Atuahene F (2011) Re-thinking the missing mission of higher education: an anatomy of the research challenge of African universities. *J Asian African Studies* 46:321–341. <https://doi.org/10.1177/0021909611400017>
- Awan S, Nasrullah M, Cummings KJ (2010) Health hazards, injury problems, and workplace conditions of carpet-weaving children in three districts of Punjab. *Pak Int J Occup Environ Health* 16:115–121
- Ayelo AP, Aguemon B, Santos A, Gounongbe F, Fourn L, Fayomi B (2013) Health aspects of child labour in the crushing of granite in central Benin African Newsletter on. *Occup Health Saf* 23:21–23
- Baig LA, Shahida R, Mehwash Z (2005) Health and safety measures available for young labourers in the cottage industries of Karachi JCPSP. *J Coll Phys Surg Pak* 15:7–10
- Banerjee SR, Bharati P, Vasulu TS, Chakrabarty S, Banerjee P (2008) Whole time domestic child labor in metropolitan city of Kolkata. *Indian Pediatr* 45:579–582
- Baron SL (2005) Injuries in child laborers in the informal sector in Mexico City, Mexico, 1997. *Public Health Rep* 120:598–600
- Basema S, Iman N, Williamson A, Black D (2003) Evidence of neurotoxicity in working children in Lebanon. *NeuroToxicology* 24:733–739
- Beegle K, Dehejia R, Gatti R (2009) Why should we care about child labor? The education, labor market, and health consequences of child labor. *J Human Resour* 44:871–889
- Blair SL (1992) Children’s participation in household labor: child socialization versus the need for household labor. *J Youth Adolesc* 21:241–258
- Boothe P (2016) Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all Keeping Track: Measuring Progress Toward the UN Sustainable Development Goals:52. <http://bccic.ca/wp-content/uploads/2016/06/SDG-REPORT-v6.1-WEB.pdf#page=52>
- Bose-O’Reilly S, Lettmeier B, Gothe RM, Beinhoff C, Siebert U, Drasch G (2008) Mercury as a serious health hazard for children in gold mining areas. *Environ Res* 107:89–97. <https://doi.org/10.1016/j.envres.2008.01.009>
- Caglayan C, Hamzaoglu O, Yavuz CI, Yuksel S (2010) Working conditions and health status of child workers: cross-sectional study of the students at an apprenticeship school in Kocaeli. *Pediatr Int* 52:6–12. <https://doi.org/10.1111/j.1442-200X.2009.02881.x>
- Calderón J et al (2001) Exposure to arsenic and lead and neuropsychological development in Mexican children. *Environ Res* 85:69–76. <https://doi.org/10.1006/enrs.2000.4106>
- Carmen M, del M, Blanco V (2003) Trabajo y salud en niños, niñas y adolescentes trabajadores del sector agrícola. *Salud trab. (Maracay)* 11:5–20

- Castro CL, Hunting K (2013) Measuring hazardous work and identifying risk factors for non-fatal injuries among children working in Philippine agriculture. *Am J Ind Med* 56:709–719. <https://doi.org/10.1002/ajim.22185>
- Castro CL, Gormly S, Ritualo AR (2005) The SIMPOC Philippine survey of children 2001: a data source for analyzing occupational injuries to children. *Public Health Reports* 120:631–641
- Center TWPA (2017) Child labor. <https://www.worldpolicycenter.org/topics/child-labor/policies>. Accessed 17 April 2017
- Chandrasekhar L (2014) Nutritional and social constraints of child labourers: a study in Bhubaneswar. *Asian J Home Sci* 9:422–426
- Cigno A, Rosati FC (2005) *The economics of child labour*. Oxford University Press, Oxford (on Demand)
- Clinch J, Eccleston C (2009) Chronic musculoskeletal pain in children: assessment and management. *Rheumatology* 48:466–474. <https://doi.org/10.1093/rheumatology/kep001>
- Convention ILO (2005) C182–worst forms of child labour convention, 1999. *Public Health Rep* 120:591–593
- Cortez SAE, Barbieri MA, Saraiva M, Bettiol H, da Silva AA, Cardoso VC (2007) Does child labour affect final height? *Occupat Med Oxford* 57:118–125. <https://doi.org/10.1093/occmed/kql155>
- Council UES (2016) Progress towards the sustainable development goals. Report of the secretary general. 2016 Session, 3. http://www.un.org/ga/search/view_doc.asp?symbol=E/2016/75&referer=english/&Lang=E
- Cuadra SN, Linderholm L, Athanasiadou M, Jakobsson K (2006) Persistent organochlorine pollutants in children working at a waste-disposal site and in young females with high fish consumption in Managua, Nicaragua. *Ambio* 35:109–116. [https://doi.org/10.1579/0044-7447\(2006\)35\[109:popicw\]2.0.co;2](https://doi.org/10.1579/0044-7447(2006)35[109:popicw]2.0.co;2)
- Cuadra S, Athanasiadou M, Bergman A, Jakobsson K (2007a) Polybrominated diphenyl ethers in serum from children working at a waste disposal site in Nicaragua. *Epidemiology* 18:S183
- Cuadra S, Axmon A, Hernandez D, Jimenez M, Albin M, Jakobsson K (2007b) Work related injuries in children working at a waste disposal site in Nicaragua. *Epidemiology* 18:S186
- Cuadra S, Lundh T, Jakobsson K (2009) Exposure to heavy metals in children working at a waste disposal site, and in reference children from managua, Nicaragua. *Epidemiology* 20:S95
- Daga AS (2000) Relative risk and prevalence of illness related to child labor in a rural block. *Indian Pediatr* 37:1359–1360
- Dalal K, Rahman F, Gifford M, Rahman A (2016) The magnitude of injury problems among child labourers in a rural community of Bangladesh: findings from an injury surveillance system. *Int Health* 8:73–76
- Das B, Ghosh T, Gangopadhyay S (2011) Peak expiratory flow rate among child labourers in West Bengal. *India Indian Pediatr* 48:487–488
- Das B, Ghosh T, Gangopadhyay S (2013) Child work in agriculture in west bengal, India: assessment of musculoskeletal disorders and occupational health problems. *J Occup Health* 55:244–258
- De Vasconcelos RBA, Gurgel RQ, Santos JCV, Araujo RF, Dantas RAA (2010) Occupational injuries in children and adolescents in emergency services of Aracaju. *Brazil Child Care Health Dev* 36:369–374. <https://doi.org/10.1111/j.1365-2214.2010.01078.x>
- Dey I (2008) Working environment and morbidities of child laborers in an urban slum of kolkata. *Indian J Commun Med* 33:278–279
- Doocy S, Crawford B, Boudreaux C, Wall E (2007) The risks and impacts of portering on the well-being of children in Nepal. *J Trop Pediatr* 53:165–170
- Duyar I, Ozener B (2005) Growth and nutritional status of male adolescent laborers in Ankara, Turkey. *Am J Phys Anthropol* 128:693–698
- Elci O, Yener G, Ucku R (2007) Working conditions and related neuropsychiatric problems among shoemakers in Turkey: do child workers differ from others? *Indian J Occup Environ Med* 11:9–14
- El-Gilany AH, Khalil IAH, El-Wehady A (2007) Epidemiology and hazards of student labour in Mansoura, Egypt *Eastern Mediterranean health journal = La revue de sante de la Mediterranee orientale = al-Majallah al-sihhiyah li-sharq al-mutawassit*. *East Mediterr Health J* 13:347–363
- Esin MN, Bulduk S, Ince H (2005) Workrelated risks and health problems of working children in urban Istanbul, Turkey. *J Occup Health* 47:431–436
- Etiler N, Caglayan C, Cizmecioglu FM, Yavuz CI, Hatun S, Hamzaoglu O (2011) Effect of labour on child body: the comparison of two studies in Izmit Turk *Pediatric Arsivi-Turkish Archives Pediatr* 46:111–117. <https://doi.org/10.4274/tpa.46.56>
- Fan WY, Tong YY, Pan YL, Shang WL, Shen JY, Li W, Li LJ (2008) Traditional Chinese medical journals currently published in mainland China. *J Altern Complement Med (New York)* 14:595–609
- Fassa AG, Facchini LA, Dall’Agnol MM, Christiani DC (2000) Child labor and health: problems and perspectives. *Int J Occup Environ Health* 6:55–62
- Fassa AG, Facchini LA, Mor Dall’Agnol M, Christiani DC (2005) Child labor and musculoskeletal disorders: the pelotas (Brazil) epidemiological survey. *Public Health Rep* 120:665–674
- Fischer FM, Martins IS, Oliveira DC, Teixeira LR, do Rosario DLM, Cooper SP (2003) Occupational accidents among middle and high school students of the state of Sao Paulo. *Brazil Revista de Saude Publica* 37:351–356
- French JL (2010) Children’s Labor Market Involvement, household work, and welfare: a Brazilian case study. *J Bus Ethics* 92:63–78. <https://doi.org/10.1007/s10551-009-0140-y>
- Furman A, Laleli M (2000) Semi-occupational exposure to lead: a case study of child and adolescent street vendors in Istanbul. *Environ Res* 83:41–45
- Gargy L, Tania R, Hasan AKMM, Dutta AK, Arif M, Howlader ZH (2011) Assessment of impact on health of children working in the garbage dumping site in Dhaka, Bangladesh. *J Trop Pediatr* 57:472–475
- Genicot G (2005) Malnutrition and child labor. *Scand J Econ* 107:83–102
- Gol I (2016) Evaluation of working conditions and perceptions of health status and the importance of health in child and young workers in the industrial site. (Turkish) *TAF Prev Med Bulletin* 15:347–353
- Graves JM, Ali MV, Gunn SE (2014) Occupational injuries among child labourers: Preliminary results from a study of the brick manufacturing industry in four countries 24th International Conference on Epidemiology in Occupational Health, EPICOH 2014: Challenges for Occupational Epidemiology in the 21st Century Chicago, IL United States Conference Start: 20140624 Conference End: 20140627 71:A54
- Gross R, Landfried B, Herman S (1996) Height and weight as a reflection of the nutritional situation of school-aged children working and living in the streets of Jakarta. *Soc Sci Med* 43:453–458
- Harari R, Forastiere F, Axelson O (1997) Unacceptable “occupational” exposure to toxic agents among children in Ecuador. *Am J Ind Med* 32:185–189
- Hawamdeh H, Spencer N (2002) Growth of working boys in Jordan: a cross-sectional survey using non-working male siblings as comparisons child: care. *Health Dev* 28:47–49
- Hawamdeh H, Spencer N (2003a) Effect of work related variables on growth among working boys in Jordan. *J Epidemiol Commun Health* 57:154–158
- Hawamdeh H, Spencer N (2003b) The effects of work on the growth of Jordanian boys Child: care. *Health Dev* 29:167–172

- Hawamdeh H, Spencer N, Waterston T (2001) Work, family socioeconomic status, and growth among working boys in Jordan. *Arch Dis Child* 84:311–314
- Hincapie D (2007) Child labor and the nutritional status of Colombian children. *Desarrollo y Sociedad* 59:63–115
- Ide LS, Parker DL (2005) Hazardous child labor: lead and neurocognitive development. *Public Health Rep (Washington DC:1974)* 120:607–612
- ILO (2011) Definition: What is meant by child labour?. http://www.ilo.org/moscow/areas-of-work/child-labour/WCMS_249004/lang-en/index.htm. Accessed 06 April 2017
- International Labour Office ILO (2017) ILO Declaration on fundamental principles and rights at work. ILO. <http://www.ilo.org/declaration/lang-en/index.htm>. Accessed 17 Feb 2017
- Javed S, Shah N, Memon MY (2013) Occupational hazards, illness and injuries faced by child labourers JPMA The. *J Pak Med Assoc* 63:139–142
- Jildeh C, Abdeen Z, Al Sabbah H, Papandreou C, Ghannam I, Weller N, Philalithis A (2014) Labor and related injuries among schoolchildren in palestine: findings from the National Study of Palestinian Schoolchildren (HBSC-WBG2006). *ISRN Pediatr* 3:2014
- Joshi SK, Sharma P, Sharma U, Sitaraman S, Pathak SS (1996) Peak expiratory flow rate of carpet weaving children. *Indian Pediatr* 33:105–108
- Junaid M, Malik RN, Pei DS (2017) Health hazards of child labor in the leather products and surgical instrument manufacturing industries of Sialkot. *Pak Environ Pollution* 226:198–211
- Kana M, Phoumin H, Seiichi F (2010) Does child labour have a negative impact on child education and health? A Case Study in Rural Cambodia. *Oxford Dev Stud* 38:357–382. <https://doi.org/10.1080/13600818.2010.505682>
- Khan H, Hameed A, Afridi AK (2007) Study on child labour in automobile workshops of Peshawar. *Pak East Mediterr Health J* 13:1497–1502
- Laraqui CH, Caubet A, Laraqui O, Belamalle I, Harourate K, Curies JP, Verger C (2000) Child labour in the handicraft sector of Morocco: causes and repercussions on health. (French) *Sante Publique* 12:31–43
- Miquilin Ide O, Marin-Leon L, Luz VG, La-Rotta EI, Correa Filho HR (2015) Demographic, socioeconomic, and health profile of working and non-working Brazilian children and adolescents: an analysis of inequalities. *Cad Saude Publica* 31:1856–1870. <https://doi.org/10.1590/0102-311x00142214>
- Mohan SM, Bharadwaj SK, Omre PK (2015) Physical and intellectual development of children (9–12 years) in child labour schools in relation to nutrition and labour with special reference to Durg district. *Int J Trop Agric* 33:1869–1874
- Moher D, Liberati A, Tetzlaff J, Altman DG, Group P (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 6:e1000097
- Nicolella AC, Kassouf AL, Barros ALMd (2008) O impacto do trabalho infantil no setor agrícola sobre a saúde. *Revista de Economia e Sociologia Rural* 46:673–701
- Nishijima M, Souza AP, Sarti FM (2015) Trends in child labor and the impact on health in adulthood in Brazil from 1998 to 2008. *Cadernos de saude publica* 31:1071–1083
- Nuwayhid IA, Usta J, Makarem M, Khudr A, El-Zein A (2005) Health of children working in small urban industrial shops. *Occup Environ Med* 62:86–94
- O'Donnell O, Rosati FC, Van Doorslaer E (2005) Health effects of child work: evidence from rural Vietnam. *J Popul Econ* 18:437–467
- Office IL (2011) Children in hazardous work: what we know, what we need to do. International Labour Office, Geneva
- Omokhodion FO, Omokhodion SI (2004) Health status of working and non-working school children in Ibadan, Nigeria. *Ann Trop Paediatr* 24:175–178
- Oviedo-Trespalacios O, Manjarrés R, Maestre-Meyer M, Peñaabaena-Niebles R, Holgado D (2013) Study of hazardous work conditions prevalence in child labour: a survey of the colombian caribbean region. *Soc Sci Edu* 47:21–26
- Parker DL (1997) Child labor: the impact of economic exploitation on the health and welfare of children. *Minn Med* 80(10–13):52–55
- Pinzon-Rondon AM, Koblinsky SA, Hofferth SL, Pinzon-Florez CE, Briceno L (2009) Work-related injuries among child street-laborers in Latin America: prevalence and predictors, *Revista Panamericana de Salud Publica/Pan. AM J Public Health* 26:235–243
- Roggero P, Mangiaterra V, Bustreo F, Rosati F (2007) The health impact of child labor in developing countries: evidence from cross-country data. *Am J Public Health* 97:271–275. <https://doi.org/10.2105/ajph.2005.066829>
- Rothman KJ, Greenland S, Lash TL (2008) *Modern epidemiology*. Lippincott Williams & Wilkins, Philadelphia
- Saddik B, Williamson A, Nuwayhid I, Black D (2005) The effects of solvent exposure on memory and motor dexterity in working children. *Public Health Rep* 120:657–663
- Saha A, Sadhu HG (2014) Occupational injury proneness in young workers: a survey in stone quarries. *J Occup Health* 55:333–339
- Satpathy DM, Sahu T (2005) Socio-clinical profile of rabies cases in anti-rabies clinic, M.K.C.G Medical College, Berhampur, Orissa. *Indian J Public Health* 49:241–242
- Schlick C, Joachin M, Briceno L, Moraga D, Radon K (2014) Occupational injuries among children and adolescents in Cusco Province: a cross-sectional study. *BMC Public Health* 14:766
- Shendell DG, Noomnuai S, Chishti S, Sorensen Allacci M, Madrigano J (2016) Exposures resulting in safety and health concerns for child laborers in less developed countries. *J Environ Public Health* 12:2016
- Siddiqi MA, Laessig RH, Reed KD (2003) Polybrominated diphenyl ethers (PBDEs): new pollutants-old diseases. *Clin Med Res* 1:281–290
- Singhal S, Singhal A, Singh PN, Agarwal DK, Gulati R (2006) Peak expiratory flow rate of children working in lock factories. *Indian J Public Health* 50:47–48
- Sughis M, Nawrot TS, Haufroid V, Nemery B (2012) Adverse health effects of child labor: high exposure to chromium and oxidative dna damage in children manufacturing surgical instruments. *Environ Health Perspect* 120:1469–1474. <https://doi.org/10.1289/ehp.1104678>
- Sughis M, Nawrot TS, Riaz A, Ikram-Dar U, Mahmood A, Haufroid V, Nemery B (2014) Metal exposure in schoolchildren and working children. A urinary biomonitoring study from Lahore, Pakistan. *Int J Hyg Environ Health* 217:669–677
- Tiwari RR (2013) Eyestrain in working children of footwear making units of Agra. *India Indian Pediatr* 50:411–413
- Tiwari RR, Saha A, Parikh JR, Saiyed HN (2004) Injuries and injury care among child labourers in gem polishing industries in Jaipur. *India J Occup Health* 46:216–219
- Tiwari RR, Saha A, Parikh JR (2009) Respiratory morbidities among working children of gem polishing industries. *India Toxicol Indus Health* 25:81–84
- Wells G, Shea B, O'Connell D, Peterson J, Welch V, Losos M, Tugwell P (2011) The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. *Ottawa Hospital Research Institute, Ottawa*
- WorldBank (2016) Country Profiles. <http://data.worldbank.org/data-catalog/country-profiles>
- Xia J, Wright J, Adams CE (2008) Five large Chinese biomedical bibliographic databases: accessibility and coverage. *Health*

- Inform Lib J 25:55–61. <https://doi.org/10.1111/j.1471-1842.2007.00734.x>
- Zainab S, Kadir M (2016) Nutritional status and physical abuse among the children involved in domestic labour in Karachi Pakistan: a cross-sectional survey. JPMA J Pak Med Assoc 66:1243–1248
- Zaki A, El Shazly M, Abdel Fattah M, El Said K, Curtale F (1998) Lead toxicity among working children and adolescent in Alexandria, Egypt. East Mediterr Health J 4:520–529