

# **Sports Involvement, Head Injury, and Delinquency: Evidence from a Sample of Juvenile Justice Involved Youth**

## **Abstract**

Previous research suggests that youth sports participation is moderately associated with lower delinquency. However, little is known about whether head injury dampens this protective role of sports involvement. The current study analyzes data from a sample of justice involved youth to: 1) examine the relationship between sports involvement and head injury, 2) assess whether groups of sports involved youth with and without a head injury are related to general, violent, and/or nonviolent delinquency, and 3) examine potential sex differences in these group differences. Results suggest that sports participation is not associated with head injury. Non-sports involved youth with a head injury report higher levels of general and violent delinquency compared to non-sports involved youth without a head injury. Sports involved females with a head injury report higher levels of general and violent delinquency compared to sports involved males with a head injury. Implications and avenues for future research are discussed.

*Keywords:* Sports participation; delinquency; head injury; Northwestern Juvenile Project

## **Introduction**

Physical activity is essential for healthy cognitive and mental health (Bouchard, Blair, & Haskell, 2012). A longstanding body of research reports that physical exercise is associated with a range of positive behavioral and psychological benefits including elevated mood (Strasser & Fuchs, 2015), longer attention span (Coe et al., 2006), and overall life satisfaction (Maher et al., 2015). Adolescent youth who exercise report lower levels of anxiety (McMahon et al., 2017), higher levels of self-efficacy (Dishman et al., 2005), and less depressive symptomatology (Kandola et al., 2020). Based on previously reported associations between exercise and positive life outcomes, it is not surprising that physical education is a required component of middle and high school curriculum in the United States and worldwide. Along these lines, it is theorized that over and above the physical benefits of sports participation, involvement in organized sports may act as a form of structured socialization that protects against delinquent behavior by providing positive role modeling, good values about fair play and respect, and hard work and commitment. Existing research analyzing community samples of adolescents have found moderate support for this theoretical proposition suggesting that sports involvement is generally - albeit inconsistently - associated with reductions in delinquent behaviors (Jugl et al., 2021; Kreager, 2007).

While most studies report some support for a negative association between sports involvement and delinquency during adolescence, comparatively less is understood about whether this applies to samples of at-risk youth with a history of juvenile justice involvement. Youth with a history juvenile behavior and system contact may be qualitatively different from participants drawn from nationally representative and/or population-based samples. For example, youth from disadvantaged backgrounds who are overrepresented in juvenile justice system may receive more benefits from well implemented and organized sports programs since they are

growing up in communities with a host of neighborhood, familial, and individual risk factors for delinquency. Indeed, sports-based intervention efforts for at-risk adolescents have been widely implemented by several local community agencies and institutions (Kelly, 2013; Nicholson, 2007) to reduce these pulls toward delinquency. Yet, empirical support for the effectiveness of these approaches remains mixed (Holt et al., 2017; Inoue et al., 2015; Jones et al., 2017).

There may be a few reasons for this current state of research. First, very few studies have used quantitative research methodologies with data from juvenile justice involved youth to explore the role of sports involvement for different forms of delinquent offending (for an exception see Spruit et al., 2018). While existing theory argues that sports involvement may protect against delinquency through structured social supervision (Purdy & Richard, 1983), there is also the possibility that youth may be at an elevated risk of sustaining serious injuries that impair cognitive functioning and increase behavioral problems, such as head injury (HI) (Veliz et al., 2017). HI has been shown to be associated with delinquent behavior in samples of urban (Connolly & McCormick, 2019; Stoddard & Zimmerman, 2011) and juvenile justice involved youth (Schwartz, Connolly, & Brauer, 2017). It is possible then that previously juvenile justice detained youth who return back to their communities are faced with school districts that have little funding for sports programs. As a result, there may only be opportunities to participate in contact sports that have high incidents of HI, such as football, basketball, or wrestling (Veliz et al., 2017). Sustaining a head injury from involvement in these sports may therefore dampen the protective effect of organized sports for delinquent behavior.

Second, much is currently unknown about whether the strength of the relationship between sports involvement and delinquency varies across males and females, particularly with a history of juvenile justice involvement. Given that there are pronounced biological differences

between males and females, males could benefit more from sports participation than females. One reason to expect this is based on two brain structures that differ between males and females - specifically the hippocampus and amygdala (Wierenga et al., 2014). These brain structures are involved in emotional processing and regulation (Yang & Wang, 2017) - including the regulation of physical aggression - and are generally larger and more active in males (Wierenga et al., 2014). Males involved in athletics may therefore learn to better regulate their higher aggressive tendencies as they practice sport-related discipline, emotional control, and teamwork while being mentored by positive adult influences. While females may also benefit in these respects, they might not be as pronounced, as females are generally less aggressive than males. Even when sports involved adolescents sustain a HI, it is possible that males may be less likely to engage in delinquent behavior compared to their female counterparts. Females generally report more symptoms of HI than males (Mollayeva et al., 2018), including experiencing impaired decision-making skills, which are important for emotional and behavioral regulation. Therefore, sports involved males may be less likely to engage in delinquent behavior following a HI as they experience fewer behavior-related side effects.

To date, these two empirical questions have yet to be examined using quantitative data from juvenile justice involved males and females. As such, much is currently unknown about the role of HI on the relationship between sports involvement and different forms of delinquency. Existing evidence suggesting that sports participation may be beneficial for juvenile justice involved youth and, specifically, more so for males compared to females - or vice versa - has important implications for juvenile justice prevention and intervention efforts. The current study aims to begin to address these existing voids in the current juvenile justice literature.

## **Sports Participation and Delinquency**

Thus far, the majority of research examining sports participation and delinquent behavior has found that sports involvement among community-based samples of adolescents is associated with slight reductions in delinquency. A recent meta-analysis that included results from 13 previously published studies reported that sports programs for adolescents protect against criminal behavior (Jugl et al., 2021). Further, Veliz & Shakib (2012) found that U.S. high schools with higher rates of students on athletic teams reported fewer violent (but not nonviolent) crimes on campus, relative to schools with lower percentages of students involved in athletics. However, there are several studies that find no association between sports participation and delinquency among community dwelling adolescents. Specifically, in an earlier meta-analysis of 51 studies, Spruit et al. (2016) reported that there was no overall relationship between sports participation and juvenile delinquency.

While much of the previous literature on sports, delinquency, and crime has been meta-analyzed, highlighted in both reviews are areas that have not been covered and therefore not considered in the employed analyses. Chiefly absent from this line of research is a multivariate quantitative examination of how sports involvement is associated with delinquent behavior in juvenile justice involved youth. Adolescents with previous justice involvement may benefit more from sports involvement as they might not have other prosocial influences in their lives to protect them from the pulls towards engaging in illegal activities. By engaging in sports games and practices, adolescents may not have as much time to socialize with peers in unstructured settings that could facilitate involvement in delinquency. Among the studies that have been conducted with justice-involved adolescents, results suggest that athletic participation is associated with decreased delinquent recidivism (Collingwood & Engelsgerd, 1977) and

aggression (Williams et al., 2015). Though these findings shed some light on how sports can protect against delinquency in justice-involved adolescents, the studies do not control for any theoretical or demographic covariates, potentially limiting the external reliability of the results.

Another consideration that has yet to be examined is the possibility of sustained physical injuries - such as HIs - during sports participation that may weaken the benefits, render them nonexistent, or even increase the risk for delinquency. Past research demonstrates that sustaining a HI is associated with increased perpetration of delinquent behaviors (Schwartz, 2021) partly due to the alteration of the structure and functionality of the brain, which can negatively impact cognitive and emotional regulation (Li & Liu, 2013). While the consequences of HI might not completely negate the benefits of sports participation, adolescents who suffer a HI often need to take a break from sports so they can heal. During this time, these individuals are no longer receiving the daily social benefits of sports. Additionally, sports involved adolescents who are recovering from a HI might choose to spend extra time (which was previously occupied by sports practices and competitions) with new groups of peers who may encourage them to participate in risky behaviors. The combination of neuropsychological deficit stemming from a HI, the absence of social and physical benefits from sport involvement, and possible introduction of delinquent minded peers may increase the risk of delinquency perpetration.

Lastly, there is reason to suspect that sports participation might be differentially related to different forms of delinquency in males and females. As males tend to exhibit greater aggressive tendencies than females, specifically with respect to physical aggression (Björkqvist, 2018) involved in many delinquent acts, it is possible that they may benefit more from the social aspects of athletics than females. Working on skills like goal setting, strategic planning, and emotional control during tough competition might enable young males to translate these skills to

other aspects of their lives, especially if they have coaches who explain how some of these skills can be applied outside of sports. While females may also benefit from practicing these skills, they tend to exhibit lower baseline levels of physical aggression so the focus of their translational skills may lie in other areas such as improving communication. However, as justice-involved males and females both generally have a history of aggressive behavior, these hypothesized sex differences might not emerge.

There may also be differences in delinquent behavior among sports involved males in females who sustain a HI. Previous research has shown that sports involved adolescent females are more likely to sustain a HI relative to sports involved adolescent males who play the same sport (Covassin et al., 2013). In addition, females are also more likely than males to report a greater number of symptoms of HI than males (Mollayeva et al., 2018), such as experiencing impaired memory and decision-making skills (Broshek et al., 2005). Such skills are critical for emotional control, especially in stressful and risky situations (Heilman et al., 2010). As such, it is possible that females with a history of juvenile behavior may be more likely than males to engage in delinquency after suffering a HI since they find it more difficult to refrain from aggressive impulses and negative peer influences because of diminished cognitive control.

### **The Current Study**

There is currently little research regarding if, and to what extent, associations between sports involvement, HI, and forms of delinquency exist among juvenile justice involved youth and whether they vary across males and females. The current study aims to answer the following three research questions with data from a sample of juvenile justice involved youth growing up in the United States:

1. Is sports involvement positively associated with sustaining a HI?

2. Are there differences in general, violent, and nonviolent delinquency across groups of: 1) sports involved youth with a HI; 2) sports involved youth without a HI; 3) non-sports involved youth with a HI, and; 4) non-sports involved youth without a HI?
3. Do observed associations between group membership of sports involvement and HI and general, violent, and nonviolent delinquent offending vary across males and females?

We chose to separate violent and nonviolent delinquency since past research suggests that sports participation has a stronger protective effect against violent delinquency (Veliz & Shakib, 2012). Additionally, sustaining a HI is more strongly related to increased perpetration of violent delinquent behavior (Schofield et al., 2015; Schwartz et al., 2017). If the answers to our research questions differ for nonviolent and violent delinquent offending, these differences should be considered when considering potential policy implications.

## **Methods**

### **Data**

The current study uses data from the Northwestern Juvenile Project (NJP), a longitudinal dataset of previously adjudicated youths from Cook County, IL (Teplin, 2013). The original goals of the data collection effort were to identify how patterns of risky behavior, substance use disorders, and mental illness develop over time. One thousand eight hundred twenty-nine ( $N = 1,899$ ) juveniles entering the Cook County Correctional Facility were initially recruited for the study and interviewed during intake between 1995 and 1998. Over the course of the next eight years, participants were interviewed six more times, with the first of these follow-up interviews occurring three years after the baseline interview. All participants were eligible for follow-up wave 1, 4, 5, and 6 interviews while a random sample of 997 respondents were selected for



follow-up wave 2 and 3 interviews. The present study uses data from the baseline and Follow-Up Wave 1 interviews.

## **Measures**

*Sports Involvement.* Sports involvement was assessed during Follow-Up Wave 1 by asking participants if they had been involved in any school or community athletic team in the past year. Responses were coded such that 0 = no participation on any athletic teams, and 1 = participated on at least one school and/or community athletic team. Descriptive statistics for sports participation is presented in Table 1. As can be seen in Table 1, approximately 30% of respondents reported having participated on an athletic team in the past year.

\*\*\*Insert Table 1 About Here\*\*\*

*Head Injury (HI).* Head injury was assessed at Follow-Up Wave 1 by asking participants if they had sustained a HI since the baseline interview. Responses were 0 = no and 1 = yes. As shown in Table 1, approximately 20% of respondents reported sustaining a HI at Wave 1 after the baseline interview, which is similar to previous findings on justice-involved adolescents (Moore et al., 2014). Males reported a higher prevalence of HI compared to females ( $\chi^2 = 12.85, p < .001$ ).

*General Delinquency.* General delinquency was measured by six self-report questions from Follow-Up Wave 1 which asked respondents to report how many times they had engaged in a range of delinquent behaviors since the baseline interview. These behaviors included: 1) using a gun, 2) attacking someone with a weapon with the idea of seriously hurting them, 3) beating someone up with the idea of seriously injuring them, 4) stalking, kidnapping, and/or abducting someone, 5) stealing something and, 6) selling drugs. Responses to each behavior were dichotomized such that 0 = zero times and 1 = one or more times. The index demonstrated good reliability (Kuder Richardson coefficient = .74). Values were summed together to create a variety

index of general delinquent offending with higher scores representing higher levels of general delinquency.

*Violent Delinquency.* Violent delinquency was measured by four items from the variety index of general delinquency capturing aggressive and interpersonal offending such as: 1) using a gun, 2) attacking someone with a weapon with the idea of seriously hurting them, 3) beating someone up with the idea of seriously injuring them, and 4) stalking, kidnapping, and/or abducting someone. The index demonstrated good reliability (Kuder Richardson coefficient = .78). Responses were summed together where higher values represent higher levels of offending.

*Nonviolent Delinquency.* Nonviolent delinquency was measured by two items from general delinquency index that captured nonviolent delinquent offending. These items captured stealing something and selling drugs. The index demonstrated adequate reliability (Kuder Richardson coefficient = .69). Values for both items were summed together to create a measure of nonviolent delinquency where higher levels reflect higher level of nonviolent delinquent behavior.

*Theoretical Covariates.* A total of 10 variables that could theoretically be correlated with sports participation, HI, and engagement in delinquent behaviors were included in the analysis. These variables included three measures of early abuse that were collected during the baseline interviews including psychological abuse, physical abuse, and sexual abuse, and seven other variables collected at Follow-Up Wave 1 including school enrollment, employment status, neighborhood disadvantage, gang membership, self-esteem, alcohol use, and marijuana use. Psychological abuse was measured by four items capturing respondents' history with psychological victimization from adult caretakers, including being made to feel like a bad person. Physical abuse was measured by six items capturing each respondent's history of physical victimization from adult caretakers, including being hit with an object, kicked, and/or

severely injured. Sexual abuse was measured by five items tapping into each respondent's history of unwanted sexual advances from adults around them. For each measure of abuse, higher scores reflected higher levels of a history of abuse. School enrollment was measured as a dichotomous measure where respondents who were currently enrolled in school were given a value of 1, respondents who were not currently enrolled were given a value of 0. Employment status was measured as a dichotomous variable where respondents who reported employment at Follow-Up Wave 1 were given a value of 1 and those who reported no employment were given a value of 0. Neighborhood disadvantage was measured by eight items tapping into neighborhood-level problems, such as prevalence of abandoned homes and assault incidents. Higher scores for this measure reflected higher levels of neighborhood disadvantage. Gang membership was measured by a dichotomous measure indicating whether a respondent reported being a member of a gang at Follow-Up Wave 1 (0 = no and 1 = yes). A measure of self-esteem comprised of four measures tapping into respondents' views of their worth and abilities, such as feeling good about themselves and having something to be proud of. Higher scores on this measure indicated higher self-esteem. Both alcohol use and marijuana use are continuous measures, which indicated how many times respondents used each type of substance in the last 30 days.

*Demographic Covariates.* Four demographic variables – age, race, gender, and verbal aptitude – were included in the analysis to control for demographic differences between participants. Age was measured in years. Race was a single variable consisting of four mutually exclusive categories indicating if participants identify as Black/African American (= 1), White/Caucasian (= 2), Hispanic (= 3), or another racial category (= 4). Sex was a binary measure in which male = 0 and female = 1. Verbal aptitude was measured by respondent scores on the Peabody Picture

Vocabulary Test (PPVT), which is a valid and standardized assessment (Dunn & Dunn, 1965) that has been shown to correlate highly with intelligence (Hodapp & Gerken, 1999).

### **Plan of Analysis**

The analysis was conducted in a series of sequential steps designed to answer each research question. First, a chi-square test was calculated to examine whether sports involvement was associated with HI among juvenile justice involved youth. Second, a one-way ANOVA was calculated to assess mean levels of general, violent, and nonviolent delinquency across groups of sports involvement and HI. The first group consisted of respondents who were not involved in sports and did not sustain a HI ( $n = 616$ ). The second group consisted of respondents who were not involved in sports but sustained a HI ( $n = 147$ ). The third group consisted of respondents who were involved in sports and did not sustain a HI ( $n = 242$ ), while the fourth and final group consisted of respondents who were involved in sports and reported sustaining a HI ( $n = 56$ ). Based on the results from the ANOVA analyses and the count nature of variables for delinquent offending, multivariate negative binomial regression equations were calculated to examine the relations between group membership and general, violent, and nonviolent delinquent behavior, while controlling for theoretical covariates and demographic characteristics. A second series of regression models was then estimated that included interaction terms specified between group status and sex to examine whether and to what extent associations between group membership and delinquency varied across sex. All analyses were performed using Stata 17.1 (StataCorp, 2017) with regression models using robust standard errors.

### **Results**

The analysis began by examining the bivariate relation between sports involvement and HI in the sample. Figure 1 presents the results from a chi-square analysis. As can be seen, rates

of HI did not vary across sports involvement status ( $\chi^2 = .03, p = .86$ ), suggesting that the prevalence of HI did not vary across sports involved and non-sports involved juvenile justice involved youth. Results from supplemental correlation analyses revealed that sports involvement was weakly correlated with general delinquency ( $r = .02, p = .062$ ), violent delinquency ( $r = .03, p = .053$ ), and nonviolent delinquency ( $r = .01, p = .071$ ). HI was significantly and positively correlated with general delinquency ( $r = .16, p < .001$ ), violent delinquency ( $r = .17, p < .001$ ), and nonviolent delinquency ( $r = .09, p = .014$ ).

\*\*\*Insert Figure 1 About Here\*\*\*

Table 2 presents the results from one-way ANOVAs testing for differences in delinquent offending across groups of sports involvement and HI. The results revealed that there was significant variation in general ( $F(3, 980) = 19.10, p < .001$ ), violent ( $F(3, 1002) = 17.09, p < .001$ ), and nonviolent ( $F(3, 1020) = 10.77, p < .001$ ) delinquent offending across all groups. This suggests that, without controlling for any other variables, there are mean differences in each type of delinquency across groups of: 1) sports involved youth with a HI; 2) sports involved youth without a HI; 3) non-sports involved youth with a HI, and; 4) non-sports involved youth without a HI.

\*\*\*Insert Table 2 About Here\*\*\*

Having established that there were significant differences in levels of delinquency across groups, the next step in the analysis focused on estimating three multivariate negative binomial regression models to assess the independent relationship between group status and delinquent offending. The results from these models are presented in Table 3. Model 1 for general delinquency shows that relative to respondents with no sports involvement and no HI, participants with no sports involvement, but with a HI, reported higher levels of general

delinquent offending ( $b = .20$ , 95% CI = .08-.32). Respondents who were involved in sports with no HI ( $b = .03$ , 95% CI = -.28-.35) and a HI ( $b = .57$ , 95% CI = -.08-1.23) also reported higher levels of general delinquency, but these results were not statistically significant ( $ps > .05$ ). Model 2 reveals similar results for violent delinquency. Respondents with no sports involvement and a HI reported higher levels of violent offending ( $b = .27$ , 95% CI = .12-.42) compared to respondents with no sports involvement and no HI. Again, respondents involved in sports with no HI ( $b = .02$ , 95% CI = -.12-.18) and involved in sport with a HI ( $b = .16$ , 95% CI = -.06-.39) reported higher levels of violent delinquent behavior than sports involved respondents with no HI, but these results were not statistically significant ( $ps > .05$ ). The results from Model 3 predicting nonviolent delinquency revealed that compared to respondents without a HI who were involved in sports, none of the other three groups reported significantly higher levels of nonviolent behavior (no sports involvement/HI:  $b = .10$ , 95% CI = .03-.25; sports involvement/no HI:  $b = .01$ , 95% CI = -.14-.17; sports involvement/HI:  $b = .20$ , 95% CI = .003-.40). Notably, for each model, high neighborhood disadvantage, gang membership, low self-esteem, verbal reasoning, and sex were all significantly associated with delinquency ( $ps < .05$ ).

\*\*\*Insert Table 3 About Here\*\*\*

Based on the results from the first series of multivariate regression models, two additional models predicting general and violent delinquency were estimated with interaction terms for group status by sex. The results from these models are presented in Table 4. Female respondents with a history of HI who were involved in sports reported higher levels of general delinquency ( $b = .74$ , 95% CI = .47-1.01] and violent delinquency ( $b = .82$ , 95% CI = .45-1.19), relative to male respondents with a HI involved in sports.

\*\*\*Insert Table 4 About Here\*\*\*

## Discussion

A small body of previous research reports that sports involved youth are less likely to engage in delinquent behaviors, compared to peers who are not involved in sports (Jugl et al., 2021). It is argued that sports provide a structured outlet for adolescents in which they can learn important lessons in teamwork, goal setting, coping with disappointment, and are kept busy so they do not engage in delinquent behavior outside of school hours (Hansen et al., 2003; Kreager, 2007). Yet, sports participation also provides more opportunities for youth to sustain a HI than other activities (Van Pelt et al., 2019), and HI is a risk-factor for aggression and delinquent behavior (Connolly & McCormick, 2019; Mongilio, 2022). However, many previous studies providing evidence of these associations are primarily conducted on community-based samples of adolescents, so it remains unknown if these patterns apply to at-risk youth with a history of juvenile justice involvement. The current study sought to begin to address this gap in the existing body of research by examining the following questions with self-report data from a sample of juvenile justice involved males and females: 1) are sports involved adolescents more likely to report a head injury compared to non-sports involved adolescents?; 2) are there differences in the level of delinquent offending across groups of sports involved adolescents with a history of head injury, sports involved adolescents without a head injury, non-sports involved adolescents with a head injury, and non-sports involved adolescents without a head injury?, and; 3) are differences across group status and forms of delinquency conditioned by sex? The performed analyses designed to answer these questions revealed three key findings that warrant further discussion.

First, respondents who reported participating in sports were not more or less likely to suffer a HI compared to respondents not involved in sports. This finding is contrary to previous research reporting that sports involvement is commonly associated with higher rates of HI

(Breck et al., 2019). However, past research has primarily analyzed data from community-samples of youth, and it could be that community youth and at-risk involved youth engage in different types of non-sporting activities. More specifically, community youth might join school clubs or simply return home after school in which case the likelihood of sustaining a HI is low. At-risk youth, on the other hand, might engage in non-structured activities that have an increased risk of HI, such as gang activities or drug use. Future research should examine if samples of at-risk youth and samples of community youth who do not participate in sports report different levels of HI and specifically, what other factors or activities contribute to the occurrence of HI in these two groups of youth.

Second, non-sports involved youth with a HI reported higher levels of general and violent delinquency than non-sports involved youth without a HI. Yet respondents who participated in sports, both with and without a history of HI, did not report significantly higher levels of general and violent delinquency than respondents in the no sports and no HI group. None of the three comparison groups were significantly different from the group of non-sports involved youth without a HI for nonviolent delinquency. On average, the group of non-sports involved youth with a HI had a score of 2.3 for general delinquency and 1.4 for violent delinquency. In real terms, this means they reported committing about 2.3 different types of offenses of the crime categories measured, for general delinquency and about 1.4 different violent offense categories. The effect size for non-sport head injury respondents is about 0.57 and 0.47 for general and violent delinquency, respectively, relative to the nonathlete non-head injury group. In other words, this group is more likely to commit a wider range of offenses at an effect size of approximately an additional half of an offense category across a three-year period. This finding has important implications for the prevention and treatment of HIs among at-risk youth who are



not athletes. Additionally, future research should begin to explore other factors that can predispose at-risk youth to HI. In doing this, delinquency intervention programs can aim to address these factors and potentially prevent future occurrences of violence.

Third, sport involved female respondents with a history of HI reported higher levels of general and violent delinquency compared to sport involved male respondents with a HI. This finding suggests that there could be a sex-specific effect of HI on athletes, such that HI adversely affects females more than males. One possible reason for this is that male athletes might have better access to recovery resources than female athletes. As males tend to participate in more contact sports such as football and hockey, they may have better access to HI protocols that allow them to receive medical care or counselling sessions in which trained professionals teach them with ways to cope with the negative emotions that accompany. Such emotions, if left untreated, might cause them to act out violently. Female athletes might not have the same access to these resources because sports officials could believe that female sports are not as violent or as likely to result in a HI. As a result, they might not be taught how to work through the emotional consequences of their HIs. Instead of being helped, females might turn to engaging in delinquent behaviors in response to the aggression or impulsivity that they might experience after suffering a HI. Future research should explore this issue to further unpack the reasons for this difference.

While the current study provides insight into the associations between sports involvement, HI, and different forms of delinquency, there are some limitations that should be discussed. First, based on the cross-sectional nature of the data, it is not possible to untangle causal relationships that might exist between HI/sports involvement and delinquency. Even though there are five additional follow-up waves of NJP data, Follow-Up Waves 2 and 3 consisted of an abbreviated version of data collection, which resulted in a small number of

complete cases that could be used in the analysis. Additionally, by the later follow-up waves, most of the participants are well into early adulthood and are no longer involved in athletics and have desisted from many criminal activities. Another limitation is that the data were collected in the late 1990s and early 2000s, several years before most mild/moderate HIs, especially sports-related HIs were reported and sufficiently treated (Graham et al., 2014). Therefore, there might be far more respondents in the HI group than what is reflected in the data due to non-reporting of mild HIs. Third, because our sports involvement measure is a dichotomous measure of whether the respondents participated in any sports, we do not have information on the types of sport(s) they participated in, or if reported HIs were a direct result of their participation. It is possible that HI and delinquency are uniquely associated with certain sports – such as contact sports that encourage physicality and controlled fighting (e.g., boxing, football, hockey, mixed martial arts, wrestling, etc.). While a limited body of research has investigated physical characteristics associated with skilled fighting in adolescent males (Beaver, Connolly, & Schwartz, 2015), future research should examine whether youth involved in certain sports sustain HIs or engage in delinquent behaviors at higher rates than youth involved in other types of sports. Lastly, the employed delinquency measures did not assess how many offenses respondents committed, but rather how many categories of offenses. This limits our ability to assess how sports participation and HI are associated with the sheer number of delinquent acts committed by NJP participants.

### **Conclusion**

The results of the current study provide some of the first evidence from multivariate quantitative data analysis that sports programs, in general, may not reduce delinquency for juvenile justice involved youth. Results suggest that suffering a head injury and not being involved in sports is related to higher levels of general and violent delinquency. Moreover, the

findings implicate a sex-specific effect of HI among athletes, such that sustaining a HI is associated in increased delinquency among female athletes. Moving forward, female sports programs should provide adequate resources focused on HI prevention and treatment protocols, especially as females are more likely to sustain a HI than their male counterparts who play the same sports (Kerr, 2014).

## References

- Beaver, K. M., Connolly, E. J., & Schwartz, J. A. (2015). Male physical fighting ability during adolescence is influenced by height and bulk. *Journal of Developmental and Life-Course Criminology, 1*, 434-446.
- Björkqvist, K. (2018). Gender differences in aggression. *Current Opinion in Psychology, 19*, 39-42.
- Bouchard, C., Blair, S. N., & Haskell, W. L. (2012). *Physical activity and health*. Human Kinetics.
- Breck, J., Bohr, A., Poddar, S., McQueen, M. B., & Casault, T. (2019). Characteristics and incidence of concussion among a US collegiate undergraduate population. *JAMA Network Open, 2*(12), e1917626-e1917626.
- Broshek, D. K., Kaushik, T., Freeman, J. R., Erlanger, D., Webbe, F., & Barth, J. T. (2005). Sex differences in outcome following sports-related concussion. *Journal of Neurosurgery, 102*(5), 856-863.
- Coe, D. P., Pivarnik, J. M., Womack, C. J., Reeves, M. J., & Malina, R. M. (2006). Effect of physical education and activity levels on academic achievement in children. *Medicine & Science in Sports & Exercise, 38*(8), 1515-1519.
- Collingwood, T. R., & Engelsgerd, M. (1977). Physical fitness, physical activity, and juvenile delinquency. *Journal of Physical Education and Recreation, 48*(6), 23-23.
- Connolly, E. J., & McCormick, B. F. (2019). Mild traumatic brain injury and psychopathology in adolescence: evidence from the project on human development in Chicago neighborhoods. *Journal of Adolescent Health, 65*(1), 79-85.

- Covassin, T., Elbin, R. J., Crutcher, B., & Burkhart, S. (2013). The management of sport-related concussion: considerations for male and female athletes. *Translational Stroke Research, 4*, 420-424.
- Dishman, R. K., Motl, R. W., Sallis, J. F., Dunn, A. L., Birnbaum, A. S., Welk, G. J., ... & Jobe, J. B. (2005). Self-management strategies mediate self-efficacy and physical activity. *American Journal of Preventive Medicine, 29*(1), 10-18.
- Dunn, L. M., & Dunn, L. M. (1965). Peabody picture vocabulary test.
- Graham, R., Rivara, F. P., Ford, M. A., Spicer, C., & Graham, R. (2014). Sports-related concussions in youth. *National Research Council and Institute of Medicine Sports-Related Concussions in Youth: Improving the Science, Changing the Culture*, 309-330.
- Hansen, D. M., Larson, R. W., & Dworkin, J. B. (2003). What adolescents learn in organized youth activities: A survey of self-reported developmental experiences. *Journal of Research on Adolescence, 13*, 25-55.
- Heilman, R. M., Crişan, L. G., Houser, D., Miclea, M., & Miu, A. C. (2010). Emotion regulation and decision making under risk and uncertainty. *Emotion, 10*(2), 257.
- Hodapp, A. F., & Gerken, K. C. (1999). Correlations between scores for Peabody picture vocabulary test—III and the Wechsler intelligence scale for children—III. *Psychological Reports, 84*(3), 1139-1142.
- Holt, N. L., Neely, K. C., Slater, L. G., Camiré, M., Côté, J., Fraser-Thomas, J., ... & Tamminen, K. A. (2017). A grounded theory of positive youth development through sport based on results from a qualitative meta-study. *International Review of Sport and Exercise Psychology, 10*(1), 1-49.

- Jones, G. J., Edwards, M. B., Bocarro, J. N., Bunds, K. S., & Smith, J. W. (2017). An integrative review of sport-based youth development literature. *Sport in Society*, 20(1), 161-179.
- Jugl, I., Bender, D., & Lösel, F. (2021). Do sports programs prevent crime and reduce reoffending? A systematic review and meta-analysis on the effectiveness of sports programs. *Journal of Quantitative Criminology*, 1-52.
- Kandola, A., Lewis, G., Osborn, D. P., Stubbs, B., & Hayes, J. F. (2020). Depressive symptoms and objectively measured physical activity and sedentary behaviour throughout adolescence: a prospective cohort study. *The Lancet Psychiatry*, 7(3), 262-271.
- Kelly, L. (2013). Sports-based interventions and the local governance of youth crime and antisocial behavior. *Journal of Sport and Social Issues*, 37(3), 261-283.
- Kerr, H. A. (2014). Concussion risk factors and strategies for prevention. *Pediatric Annals*, 43(12), e309-e315.
- Kreager, D. A. (2007). Unnecessary roughness? School sports, peer networks, and male adolescent violence. *American Sociological Review*, 72, 705-724.
- Li, L., & Liu, J. (2013). The effect of pediatric traumatic brain injury on behavioral outcomes: a systematic review. *Developmental Medicine & Child Neurology*, 55(1), 37-45.
- Maher, J. P., Pincus, A. L., Ram, N., & Conroy, D. E. (2015). Daily physical activity and life satisfaction across adulthood. *Developmental Psychology*, 51(10), 1407.
- McMahon, E. M., Corcoran, P., O'Regan, G., Keeley, H., Cannon, M., Carli, V., ... & Wasserman, D. (2017). Physical activity in European adolescents and associations with anxiety, depression and well-being. *European Child & Adolescent Psychiatry*, 26, 111-122.

- Mollayeva, T., El-Khechen-Richandi, G., & Colantonio, A. (2018). Sex & gender considerations in concussion research. *Concussion*, 3(1), CNC51.
- Mongilio, J. (2022). Childhood Head Injury as an Acquired Neuropsychological Risk Factor for Adolescent Delinquency. *Journal of Research in Crime and Delinquency*, 59(6), 756-790.
- Moore, E., Indig, D., & Haysom, L. (2014). Traumatic brain injury, mental health, substance use, and offending among incarcerated young people. *The Journal of Head Trauma Rehabilitation*, 29(3), 239-247.
- Nicholson, J. (2017). The influence of sport participation on youth binge drinking.
- Purdy, D. A., & Richard, S. F. (1983). Sport and juvenile delinquency: An examination and assessment of four major theories. *Journal of Sport Behavior*, 6(4), 179.
- Schofield, P. W., Malacova, E., Preen, D. B., D'Este, C., Tate, R., Reekie, J., ... & Butler, T. (2015). Does traumatic brain injury lead to criminality? A whole-population retrospective cohort study using linked data. *PLoS One*, 10(7), e0132558.
- Schwartz, J. A. (2021). A longitudinal assessment of head injuries as a source of acquired neuropsychological deficits and the implications for criminal persistence. *Justice Quarterly*, 38(2), 196-223.
- Schwartz, J. A., Connolly, E. J., & Brauer, J. R. (2017). Head injuries and changes in delinquency from adolescence to emerging adulthood: The importance of self-control as a mediating influence. *Journal of Research in Crime and Delinquency*, 54(6), 869-901.
- Spruit, A., Hoffenaar, P., van der Put, C., van Vugt, E., & Stams, G. J. (2018). The effect of a sport-based intervention to prevent juvenile delinquency in at-risk adolescents. *Children and Youth Services Review*, 94, 689-698.

- Spruit, A., Van Vugt, E., Van Der Put, C., Van Der Stouwe, T., & Stams, G. J. (2016). Sports participation and juvenile delinquency: A meta-analytic review. *Journal of Youth and Adolescence, 45*, 655-671.
- Strasser, B., & Fuchs, D. (2015). Role of physical activity and diet on mood, behavior, and cognition. *Neurology, Psychiatry and Brain Research, 21*(3), 118-126.
- StataCorp. 2021. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp LLC.
- Stoddard, S. A., & Zimmerman, M. A. (2011). Association of interpersonal violence with self-reported history of head injury. *Pediatrics, 127*(6), 1074-1079.
- Teplin, Linda A. Northwestern Juvenile Project (Cook County, IL): Baseline, 1995-1998 [Restricted]. Inter-university Consortium for Political and Social Research [distributor], 2013-08-30. <https://doi.org/10.3886/ICPSR32603.v1>
- Van Pelt, K. L., Allred, D., Cameron, K. L., Campbell, D. E., D'Lauro, C. J., He, X., ... & Broglio, S. P. (2019). A cohort study to identify and evaluate concussion risk factors across multiple injury settings: findings from the CARE Consortium. *Injury Epidemiology, 6*(1), 1-11.
- Veliz, P., McCabe, S. E., Eckner, J. T., & Schulenberg, J. E. (2017). Prevalence of concussion among US adolescents and correlated factors. *Jama, 318*(12), 1180-1182.
- Veliz, P., & Shakib, S. (2012). Interscholastic sports participation and school based delinquency: Does participation in sport foster a positive high school environment?. *Sociological Spectrum, 32*(6), 558-580.
- Wierenga, L., Langen, M., Ambrosino, S., van Dijk, S., Oranje, B., & Durston, S. (2014). Typical development of basal ganglia, hippocampus, amygdala and cerebellum from age 7 to 24. *Neuroimage, 96*, 67-72.



- Williams, D., Collingwood, L., Coles, J., & Schmeer, S. (2015). Evaluating a rugby sport intervention programme for young offenders. *Journal of Criminal Psychology*.
- Yang, Y., & Wang, J. Z. (2017). From structure to behavior in basolateral amygdala-hippocampus circuits. *Frontiers in Neural Circuits*, *11*, 86.

**Table 1: Descriptive Statistics**

	Mean/%	SD/n	Min	Max	<i>N</i>
Head Injury	19.66%	321	0	1	1,633
Sports Involvement	28.13%	319	0	1	1,134
General Delinquency	2.46	1.72	0	6	1,610
Violent Delinquency	1.48	1.18	0	4	1,653
Nonviolent Delinquency	.99	.78	0	2	1,671
School Enrollment	91.32%	1,589	0	1	1,740
Employment Status	76.81%	1,335	0	1	1,738
Neighborhood Disadvantage	14.98	4.64	8	24	1,270
Gang Membership	30.43%	520	0	1	1,709
Self-Esteem	16.74	2.91	4	20	1,420
Alcohol Use	3.85	13.49	0	300	1,648
Marijuana Use	13.6	44.41	0	995	1,639
Psychological Abuse	8.05	6.12	0	24	1,728
Physical Abuse	8.89	7.39	0	31	1,322
Sexual Abuse	0.12	0.36	0	3	1,729
PPVT	72.14	16.51	19	125	1,751
Age	18.18	1.55	13	25	1,751
Race					
Black/African American	56.26%	1,029	-	-	1,829
White/Caucasian	18.15%	332	-	-	1,829
Hispanic	25.37%	464	-	-	1,829
Other	0.22%	4	-	-	1,829
Gender					
Male	64.08%	1,172	-	-	1,829
Female	35.92%	657	-	-	1,829

**Table 2: One-Way ANOVA of Group Membership and Delinquency**

Delinquency	Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>
General	Between groups	3	158.29	52.77	19.10	< .001
	Within groups	980	2702.67	2.76		
	Total	983	2865.96	2.92		
Violent	Between groups	3	67.04	22.35	17.09	< .001
	Within groups	1002	1310.46	1.31		
	Total	1005	1377.50	1.37		
Nonviolent	Between groups	3	18.51	6.17	10.77	< .001
	Within groups	1020	584.32	0.57		
	Total	1023	602.83	0.59		

Notes: *df* = degrees of freedom. *SS* = sum of squares. *MS* = mean squares.

**Table 3: Negative Binomial Regressions Predicting General, Violent, and Nonviolent Delinquency**

	General Delinquency		Violent Delinquency		Nonviolent Delinquency	
	Model 1		Model 2		Model 3	
	<i>b</i>	95% CI	<i>b</i>	95% CI	<i>b</i>	95% CI
Group <sup>a</sup>						
No Sports Involvement/HI	.20**	[.08, .32]	.27***	[.12, .42]	.10	[.03, .25]
Sports Involvement/No HI	.02	[-.10, .15]	.02	[-.12, .18]	.01	[-.14, .17]
Sports Involvement/HI	.18	[-.00, .38]	.16	[-.06, .39]	.20	[.003, .40]
School Enrollment	-.02	[-.20, .14]	.001	[-.19, .20]	-.06	[-.27, .15]
Employment Status	.03	[-.09, .17]	.07	[-.07, .22]	-.02	[-.17, .12]
Neighborhood Disadvantage	.02***	[.01, .03]	.02***	[.01, .03]	.01*	[.001, .02]
Gang Membership	.35***	[.24, .45]	.41***	[.28, .53]	.24***	[.12, .36]
Self-Esteem	-.02**	[-.03, -.008]	-.02*	[-.04, -.004]	-.02*	[-.04, -.006]
Alcohol Use	.001*	[.0004, .004]	.002*	[.0004, .005]	.002	[-.001, .005]
Marijuana Use	.001*	[.0002, .002]	.001*	[.0001, .002]	.001*	[.0001, .002]
Psychological Abuse	-.00	[-.01, .006]	-.004	[-.01, .009]	-.006	[-.01, .006]
Physical Abuse	.00	[-.003, .01]	.006	[-.002, .01]	.001	[-.008, .01]
Sexual Abuse	.16**	[.04, .29]	.15*	[.007, .29]	.21**	[.08, .33]
PPVT	.005**	[.001, .008]	.004*	[.0003, .008]	.06**	[.002, .01]
Female	-.33***	[-.47, -.20]	-.32***	[-.48, -.16]	-.36***	[-.52, -.20]
Race						
White	.003	[-.16, .17]	-.10	[-.30, .09]	.14	[-.03, .32]
Hispanic	.06	[-.05, .18]	.009	[-.12, .14]	.14	[-.001, .28]
Other	.23	[-.07, .54]	.14	[-.22, .51]	.40*	[.06, .74]
Age	-.007	[-.04, .02]	-.01	[-.06, .02]	-.006	[-.04, .03]
<i>N</i>		571		582		589

Notes: <sup>a</sup> Reference category = No HI/No Sports Involvement. *b* = unstandardized coefficient. CI = confidence interval.

\* *p* < .05; \*\* *p* < .01, \*\*\* *p* < .001

**Table 4. Negative Binomial Regressions Predicting General and Violent Delinquency with Interactions**

	General Delinquency		Violent Delinquency	
	Model 1		Model 2	
	<i>b</i>	95% CI	<i>b</i>	95% CI
Group <sup>a</sup>				
No Sports Involvement/HI	.16*	[.02, .30]	.19*	[.02, .35]
Sports Involvement/No HI	.01	[-.13, .16]	-.01	[-.19, .15]
Sports Involvement/HI	.03	[-.17, .24]	-.01	[-.26, .24]
School Enrollment	-.03	[-.20, .13]	-.0002	[-.19, .19]
Employment Status	.04	[-.08, .17]	.08	[-.06, .23]
Neighborhood Disadvantage	.02***	[.01, .03]	.02***	[.01, .03]
Gang Membership	.34***	[.24, .44]	.40***	[.28, .52]
Self-Esteem	-.02**	[-.04, -.009]	-.02*	[-.04, -.005]
Alcohol Use	.002	[-.0001, .004]	.002	[-.0007, .005]
Marijuana Use	.001*	[.0001, .002]	.0009	[-.00007, .05]
Psychological Abuse	-.006	[-.01, .005]	-.006	[-.02, .007]
Physical Abuse	.005	[-.002, .013]	.007	[-.001, .01]
Sexual Abuse	.20**	[.07, .32]	.19**	[.04, .33]
PPVT	.005**	[.002, .009]	.004*	[.0006, .008]
Female	-.40***	[-.57, -.23]	-.44***	[-.64, -.23]
Race				
White	-.002	[-.16, .15]	-.10	[-.30, .08]
Hispanic	.05	[-.06, .17]	-.004	[-.14, .13]
Other	.14	[-.21, .50]	-.008	[-.41, .39]
Age	-.01	[-.04, .02]		
Group x Female				
No Sports/HI x Female	.16	[-.13, .45]	.30	[-.02, .64]
Sports/No HI x Female	-.02	[-.29, .24]	.08	[-.25, .41]
Sports/HI x Female	.74***	[.47, 1.01]	.82***	[.45, 1.19]
<i>N</i>		571		582

Notes: <sup>a</sup> Reference category = No HI/No Sports Involvement. *b* = unstandardized coefficient. CI = confidence interval.

\*  $p < .05$ ; \*\*  $p < .01$ , \*\*\*  $p < .001$

**Figure 1. Sports Involvement and Head Injury**

