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Injury Prevention: Falls

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Introduction

As children learn to explore and master their environment, stumbles, tumbles, trips and falls are typical and often “expected” consequences of learning to walk, run, jump and climb. Luckily, most falls result in only bumps and bruises. A considerable number of falls, however, result either in death or in short- or long-term disability. Because falls are the most common injury event, and because they frequently result in severe consequences, falls are an important part of the injury burden that should be explored.

Subject

As defined by the World Health Organization, a fall is “an event which results in a person coming to rest inadvertently on the ground, the floor or a lower level.”[1] Falls can occur on the same level as when a child trips or loses his balance, or from one level to another as when a child falls from a window, down the stairs, or off furniture. When these events result in medical care or are fatal, they are coded as fall injuries.

Several factors contribute to the extent of the injury from a fall. Higher distances are more likely to generate injury. The greater the energy-absorbing surface upon which the victim lands, the less

severe the injury is likely to be. Factors, such as gender, ethnicity and physical development, are important factors linked to injury.[1] Individual differences in anatomy, such as bone structure and fat composition, also affect injury severity and depend in part on the individual's age.[2,3]

Problems

The World Health Organization identifies falls as one of the leading causes of injury burden in the world for children ages 0-4 and acknowledges the inequalities that exist in childhood death and injury rates from falls.[4] Worldwide fall death rates vary by country income level and by child gender. For instance, girls living in the high-income countries within the Americas have the lowest fatal fall injury rate (0.1/100,000) while boys in the low- and middle-income countries of the Eastern Mediterranean have the highest (3.0/100,000).[5]

In the United States, since 2010, falls have remained out of the 'top ten' causes of injury death for children 0-4 years old, save 2015 when falls were the tenth leading cause of injury death for children 1-4 years.[6] In fact, fatal falls among children 0-4 years old dropped from 60 per 100,000 in 2007 to 25 per 100,000 in 2017.[7] It is not known if improvement in the fall fatality rate is due to injury prevention programs and policies or to advances in emergency medical services and medical treatment. Despite this good news, falls continue to be the most common source of nonfatal injuries treated in hospital emergency departments among children in age groups <1, 1-4 years and 5-9 years.[8] The pattern of pediatric injuries tends to track to children's changing developmental abilities and mobility, with younger children's fall injuries happening mostly in the home and older children's fall injuries happening as a result of recreation and sports activities. A recent review of consumer products contributing to children's fall injuries between 2010-2013 found that home furnishings (e.g., beds, sofas, tables and chairs) were associated with fall injuries in children 4 and younger while recreational equipment found outside the home (e.g., monkey bars, swings, trampolines) were commonly associated with fall injuries in children 5 and older.[9]

Internationally, the European Union has had some success in reducing overall injury mortality, but persistent inequalities are reported between low- and middle-income (LMIC) countries compared to high-income countries (HIC).[5,10] Falls, however, are one area where this is not the case.[10,11] Relative to HIC, LMIC falls mortality rates remain higher in both 2007 (0.27 to 1.44) and in 2011 (0.21 to 1.11). The rate ratio for falls deaths remained roughly the same during this time period (5.32 to 5.31, $p = 1$).[11]

Research Context

Most epidemiologic and intervention research has been conducted in HIC countries, although the burden is great in LMIC where the need for reliable and valid data is critical.[5] The research context is complex because there are so many varied circumstances under which children of different ages fall and sustain injury – from rolling off a changing table to falling from residential windows and playground equipment to falls from trees. Risk factors, and therefore the appropriate prevention options, vary greatly. There are few truly passive countermeasures (e.g., energy absorbing surfacing in playgrounds), although there are many effective strategies that require a limited degree of active engagement by adults – e.g., installing window guards and using stair gates. On the other hand, there are numerous supervision-related strategies for parents, such as never leaving a baby on a changing table and monitoring their natural climbing behaviours.

Many challenges exist to defining adequate supervision and demonstrating its effectiveness across the spectrum of ages and behaviours relevant to children's injuries, and supervision as a prevention strategy has received modest research attention. Morrongiello and colleagues[12] are among the few who study this area and have reported an equivocal relationship between parent supervision and child attributes. Supervision interacted with some child attributes to elevate children's risk of medically attended injury (not just falls) and with other attributes to decrease injury risk.[12]

At a broader level, contemporary public health has experienced an increased focus on social determinants of health. For instance, the US Department of Health and Human Services 2020 health objectives for the nation include safe and healthy housing metrics.[13] This raises the prominence of the role of housing and other aspects of the built environment – including those that contribute to fall risks -- within public health practice.[14] Another shift in contemporary public health practice has occurred in the field of environmental health, specifically the integration of injury prevention in the conceptualization of healthy and safe housing. The 2014 National Healthy Housing Standard[15] addresses many potential falls risk (e.g., condition of stairs, tripping hazards, presence of handrails, etc.) in the home. Together, these two separate but related trends in public health practice create a richer environment within which to study falls from a multidisciplinary perspective and may result in new, more robust interventions.[14] However, we found no such intervention research in the published literature.

Key Research Questions

- How can we most accurately describe the burden of fall-related injuries?
- How can we address the inequalities in fall related morbidity and mortality, both within and among countries and among different socioeconomic groups?
- How can we better understand parents' protective behaviours and the relationship between the use of safety devices and the potential for reduced supervision?
- How can the built environment be (re)designed with the needs and abilities of children in mind to minimize their falls risks?
- How can product regulation be strengthened to reduce child fall risks?
- What environmental and policy changes are necessary to reduce falls in children?
- What types of housing interventions serve to protect children from fall risks?

Recent Research Results

Improvements have been made in data collection efforts globally but the availability of accurate, timely falls data still vary greatly among countries. Surveillance reports have been published from the United States[16] as well as from other countries around the world.[17,18,19] While some cover multiple types of injuries, falls among children are consistently identified as major contributors to the overall burden of injury. Consistently, these findings document the higher rates of fall injuries in males compared to females.

Recent research reports continue to illuminate mechanisms of injury and to elucidate risk and protective factors at the individual level. The home continues to be identified as a significant location for pediatric fall injuries, with works describing falls related to stairs and steps, windows, furniture and beds.[9,14,16-22] Playground and play equipment, balconies and roofs have also been identified as fall risks.[18,19,23,24,25] Strides also have been made in better understanding caregivers' protective behaviours related to falls. For example, parents report being more permissive with risk taking (including during climbing, jumping and running activities) when the child is wearing safety gear or is perceived to be in a safer environment.[20,21,26]

Research that explores falls beyond individual factors is beginning to emerge. For instance, Husain and colleagues geographically mapped pediatric falls in one state to identify high incidence areas.[27] Still another group of researchers used a statewide hospital network to explore neighborhood level risk factors for pediatric falls. Veras and colleagues[28] created a neighborhood

risk index from eight socioeconomic census block group measures (education, crowding, vacancy, renter occupancy, poverty, family structure, race/ethnicity, and housing age) and explored the association with pediatric fall rates. Finally, Shields and colleagues[29] created and tested a housing assessment tool with injury-specific assessment items that were identified after a review of leading housing elements linked to pediatric injury. The tool, Child Housing Assessment for a Safe Environment (CHASE), in a retrospective case-control study, successfully revealed statistically significant scores in homes of cases (children coming to emergency department for an injury) relative to homes of controls (children coming to emergency department for an illness).[29]

Prevention recommendations exist but research suggests that they have not been fully adopted or endorsed. For instance, handrails on stairs are known to offer some protection from falls, yet a U.S. survey found that 43% of homes with young children and stairs did not have banisters or handrails.[26] Stair gates are recommended for homes with infants and toddlers, yet there use does not appear to be widespread, with only one-quarter to one-third of families observed to be using them.[30,31] Window locks or safety guards are recommended for homes with floors above ground level, yet a national survey found that 73% of households in which children live or visit did not have such devices installed.[26] Moreover, only two states (New Jersey and Minnesota) have legislation that protects children from falls from windows.[32]

A systematic review was done to identify successful interventions that attempted to modify the home environment specifically for fall risks.[33] The most common countermeasure tested was the provision of stair gates, but other practices included the use or possession of a baby walker, use of window locks or guards, and the use of non-slip mats or decals in the bathtub. The researchers reported that the provision of free or subsidized stair gates was effective in increasing their use, and that there was some evidence that the interventions were effective in reducing baby walker use. However, reductions in fall rates were not observed due to limitations with these studies, including small sample sizes and relatively short follow-up periods.

Another recent systematic review catalogued technology-based interventions, defined as any computer or mobile-based health behavior change program, on unintentional injuries for either children and adults.[34] Fire and burn interventions were the most common injury topic. While no study focused exclusively on pediatric fall prevention, three studies included it as one of their areas of focus.[35,36,37] The reviewed studies provide evidence that technology-based interventions are effective in educating about injury topics and promoting this use of certain safety products (e.g., using stair gates at the top and bottom of stairs) but none of the studies were powered to

evaluate their influence on fall rates. Despite this shortcoming, the authors of the review describe such technology approaches as having great promise.[34]

Research Gaps

The prevalence and incidence of fall-related injuries, risk factors, and prevention strategies from low- and middle-income countries is still in a nascent stage. Challenges persist related to accurate and complete reporting and therefore hamper the field's ability to consider the most effective prevention strategies.

Intervention trials focusing on preventing falls in children have been conducted primarily in HIC. Given the importance of the physical environment as a risk factor for falls, more research is needed to understand the unique risk factors and concomitant prevention strategies for LMIC. Similarly, additional work is needed to evaluate the impact of laws, regulations and policies on child safety, including falls. One U.S. study that focused only on child care settings found that many state regulations for safe playground equipment do not comply with published national health and safety standards.[38] Another study[39] conducted in China examined six common causes of pediatric injury mortality (including falls) and explored the existence of any laws, policies or regulations promoting the use of recommended safety practices. None were found to support any fall prevention recommendations.[39] Studies are needed to better understand how to ensure compliance with national standards and to determine the impact and appropriateness of such standards.

Conclusions

Despite the continuing issues of quality data, falls contribute significantly to the global burden of injury. In order to better direct limited resources, a more accurate and complete reporting of falls is needed. Effective strategies exist for primary prevention of certain types of falls, and these need to be more widely and effectively disseminated to both parents and providers to promote their widespread adoption. However, additional research is needed to identify the best combination of approaches (education, engineering, enforcement) to address the multiple injury risks related to falls across the childhood years. Translation research is needed to better identify and understand the key implementation issues related to success so that lessons learned in one country can strategically guide others. Digital technologies offer new ways to efficiently and effectively reach audiences.

Implications for Parents, Services and Policy

Effective fall prevention requires a coordinated and comprehensive approach that considers the changing developmental capabilities of children within the context of an environment built primarily for adults. Parents and caregivers of infants need to be educated about the fall risks of infants and young children and how to prevent them. Delivering such education, along with free or low-cost products through the health care system would ensure reaching a large proportion of the population, at least in high income countries. Pediatricians can provide effective anticipatory guidance as well as lend support to additional efforts both in the health care setting and in the community. Day care providers, school administrators, housing authority administrators and policy makers should be encouraged to comply with all relevant safety standards for creating safe environments for the children in their care.

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