Spring 4-10-2018

Unintentional Minor Injury in Children: The Role of Executive Function and Motor Ability

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UNINTENTIONAL MINOR INJURY IN CHILDREN: THE ROLE OF EXECUTIVE FUNCTION AND MOTOR ABILITY

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10 April 2018

Submitted in partial fulfillment of the requirements for graduation with Distinction

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Abstract

This study builds off of previous research developed by Bennett Murphy and colleagues (Bennet Murphy, Gilliland, & Griswold-Rhymer, 2001; Bennett Murphy, Murphy, & Laurie-Rose, 2001) by examining executive function (EF) in an attempt to isolate the aspects of attention that may contribute to unintentional injury. The aim of the present study was to explore whether a relationship exists between EF, motor ability, and unintentional injury in preschool aged children. This study consisted of 13 preschool children between the ages of 5 and 6 who were recruited from two Catholic preschools located in Ohio. All children took part in two different tests assessing EF and motor ability. Parents of the participating children completed a Retrospective Minor Injury survey, dealing with injuries their child experienced in the past, and a Daily Injury Log that documented how many injuries their child sustained every day. Data from the EF, motor ability, and injury surveys were analyzed to determine whether or not a relationship exists. Results showed no correlation between EF, motor ability, and unintentional injury. However, results give more insight to how much children are injured and what types of injury are most prevalent in preschool aged children.

Unintentional Minor Injury in Children: The Role of Executive Function and Motor Ability

Major and minor injuries affecting young children are a significant concern for many parents and caretakers. Unintentional injury, the main focus of the current study, can be explained as injuries that cause unexpected and accidental harm to a person, resulting in emotional and physical consequences. Unintentional injuries fall on a spectrum of minor (e.g., scraped knee) to fatal (e.g., accidental drowning). Unintentional injuries can be described as events that occur within a brief duration, that are unplanned and sudden, and are often but not always the result of an uncontrollable environmental event (The Maine Division of Disease Prevention, 2017). Researchers estimate that unintentional injuries are responsible for approximately 90% of annual deaths in children (Alonso-Fernández, Jiménez-García, Alonso-Fernández, Hernández-Barrera, & Palacios-Ceña, 2017). The CDC estimates that more children die per day from unintentional injuries than from all diseases combined (Borse, Gilchrist, Dellinger, Rudd, Ballesteros, & Sleet, 2008). More specifically, the CDC (2015) recently estimated that about 12,00 people under the age of 19 die each year as a result from sustaining an unintentional injury. Estimates of nearly half a million deaths for children worldwide occur as a result of unintentional injuries, and many more are affected by a lifetime of disability (Ruiz-Goikoetxea, Cortese, Aznarez-Sanado, Magallon, Luis, Zallo, Castro-Manglano, Soutullo, & Arrondo, 2017). Frequently occurring injuries that have caused death, or major debilitation for many young children and adolescents include car accidents, falls, fires, drowning, suffocation, and poisoning (CDC, 2015).

Minor injuries include those that a child will recover from with far less impact on daily life and future behaviors—but at least some of these injuries can require medical attention (e.g., stitches, broken bone). Although the child will recover, even minor injuries can cause serious emotional and physiological stress for a child and their family. For children, minor injuries can cause emergency room or doctor visits, days missed from school to heal, anxiety during the injury, and fear of getting hurt again. Minor unintentional injuries not only have a negative consequence for the child, but they may also impact parents greatly. Parents experience emotional distress, dealing with the many hospital/doctor visits, missed work, and medical bills. The CDC (2015) has estimated that over 9.2 million children are treated in emergency rooms for unintentional minor injuries. The cost of medical care for children who have experienced injuries adds up to about $350 billion every year (Morrongiello, McArthur, & Spence, 2016).

The most common causes of nonfatal unintentional injury in children include falls and being struck by or against an object (Borse, Gilchrist, Dellinger, Rudd, Ballesteros, & Sleet, 2008). Examples of minor injuries include sprains or strains in muscles, broken bones, bumps, scrapes, bruises, eye injuries, and burns or minor falls. The child, parent, and also the child's environment are all key factors that play a part in unintentional injuries (Nocera, Gjelsvik, Wing, & Amanullah, 2016). Although many factors influence unintentional injury, in the following sections I focus on two broad categories: 1) characteristics of the child, and 2) characteristics of the parent/family environment.

Characteristics of the Child

Researchers have studied factors contributing to unintentional injury including age, gender, temperament and personality traits, and physical capacity (Schwebel & Plumert, 1999). Researchers and health care workers argue that it is essential to know what cognitive and physical factors are associated with unintentional injury in an effort to understand the consequences of these injuries, and how and if they can be prevented in the future (Peterson, Saldana, & Heiblum, 1996). In this section, I will review some characteristics of the child that are associated with increased risk for unintentional injury.

Many researchers who study unintentional injuries in young children identify that age factors are studied a great deal, and most injuries are closely connected with childhood compared to adulthood (Ruiz-Goikoetxea, et al., 2017). Unintentional injury risk varies with age, and it is estimated that around 2.8 million children between the ages of five and under experience unintentional injuries in a year (Nocera et al., 2016). Within these five years, however, rates vary: they are significantly prevalent from birth to age two, continue to rise from ages two to four, and then decrease when the child enters school (Bennett Murphy, et al., 2001). The CDC (2015) specifies the type of minor injures sustained by children varies by age. For example, children under one have an increased injury risk for suffocation and falls. In fact, these injuries account for over half of the injuries in this age group. Burns and drowning injuries are a greater risk for children four years old and younger (CDC, 2015). Alonso-Fernández et al. (2017) demonstrated that home injuries are more frequent in young children—where they often spend more time, however older aged children were seen to experience more injuries outside the home and while engaging in sports related activities.

Boys and girls experience different rates of unintentional injury. The CDC (2015) also confirm that boys display higher injury rates than girls between the ages of one to nineteen, though for children under one year of age injury rates were no different. Several researchers argue that boys engage in specific behaviors and activities, mainly dealing with risk taking behavior, that increase their injury incidence rate (Alonso-Fernández et al., 2017; Morrongiello et al., 2016; Nocera et al, 2016). Alonso-Fernandez and associates (2017) reported in their study that boys, more than girls, experienced more unintentional injury because of their competitive nature and high interest in physical activity. With regard to gender differences in unintentional injury, Morrongiello et al. (2016) argue that activity preference is a major key in predicting injury, though despite this, it is still confirmed that from the age of two, boys still experience more injuries than girls. They attribute this difference to the type of activity—that boys engage in more injury risk behavior than girls (Morrongiello et al., 2016).

According to Nocera and colleagues (2016), in addition to age and gender, temperament/personality factors also predict risk of injury in children. As stated by Schwebel (2004), certain temperament factors such as aggression, hyperactivity, unplanned behavior, and self-control deficits are linked to an increased risk of unintentional injury in children. Children who are seen with these particular temperamental traits, such as high impulsivity and low inhibitory control, are more at risk for injury due to the overestimation of physical abilities (Schwebel, 2004). Researchers have also studied personality as it pertains to unintentional injury. For example, Berry and Schwebel (2009) examined the personality trait of extraversion. As presented by Schwebel, Brezausek, Ramey, and Ramey (2004), children who display extraversion qualities usually seek new, stimulating environments. These researchers demonstrate that this "sensation seeking" behavior can lead to an increase of injury if uncontrolled hazards and hyperactive behavior patterns are also present within that environment (Kuhn & Damashek, 2015).

Just as temperament behavior patterns predict injury risk, physical abilities also influence a child's risk for injury. Morrongiello and Cox (2016) argue there is a difference in injury risk at the pre-mobile stage and at the mobile stage. At the pre-mobile stage injuries can occur when children place objects in their mouths. At the mobile stage, injuries are more likely due to falling. As children enter the mobile stage, they are more likely to engage in new physical activities, possibly resulting in a risk for injury. As new motor behaviors emerge, children have yet to develop motor coordination and are therefore at risk for more injuries. Martin-Diener, Wanner, Kriemler, and Martin (2013) argue that lower levels of fitness along with high levels of motor skills are closely linked with unintentional injuries. Howard and Melhuish (2017) claim that sensorimotor abilities and the formation of cognitive ability emerge together and are the foundation of early child development. Research has shown that motor coordination has been linked to executive functions (Howard & Melhuish, 2017), or cognitive ability, in which they are interrelated with development of physical activity and perhaps, injury proneness (Schmidt, Egger, Benzing, Jäger, Conzelmann, Roebers, & Pesce, 2017).

Developmental deficits can make children more prone to unintentional injuries (Ruiz-Goikoetxea et al., 2017). One area of extensive research is Attention Deficit and Hyperactivity

Disorder (ADHD). ADHD is characterized by the inability to control attention, act without thinking, and serious displays of hyperactivity (Fliers, Rommelse, Vermeulen, Altink, Buschgens, Faraone, & Buitelaar, 2008). This disorder is widely known as a neurodevelopment disorder in which deficits in performance and functioning is shown (Fliers et al., 2008). In previous studies, it has been found that ADHD is related to an increased incidence rate in unintentional injuries in children (Ayaz, Ayaz, Şentürk, Soylu, Yüksel, & Yulaf, 2016; Helseth, Bruce, & Waschbusch, 2016). For example, Ayaz et al. (2016) concluded that the main symptoms of ADHD are highly associated with risk of unintentional injury. It was also reported that children diagnosed with ADHD who also displayed symptoms of disruptive behavioral problems were injured more often than their typically developing counterparts (Ayaz et al., 2016). Children with ADHD show cognitive deficits associated with executive functioning (EF) such as working memory, perception, and inattention that effect normal development and injury risk that would otherwise not be present in typically developing children (Helseth et al., 2016). Not only do some children with ADHD have co-morbid diagnoses with cognitive abilities deficits, there also exists high co-morbidity with motor coordination deficits (Fliers et al., 2008). Helseth et al. (2016) hypothesize that children with ADHD overestimate their own abilities, specifically their physical abilities, which may be a reason that children with ADHD are at a heightened risk for unintentional injury and underestimate activities beyond what they are capable. Howard and Melhuish (2017) identify that self-regulation is a core aspect to certain cognitive capacities which children diagnosed with ADHD tend to lack, otherwise arguing an explanation for a higher risk of injury.

Characteristics of the Family

There have been many studies that focus on the emotional toll unintentional injuries causes parents, how parents cope, and how parents have taken precautions to make sure that their child stays safe. Family breakdown and even the loss of employment can result from caring for an injured child (Kendrick, Hayes, Ward, & Mytton, 2012). One major goal of studying childhood injuries is to identify family related risk factors (Rivara & Mueller, 1987). For example, some researchers focus on how parents implement safe play areas for their children, and the best strategies that parents display to prevent their children from injury risk. Parents must make important decisions to keep their children safe from minor injuries and must also make an effort to practice effective safety behaviors. Kuhn and Damashek (2015) looked at the interplay between child and parent behavior in conjunction with the environmental circumstances and how that affects a toddler's risk for unintentional injury. As a guide, they used the Haddon's matrix of injury occurrences (Haddon, 1968). Haddon's matrix explains that there are four main factors that contribute to the event of a minor injury. These four factors include characteristics of the child, what caused the injury, the environment in which the event occurred, and whether or not a parent was present. Past research on parental supervision has concluded that having a caretaker present protects most children from experiencing an unintentional injury (Morrongiello & Cox, 2016; Morrongiello et al., 2016). Researchers hypothesized that a child would be more prone to injury based on the child's behavior and if they were in an unusual environment. They also hypothesized that parental supervision would be less protective in unusual behavioral and environmental circumstances. From conducing surveys, Kuhn (2015) and colleagues found that children were two to three times more likely to experience a minor injury if they were demonstrating unusual behavior or were playing in a new environment. It was also noted that parental supervision was much more protective when child was in a new place or was exhibiting out of the ordinary behaviors. These findings support evidence that children with patterns of undisciplined behavior may be more prone to unintentional injury and that parental supervision can redirect injury risk.

Parental supervision, as previously discussed, and discipline are two huge significant factors in the study of unintentional injuries in children. Background research in this topic refers mainly to the fact that protective parental supervision decreases the likelihood of a child experiencing a minor injury. Past research has also shown that parents take on many different actions to make sure their children stay free of injury. For example, Morrongiello and Cox (2016) states that many parents will stay close to their child and constantly watch over them, teach their children correct safety when playing, and also make modifications to their home and environment to make a safe play area.

Stress experienced by parents determines how well the parent copes with caring for their children and their injuries. Nocera and researchers (2016) hypothesized that children were more likely to be at risk of an injury if the parent was not able to effectively cope with the stressors of parenting demands. They found that self-reported stress of parents was associated with severity of their child's injury and the recovery process. For example, parents who reported not coping well with parenting demands had children who had experienced an injury in the duration of this study, and children with parents who reported coping very well experienced a decreased amount of injuries.

Other parental characteristics that are explored in past research and are associated with differences in a child's risk for unintentional injury include age of parent, mother's prenatal characteristics, substance use of mother during pregnancy, and behavior patterns. Bennett Murphy et al. (2001) found that children of adolescent mothers have an increased risk of developmental deficits dealing with behavioral, emotional, and cognitive outcomes, heightening the risk for unintentional injury. Researchers have also argued that adolescent mothers, being new to parenting, display many behavioral and emotional deficits which can also lead to more unintentional injuries in their children. However, gaining more parenting experience and interaction with the child allows the young mother to become more aware of harmful situations, reducing the frequency of injuries (Bennett Murphy et al., 2001). Junger, Japel, Coté, Xu, Boivin, and Tremblay (2013) report that mothers who smoke during pregnancy and who use medications with or without prescription during the child's prenatal stage put their children at higher risk for repeated unintentional injuries.

With regard to characteristics of the mother, it has been argued that mothers who have displayed antisocial behavior, are young at the time of birth, or have been depressed at some time in their lives, are predictors of unintentional injury risk in their children (Junger et al., 2013). In the same way, children of mothers with previous diagnosis of psychopathy are at a higher risk for injury (Serbin, Peters, & Schwartzman, 1996). This past research has shown that certain behaviors displayed by mothers can have immediate or long term effects on their children and the risk for unintentional minor injuries.

The Present Study

Research has indicated that there are many factors that affect a child's risk for minor unintentional injuries. In the above section, I have reviewed factors due to individual differences of the child, and factors attributed to the family environment that influence minor injuries. Although studies have pointed to atypical development as a factor in unintentional injury, it is reasonable to question whether variations in children along the typical spectrum may lead to differences in injury rates. Bennett-Murphy et al. (2001) questioned whether variations in attention may be related to injury rates. These researchers studied visual sustained attention and unintentional injury in the daily environment of preschool-aged children. Pontifex, Scudder, Drollette, and Hillman (2012) define sustained attention as the ability to maintain attentional focus to a certain task or stimuli over time. Children were asked to continuously monitor a computer screen in which a variety of animals flashed briefly on the screen. The attention task asked children to press a spacebar to "catch the bird" whenever it appeared. Children were asked to refrain from response, however, when any other animals appeared on the screen. In addition to the children performing the sustained attention tasks, caretakers completed the Minor Injury Severity Scale (MISS) questionnaire for 30 days. The MISS was developed to measure the amount of tissue damage that was experienced from a given injury (Peterson et al., 1996). Researchers had parents report any minor injuries which were separated into categories of different types of injuries, and were assessed on a 7-point scale, in which a report of 0 meant no injury and a report of 7 meant death (Bennett Murphy et al., 2001). For example, when coding injuries, researchers looked for observations in an injury such as swelling, tenderness, depth of laceration, and discoloration. Children with a greater incidence of unintentional injury missed more target stimuli as compared to those with a lower rate of unintentional injury, suggesting that children who are less aware of stimuli in the environment are at a higher risk for injury. Children who were more hesitant to respond, as indicated by the signal detection index response bias, also had higher incidence of injury. The authors argue that this hesitancy to respond may reflect a lack of response to environmental signs, and may stop children from acting to stay clear of injury (Bennett-Murphy et al., 2001). This study offered a first step in assessing attention and unintentional injury which can help us to better understand lack of attention in and risk for injury in our current study.

A next step in this line of research is to examine executive function (EF). EF is mainly defined by its aspects of cognitive control (Howard & Melhuish, 2017). Components of EF include working memory, shifting of attention, and suppressing distraction within visual tasks relating to space and sounds (Howard & Melhuish, 2017).

Executive function (EF) can be defined as a predictor of a child's development (Howard & Melhuish, 2017). Schmidt et al. (2017) defines executive functioning as interrelated cognitive processes that are in charge of a child's goal-directed behavior. For example, Howard and Melhuish (2017) touch on the importance of testing executive functions (EF) in young children, given that these functions often give insight to whether or not a child is ready for the school environment, and also predict social and emotional development.

Recent work also suggests a relationship between EF and motor abilities. Motor abilities are characterized by coordination, flexibility, speed, strength, and physical stamina (Schmidt et al., 2017). They hypothesized that EF is closely related to motor abilities. They aimed to present whether or not EF is associated with motor ability and academic achievement in young children. Research built on past studies proposed that children who are better developed in their motor and cognitive abilities show a higher level of academic achievement (Schmidt et al., 2017) . EF is necessary for school readiness in which the faucets of EF (working memory, inhibition, shifting) must be developed to perform complex questions or actions that are needed in the school environment. Children are challenged with cognitive and physical demands, hence it was found that both motor abilities and EF are required for academic achievement. The relationship between EF, motor abilities, and academic achievement is highly linked to non-automatic movements and sports in young children stating that these actions are associated with the same brain regions that are needed for cognitive processing and enhancing cognitive abilities (Schmidt et al., 2017). This research also builds on the studies of Pontifex et al. (2012) who proposed that children with greater fine and gross motor sills, showed a higher performance on an EF tasks, and children with low fitness levels scored more poorly on a test of cognitive abilities (Pontifex et al., 2012). Similarly, Chaddock, Hillman, Pontifex, Johnson, Raine, and Kramer (2012) noted that higher physical capabilities predicted better EF performance. Researchers speculate that tasks requiring more EF tap the same region of the brain as those tasks requiring fine motor control and coordination (Moreau, Morrison, & Conway, 2015; Tomporowski, McCullick, Pendleton, & Pesce, 2015). Regular motor skill learning is important in enhancing cognitive abilities and EF (Moreau et al., 2015).

Understanding the cognitive and physical factors associated with unintentional injury is essential to determining if and how such injuries can be prevented in the future (Peterson et al., 1996). The proposed study extends the findings of Bennett-Murphy et al. (2001) by examining EF in an attempt to isolate what aspects of attention contribute to unintentional injury. In light of the relationship between EF and motor abilities, we will also ascertain whether a relationship exists between EF, motor abilities and unintentional injury. Identifying risk factors associated with unintentional injury may ultimately help us to prevent such injuries down the line.

Toward that end, I will take assessments of EF and motor abilities in group of pre-K children. A valid and reliable toolbox to measure EF's in children was developed, called the Early Years Toolbox (EYT). The EYT uses easy to operate iPad games, simple enough for children, and tests the different facets of EF and cognitive brain functions. I will use the Test of Gross Motor Development (TGMD-2) to test two realms of gross motor development skills: (1) locomotor and (2) object control. Retrospective and daily injury data will be collected from surveys parents of the children volunteered to take.

I predict that results from the EF and TGMD-2 assessments will be closely related with unintentional minor injury in preschool aged children. It is hypothesized that low scores reported from both the EF and TGMD-2 will be associated with a higher probability of minor unintentional injury, while high scores on the EF and TGMD-2 show a lower rate of injury in the children in our study.

Method

Participants

The participants in this study consisted of both parents and children who were recruited from two different Catholic pre-schools located in Columbus, Ohio. A total of 16 parents gave consent to allow their child to participate in motor and cognitive assessments and also volunteered to answer sets of questions dealing with unintentional minor injuries in their children. Participants, after eliminating some data, included 4 male children, and 9 female children. Children ranged in age from 5 to 6 years (M = 5.15, SD = 0.38). Ethnicity and religion were not recorded. An incentive of a $20.00 Target gift card was given to parents who completed the unintentional injury surveys.

Materials

To administer the cognitive assessment test, an Apple iPad was used. The games used were previously downloaded for easy access. The TGMD-2, previously developed by Ulrich (2000), was used by researchers to assess motor ability in children participants by observation of skills. For measuring unintentional minor injuries in children, two online surveys were developed and administered through the online survey system Qualtrics.

Measures

Early Year Toolbox

Executive function was assessed via an iPad app designed to measure executive function (EF) called the Early Years Toolbox (EYT; Howard & Melhuish, 2017). Task developers assert that the EYT is valid and reliable for use in young children populations. The EYT measures various facets of EF using visually pleasing iPad games made specifically for young children.

Mr. Ant. This game was used to measure visual-spatial working memory. It required children to remember the location of colored dots placed on a cartoon image of an ant, then the dots and ant would briefly disappear. Children were to respond by tapping the screen where they previously saw the dots on the ant when the ant reappeared. Scores from the Mr. Ant game were assessed on a point scale, in which children scored 1 point for passing each level, and 1/3 of a point for passing trials after reaching the next level. See Figure 1a for a visual depiction of the task.

This Not That. This game measures phonological working memory and requires children to remember auditory direction about a given shape on the iPad screen. Questions focus on finding a shape that is, or is not, a certain color, shape, or size. It was scored in the same way as the Mr. Ant game, in which 1 point was awarded for passing a level, and 1/3 of a point for the following levels. See Figure 1b for a visual depiction of the task.

Go/No Go. This game was designed to test inhibition measure in children. Participants were asked to tap the iPad screen ("Go" or "catch the fish") when a fish swam across the screen, and to avoid tapping the screen when a shark was present ("No Go" or "avoid catching sharks"). An impulse control score was then calculated (% Go accuracy x % No Go accuracy). See Figure 1c for a visual depiction of the task.

Motor Assessment

The Test of Gross Motor Development (TGMD-2) was used specifically to measure gross motor skills. The test assessed 12 different facets of gross motor skills categorized into two main components: (1) locomotor and (2) object control. For each component there were 6 skills that were assessed. Scoring was based on a successful completion of each gross motor skill task (1 being successful completion of task, 0 being a failed attempt). Children were not penalized for refusing to participate in a task. See Table 5 and 6 for a description of each task.

Unintentional Injury Assessment

To measure injuries in children, we modified the MISS questionnaire to allow for parents to report past injuries. To gather information relevant to unintentional injuries in children, parents were required to complete two different surveys—a Retrospective survey, and a Daily survey via Qualtrics. See Table 4 for questions on each survey.

Procedure

Researchers administered the EYT iPad games to all participating children at their preschool. A total of 3 iPad games were used to test executive function measures in the children: Mr. Ant, Not This, and Go/No Go. Games were presented in counterbalanced order, and took about 5 minutes to administer, equaling about 15-20 minutes per child.

In a different session, the TGMD-2 was used to measure gross motor skills in children. Researchers and assistants administered the test to children in the school setting and in small groups so observations of motor skills were more recognizable. Each of the children who were participating completed all measures of the motor test. Within the locomotor category of motor ability, children were asked to complete tasks dealing with running, galloping, hopping, leaping, sliding, and jumping. In the object control portion, tasks required children to hit, dribble, catch, kick, throw, and roll a ball. Researchers explained each task to the participants prior to starting, and children were given a demonstration of what was expected. Children were required to be dressed appropriately to best complete the motor tests that were given. This portion of the study took around 15-20 minutes for participants to complete.

Parents of the 16 children were asked to complete a one-time Retrospective Minor Injury survey which was administered online via Qualtrics. This survey asked parents to recall any injuries that their child sustained in the past, or more specifically since beginning of the child's walking stages (for example, a broken arm, stitches, bicycle injury, etc.). Parents answered questions asking what specific type of injury the child experienced (see Table 4), and for each injury it was measured what age it occurred, seriousness of injury, treatment, length of disability, pain indication, amount of anxiety, and the amount of fear. A total of 18 injuries were assessed. The allotted time for this survey was approximately 20 minutes. Once we received the survey regarding past minor injuries, the completion of a Daily Minor Injury Log was sent to parents to complete for a total of 21 days. The daily log was a modification of the Minor Injury Severity Scale (MISS). The daily survey was sent out every night to parents via email around 7:00pm, and took less than 5 minutes to complete. Parents could complete the survey on their computer, phone, or any web enabled device. Parents were required to complete the survey every day and indicate what type of injury their child experienced that day. If the child experienced no injuries that day, parents just had to respond with "No injuries experienced". Measures pertaining to the injury were the same as the Retrospective survey.

Results

Three variables measuring executive function, corresponding to the three EF tasks from the EYT app, gross motor skills as measured by the TGMD2, retrospective and daily injury report data were included in the final analysis. According to the Daily Minor Injury Survey, within a duration of 21 days the 13 children in our study experienced a total of 52 injuries (*M*=4.00, SD=1.92), with a range from 0 to 7 injuries reported per child. Injuries that were experienced by children most often include: bumps, bruises, and scrapes (*f*=25), fall excluding stairs (*f*=8), and sports related injuries (*f*=5). Other daily injuries that were common among children were tripping, falling, crushed body part, eye injury, toy/tool injuries, and injuries involving skates, skateboards, or scooters (see Table 1). The injury ratio between number of injuries experienced by the child and number of total responses to the survey from parents were also calculated (see Table 2).

The Retrospective Minor Injury Survey reported children experiencing an overall total of 46 injuries, ranging from 2 to 7 injuries per child, within the entire sample (*M*=3.54, *SD*=2.07). Parents reported that their children, from birth to age now, experienced falling down the stairs most often (*f*=12), while falls excluding stairs (*f*=9) and burns, bruises, and scrapes (*f*=6) followed close behind (see Table 3).

In order to examine relationships between executive function, motor ability, and unintentional injury, Pearson's correlations were calculated for each variable pair (see Table 7). Results of this study show no significant correlations between executive function variables, motor ability, and unintentional injury. However, the relationship trend between the locomotor ability test and the EF game, Go/No Go, is potentially interesting ($r = 0.483$, $p = 0.095$), but the small sample size ($N = 13$) did not allow sufficient power to detect relationships in this study.

Discussion

The goal of this study was to determine if there is an association between EF and attention, while also looking at potential aspects that contribute to unintentional injury in preschool aged children. An objective of this study was also to highlight a relation between EF and motor abilities. I attempted to establish whether a relationship exists between all measures of EF, motor ability and unintentional injury. I hypothesized that scores on the EF and motor ability assessment would predict injury risk in the preschool children who participated in our study. Both of my hypothesis were not supported by the findings and limited conclusions can be made from the data collected.

The results, however, do give researchers a better understanding of the injuries that children ages 5-6 experience in their past lifetime and in their daily endeavors. I found that the most common injuries in the age group were falling down the stairs for retrospective reports, and bumps, bruises, scrapes for daily reports. Additionally, I confirmed that minor injuries were relatively common among this age group, and that some of them in fact required medical treatment or intervention. These injuries can be disruptive for parents and children in school and in their daily activities. Anecdotally, one parent reported a prior injury to the head of a child that was so common that the child needed to wear protective head gear in school to lessen the impact of those injuries. Clearly, the incidence of unintentional injury is an area calling out for further research. My findings regarding the most common minor injuries in children are consistent with prior research by Alonso-Fernández et al. (2017), who noted that bruises were the most common injury reported in his study. Most of the parents in my study also reported their children falling and getting injured frequently, which is also supported by the statistics reported by the CDC (2015) which states that each year around 2.8 million children visit an emergency room from injuries due to falling. This finding highlights the research done by Kuhn and Damashek (2014) who found that children were more at risk for injury when engaging themselves in developmentally typical activities, hence saying that children, at a young age, are learning new motor skills while playing which is possibly putting them at a higher risk for injury. In addition, Martin-Diener et al. (2013) and Kendrick et al. (2012) state that a great number of injuries in children occur when children are becoming more physically active or just by running around which is typical behavior of young children. Within the Daily Minor Injury survey, parents had an option to a free response in which they could elaborate on the injuries their child experienced. One parent described that her son usually played with older siblings/children, which sometimes resulted in minor injury. This finding is similar to that of Nocera et al. (2016) who proposed that a child's environment influences injury and that in a home with multiple children minor injury incidence is heightened.

Limitations in this study mainly deal with the way variables (EF, motor ability, and injury) were measured. In both surveys dealing with amount of injuries each child sustained, it may not have been clear how parents should report injuries. Many parents reported injuries that did not actually harm their child. For example, some parents reported the injury, "tripped and fell", however they classified it as not being very serious or no treatment was needed. It could be noted that this factor shifted our results regarding injuries, and parents may have adopted their own criteria for defining what "counted" as an injury. It could be possible that, because our injury surveys were completed by parents, parents exaggerated injuries that their child sustained. In future research, the term injury should be more clearly defined in both surveys for precise and consistent measurement.

In regard to parents responding trends, an important limitation in this study deals with the way that parents reported injuries. Self-report studies are widely used in research, however using this type of design does come with consequences. A potential major issue with the self-report by parents, dealing with injuries in their children, mainly focuses on the characteristics of the parents. Parents were given a time frame from their child's life, for example from birth to current age, in which they had report any minor injuries they could remember. Situational factors play a huge role in why parents may have underreported over exaggerated injuries. Depending on the frequency of injury in their child, the treatment needed, or severity of the injury, parents may not remember every minor injury that their child sustained in that time period, which could allow for an underreporting issue within the study. More specifically, if a child had several injuries that required medical attention, parents would have been more likely to remember them, whereas a small bruise might not be recalled as easily. In addition to this, the clarity of the questions asked about minor injury should have been better prepared and more specific.

Another limitation of this study depends on the sample size. The sample size of 13 children made it difficult to find statistically significant relationships between variables in which it is usually necessary to have a larger sample size to be more representative of a current population. This could have been because of the lack of access to children at other schools. In addition to the small sample size, I also experienced a problem with missing data. I discovered that some parents did not complete the full 21-day daily injury survey and left many days unanswered which could influence the injury data. However, most of the parents in our sample did complete the survey for the full 21 days.

The Early Years Toolbox (EYT) has been proven to be reliable and valid by the researchers who developed it. However, there are many details within each game that should be addressed. All three of the EF games appear to have face validity, but most of them last too long, resulting in boredom displayed by the child. Many children would start to get tired of the game, and then started to direct their attention elsewhere or choose random answers to speed up the game. The games should be a fun, rewarding task for children, despite the fact that they are assessments. In addition, levels within each game should be shortened so the time playing them decreases. Also, Howard and Melhuish (2017) developed easy to use excel files on their website for scoring, however despite this, each task is still quite difficult to score.

Areas for future research should be based on a different population of preschool aged children that is more representative to all groups and also a larger sample size. These two factors could yield different results and be more predictive of EF, motor ability, and unintentional injury. Gender and injury severity should be an area of research that could potentially produce different results. In this study, the difference between gender of children was quite significant, being that there was 9 female children and 4 male children, and in this case the association between injury and gender could not be defined. The focus of future research should be on preschool aged children of multiple different disciplines, not just from a church affiliated preschool, but more insight on public preschools or even daycares should be considered. Unintentional injury, EF, and motor ability should also be looked at more in children diagnosed with ADHD, or other developmental disorders. Though it was measured in the injury surveys but not particularly focused on, it would be interesting to study more in depth the way that children react to unintentional injury (pain, anxiety, fear, etc.) in attempt to find new interventions for parents to deal with injury. In addition to this, by using the same research format and looking more into child behavior assessments and the environment in which the injury took place could develop a different outlook on injury risk and prevention. It is also important to focus more on children's injuries in relation to how their parent or care giver responds in attempt to understand how future injuries can be prevented.

If the opportunity came about to replicate this current study, I would definitely ask questions on the surveys dealing with parent factors too, not only focusing on their children. For instance, it would have been a good idea to record the age, ethnicity, and maybe even religion of each parent to assess if there is more of a relationship between parental factors and their child's frequency of injury. Also, because of the difficulties experienced with asking parents to self-report their child's injuries, it would be interesting to get injury reports from the child's school, if available. This would lessen the error for recall, underreporting, and possibly the over exaggeration of injury.

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Table 1

Frequencies of minor injuries reported in the Daily Log within a duration of 21 days.

Injury Type	Frequency
Bumps, bruises, scrapes	25
Fall, excluding stairs	8
Sports related	5
Tripped and was injured	4
Hand or other extremities crushed/slammed in object	3
Injured by tool	2
Injury involving skateboard, skates, or scooter	2
Eye injury	1
Fall down stairs	1
Injured by toy	1

Table 2.

Injury ratio of the number of injuries children experienced to the number of responses parents gave within a 21 day period.

ID Number	Child Injuries	Parent Responses	Injury Ratio
2	7	19	0.37
7	3	21	0.14
14	3	14	0.21
16	7	22	0.32
17	6	19	0.32
18	3	16	0.19
34	6	21	0.29
35	3	21	0.14
36	4	21	0.19
39	3	21	0.10
42	4	21	0.19
43	0	6	0.00
44	3	19	0.16

Table 3.

Frequencies of minor injuries reported in the Retrospective Injury Survey that was completed by parents.

Injury Type	Frequency
Tricycle/Bicycle	1
Burn	5
Fall down stairs	12
Sports related	0
Sprain/strain in muscle/body part	0
Bumps, bruises, scrapes	6
Significant cut	0
Broken bone	1
Choked on object/piece of food	2
Eye injury	2
Fall, excluding stairs	9
Injury involving skateboard, skates, or scooter	1
Playing in or around water	0
Hand or other extremities crushed/slammed in object	2
Fan, electrical appliance, or heater	0

Tripped and been injured	4
Injured by a toy	1
Injured by a tool	0

Table 4.

Types of questions parents were asked to answer regarding unintentional minor injuries in their child on both the Retrospective Injury survey and the Daily Minor Injury Log survey.

Question	Code
Injury Type	Tricycle or bicycle; Burn; Fall down the stairs; Sports related; Sprain/strain in muscle or body part; Bumps, bruises, scrapes; Significant cut; Broken bone; Choked on object/piece of food; Eye injury; Fall, excluding stairs; Skateboard, skates, or scooter; Playing in or around water; hand or other extremities crushed/slammed in object; Fa, electrical appliance, heater; Tripped and injured; Injured by toy; Injured by tool
Age of child***	Free response
Seriousness of injury	1 = Not at all serious; 2 = Slightly serious; 3 = Significantly serious; 4 = Very, very serious
Treatment procedure following injury	0= No treatment needed; 1 = Cleansed and comforted; 2 = Home treatment (ice, bandages, over the counter medicine, etc.); 3 = Phone call to the Doctor’s Office; 4 = Visit to the Doctor’s Office or Emergency Room; 5 = Medical treatment (stitches, cast, etc.); 6 = Hospitalization
Length of disability experienced by child following injury	≤ 1 minute, ≤ 5 minutes, ≤ 30 minutes, ≤ 1 hour, ≤ 6 hours, ≤ I day, ≤ 3 days, ≤ 1 week, > 1 week

Amount of pain experienced by child	0 = No pain at all to 10 = Most pain experienced
Amount of anxiety experienced by child	1 = Not at all anxious; 2 = Slightly anxious; 3 = Significantly anxious; 4 = Very, very anxious
Amount of fear experienced by child	1 = Not at all frightened; 2 = Slightly frightened; 3 = Significantly frightened; 4 = Very, very frightened

*** *Age of child was not a question asked on the Daily Minor Injury Log Survey.*

Table 5.

Descriptions of gross motor skills that require fluid coordinated movements demonstrated by children in the Locomotor subtest of the TGMD-2 (Ulrich, 2000).

Gross Motor Skill	Description
Run	The ability to advance steadily by springing steps so that both feet leave the ground for an instant with each stride
Gallop	The ability to perform a fast, natural three-beat gait
Hop	The ability to hop a minimum distance on each foot
Leap	The ability to perform all of the skills associated with leaping over an object
Horizontal Jump	The ability to perform a horizontal jump from a standing position
Slide	The ability to slide in a straight line from one point to another

Table 6.

Descriptions of gross motor skills demonstrated by children in the Object Control subtest of the TGMD-2 (Ulrich, 2000).

Gross Motor Skill	Description
Striking a Stationary Ball	The ability to strike a stationary ball with a plastic bat
Stationary Dribble	The ability to dribble a basketball a minimum of four times with the dominant hand before catching the ball with both hands, without moving feet
Catch	The ability to catch a plastic ball that has been tossed underhand
Kick	The ability to to kick a stationary ball with the dominant foot
Overhand Throw	The ability to throw a ball at a point on a wall with the dominant hand
Underhand Roll	The ability to roll a ball between two cones

Table 7.

Pearson Correlation between TGMD-2 and Executive Function assessment.

Measure	Loco Motor	Object Control	Gross Q	Injury Ratio	Retro Report	Mr.Ant	This Not That	Fish
Loco Motor	—							
Object Control	0.43	—						
Gross Q	**0.90**	**0.78**	—					
Injury Ratio	0.34	0.15	0.31	—				
Retro Report	0.27	0.16	0.26	0.51	—			
Mr.Ant	-0.15	0.46	0.11	-0.12	0.33	—		
This Not That	0.37	0.32	0.41	0.14	0.48	-0.04	—	
Fish	0.48	0.20	0.43	-0.16	0.34	0.31	0.10	—

Figure 1a. Screen example of Mr. Ant (visual-spatial working memory) executive function game.

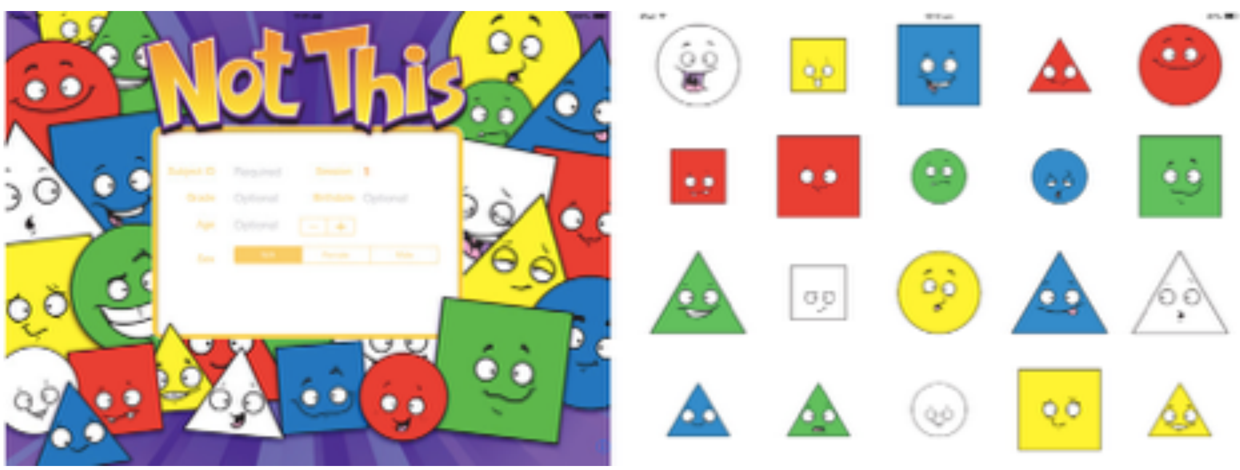

Figure 1b. Screen example of Not This (phonological working memory) executive function game.

Figure 1c. Screen example of Go/No Go (inhibition) executive function game.