

Factors Influencing College Football Players' Beliefs About Incurring Football-Related Dementia

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Background: Football participation is associated with risks to acute and long-term health, including the possibility of incurring football-related dementia. Concerns have been raised regarding media coverage of these risks, which may have influenced athletes' beliefs. However, little is known about football players' views on football-related dementia. The risk-perception literature suggests that related risk perceptions and features of individual cognition, such as the ability to switch to reasoned, deliberative thinking, may influence individual perception of a long-term risk.

Purpose: To evaluate factors influencing college football players' belief that they are likely to incur football-related dementia in the future.

Study Design: Cross-sectional study.

Methods: Members of 4 National Collegiate Athletic Association Division I Power 5 Football teams participated in this survey-based study, providing responses to demographic, athletic, and risk-posture questions, and completed the cognitive reflection test. Logistic regressions were used to evaluate relationships between beliefs about football-related dementia and factors including athletic and demographic characteristics, football risk posture, health-risk posture, and cognitive reflection test score.

Results: About 10% of the 296 participating athletes thought football-related dementia was likely to occur in their future. Skill players had lower odds than linemen of believing that football-related dementia was likely (odds ratio [OR], 0.35; 95% CI, 0.14-0.89). For each additional suspected concussion in an athlete's career, his odds of believing football-related dementia was likely increased by 24% (OR, 1.24; 95% CI, 1.07-1.45). Acute and chronic football-related risk perceptions, as well as non-football-related health-risk perceptions, were positively associated with athletes' belief that football-related dementia was likely. Higher cognitive reflection test scores, a measure of ability to switch to slow, deliberative thinking, was positively associated with odds of believing football-related dementia was likely (OR, 1.57; 95% CI, 1.12-2.21).

Conclusion: Some athletes view football as generally riskier, while others view football as generally less risky. These risk postures are informed by athletes' concussion history, primary playing position, and ability to switch from fast, reactive thinking to slow, deliberative thinking. Ensuring that athletes are appropriately informed of the risks of participation is an ethical obligation of universities; sports medicine clinicians are appropriate facilitators of conversations about athletes' health risks.

Keywords: concussion; dementia; risk perception; risk communication

Long-term neurological deficits, including chronic traumatic encephalopathy (CTE), have been associated with repetitive head impacts (RHIs) such as those sustained while playing American football (henceforth, football).^{16,33} Recent evidence suggests a possible dose-response relationship between years of football participation and likelihood of CTE at death.²⁸ Beyond CTE, former professional football players have elevated neurodegenerative causes of death, including from Alzheimer disease (AD) and amyotrophic lateral sclerosis.²² However, not all research

examining the relationship between RHI and later-life health deficits has found such an association.^{10,38} There are still many unknowns regarding football-related neurodegeneration, including population incidence and prevalence, genetic predispositions, and exact biological mechanism(s).

There have been criticisms regarding the presentation of CTE in the lay and scientific literature. Some authors have expressed concern about the lay press's reporting of CTE science, suggesting that it may inappropriately inform athletes' decision-making.⁴⁴ Others have questioned whether there is bias in the CTE research that is ultimately published in the scientific literature.⁴⁸ At the heart of many such criticisms is the notion that there is still much to learn

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about CTE and that portraying the information as unquestionable may inappropriately inform an individual's risk perceptions.

While the media influence risk perceptions across a range of issues,⁴⁷ there is limited evidence regarding specifically whether and how lay and scientific articles have informed contact sports athletes' understanding of their personal risks of incurring CTE or other long-term neurological deficits. One previous study evaluated college football players' perceptions of football-related injuries. This study found that approximately 40% of athletes studied agreed there was a strong possibility of concussion in the future, and approximately 10% predicted there was a strong possibility that they would have a long-term neurological deficit like CTE.² Another study evaluated the beliefs of youth soccer players' parents as well as the sports medicine clinicians who provide concussion care for youth athletes. This study found that the parents believed more strongly in the causal relationship between concussion and CTE, and between CTE and harm, than did the clinicians.¹⁹ Despite limited evidence on the effect of current science communication about CTE and athlete risk perceptions, there is substantial literature on risk perceptions in other domains that can inform our understanding.

Individuals differ in the ways they perceive and tolerate risk. Differences in these domains are frequently described as risk postures or risk attitudes.⁵ A number of factors may influence individuals' perceptions of risk, including social and cultural factors,³⁴ media coverage,⁴¹ numeracy,³⁵ sex,¹⁸ affect and emotions,^{23,26} familiarity of the risk,⁴³ previous precautionary behavior,⁶ and previous risky behavior.²⁹ Rather than reflecting a general trend toward optimism or pessimism in risk assessment, risk perceptions tend to be threat- or situation-dependent.¹¹ Although risk perception tends to be threat dependent, individuals are usually consistent in their risk-taking behavior within a domain. That is, within 1 area (eg, financial decisions), individuals tend to act relatively consistently as risk-averse or risk-seeking.⁵ Across domains, however, an individual may vary in their willingness to engage in risky behavior.⁴³ A number of decision-making theories assert that risk perception is an important predictor of

behavior.^{7,31,37} Understanding individual risk perceptions is important, as risk perceptions have been associated with health-related risk-taking or risk-avoiding behaviors,¹³ and an appropriate appraisal of risk perceptions can inform risk communication and health policy approaches.³⁹

One determinant of risk perceptions may be the ability of individuals to switch from fast, reactive decision-making to slow, deliberative decision-making. This skill, referred to as cognitive reflection, varies between individuals,¹⁴ but our understanding of this skill among athletes is limited. One study postulated that cognitive reflection may be influential in athletes' abilities to report a concussion to a medical professional in the heat of competition.²⁰ Another study empirically evaluated this relationship and found no significant association.⁴ The ability to switch to deliberative reasoning has been associated with reduced tendency to devalue future events^{14,46} (delay-discounting) and thus may influence an athlete's views on whether the long-term outcome of football-related dementia was likely in his future. In the sporting environment, fast, reactive decision-making is a critical component to on-field success, and playing through pain is rewarded and part of the culture.^{8,25,30} Using the concept of cognitive reflection may help advance the understanding of how these normative environmental features relate to athletes' perceptions of long-term football-associated risks.

This study, which involved National Collegiate Athletic Association (NCAA) Division I football teams, aimed to describe the characteristics of college football players who believe that they are likely to incur football-related dementia.

METHODS

Procedure

A total of 65 NCAA Division I Power 5 football teams were recruited through contact with a team representative (eg, director of sports medicine, head team physician) to participate in a survey-based, research study. Representatives from 4 teams agreed to participate; these 4 teams and their

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Ethical approval for this study was obtained from the institutional review board at the Harvard T.H. Chan School of Public Health (submission No. CR16-1496-03).

schools were similar to nonparticipating teams/schools on a range of observable characteristics.³ Surveys were administered in person during the spring of 2017, using pen and paper, on the athletes' home campuses. Athletes provided informed consent in advance of completing the survey, which took a mean of about 15 minutes, and each athlete received a \$10 Amazon gift card for participating. All research activities were approved by an institutional review board.

Measures

Athletic History and Demographic Information. Athletes indicated their primary playing position. Given previous literature demonstrating differences in concussion-related outcomes between skill positions and linemen,¹ this variable was collapsed into a binary outcome dichotomizing linemen and skill players. They also provided their total years playing tackle football and the number of suspected and diagnosed concussions during their football career. No definition of concussion was provided. Team membership was recorded. Athletes provided their race and ethnicity. Given previous risk literature documenting a "White male" effect,¹² this variable was collapsed into a binary indicator for White versus non-White. Each participant also provided their mother's and father's educational attainment, which was collapsed into the following categories: less than college, some college, and college or graduate degree.

Perceived Risk of Football-Related Neurodegenerative Disease. Using a 7-point Likert scale ranging from "definitely won't" (1) to "definitely will" (7), athletes indicated their perceived likelihood for the following prompt: "I will develop dementia, Alzheimer's disease (AD), or chronic traumatic encephalopathy (CTE) later in life because I played football." Given the distribution of responses, this variable was collapsed to a binary indicator for analysis by grouping all those who answered "likely," "very likely," and "definitely will" (5, 6, or 7) together into a "yes" category and the others into a "no" category. Athletes were also asked to rate how positive or negative developing dementia, AD, or CTE would be on a 7-point scale ranging from "very negative" (1) to "very positive" (7).

Perceived Health Risks of Football. Using a 7-point Likert scale ranging from "definitely won't" (1) to "definitely will" (7), athletes indicated their perceived likelihood for the following 5 prompts on acute health outcomes: "I will get any injury next football season," "I will sprain my ankle next football season," "I will injure my knee next football season," "I will get a concussion next football season," and "I will get an injury during the next football season that will make me stop playing football." No definition of concussion was provided. The responses to these 5 questions were summed to create a composite measure of the likelihood of future health risks (Cronbach's alpha, .9). Regarding the previously listed acute health outcomes, athletes were also asked to rate how positive or negative each would be on a 7-point scale ranging from "very negative" (1) to "very positive" (7); these items were summed to create a composite measure of the magnitude of future health risks (Cronbach's alpha, .9). They were also

asked to indicate the likelihood and positivity/negativity of 1 additional prompt on chronic health outcomes: "I will have problems with my health later in life because I played football."

Football-Related Risk-Benefit Calculation. Using a 7-point scale ranging from "strongly disagree" (1) to "strongly agree" (7), athletes were asked to indicate how strongly they agreed with the statement "the benefits of playing football outweigh the risks" across 3 specific considerations: in the short term, in the long term, and regarding health benefits specifically.

Non-Football Related Health Risks. The Domain-Specific Risk-Taking (DOSPERT) scale is a validated instrument used to assess risk-taking and likelihood across several domains.⁵ We administered the risk-taking and risk perception "health" subscale of the survey. The 2 scales each consists of 6 questions followed by responses from 1 to 7 (1 = not at all likely/risky, 7 = very likely/risky). The responses were summed, and an aggregate score was created for each athlete, with possible scores ranging from 6 to 42 (Cronbach's alpha for likely subscale, .67; risky subscale, .79).

Cognitive Reflection. A validated test of cognitive reflection was administered.¹⁴ The test asked 3 relatively simple math-based word problems with an initial intuitive answer that was incorrect; thus, participants who paused and engaged in reflective reasoned decision-making were more likely to get the answers correct. The test was scored from 0 to 3 depending on the number of correct answers.

Statistical Analysis

First, the analytic sample was characterized descriptively. Then, a series of logistic regressions, with sets of covariates chosen a priori based on conceptual categories, described below, were conducted. The primary outcome of interest was the binary indicator for an athlete viewing dementia from football as likely. We evaluated the association between this outcome and the athlete's (1) personal and football-related characteristics, (2) other football-related risk postures, (3) non-football health-related risk postures, (4) individual assessment of the risks and benefits of playing football, and (5) ability to switch from fast, reactive thinking to reasoned, deliberative thinking as measured by the cognitive reflection test. To account for nonindependence of athletes within teams, we used robust standard errors. Effect sizes are presented as odds ratios (ORs), and results were considered statistically significant if the adjusted 95% CI did not include 1. Analyses were conducted in R Version 3.5.1 (R Foundation for Statistical Computing, Vienna, Austria, <https://www.R-project.org/>).

RESULTS

Sample

Overall, 296 football players from 4 teams participated in the study. Teams represented 3 of the NCAA Division I Power 5 conferences. One school was private, and 3 were

TABLE 1

Participant Characteristics and Their Association With the Belief That Incurring Football-Related Dementia Is Likely^a

	Descriptive Measure, Median (IQR) or n (%)	OR	95% CI
Suspected concussions	1.00 (0.0-3.0)	1.24	1.07-1.45
Diagnosed concussions	0.0 (0.0-1.0)	0.81	0.50-1.34
Years of football	11.0 (9.0-13.0)	0.95	0.83-1.08
Position, lineman	82 (28)	Ref	Ref
Position, skill	214 (72)	0.35	0.14-0.89
Team 1	80 (27)	Ref	Ref
Team 2	54 (18)	0.61	0.19-1.89
Team 3	80 (27)	0.18	0.03-0.93
Team 4	82 (28)	0.76	0.26-2.19
Race, non-White	150 (52)	Ref	Ref
Race, White	140 (48)	0.82	0.34-1.97
Mom edu, HS or less	41 (14)	Ref	Ref
Mom edu, some college	62 (22)	0.30	0.07-1.23
Mom edu, college +	185 (64)	1.13	0.34-3.76
Dad edu, HS or less	61 (22)	Ref	Ref
Dad edu, some college	48 (17)	0.54	0.11-2.69
Dad edu, college +	171 (61)	0.58	0.16-2.04

^aDescriptive results are provided with item-level complete cases, which varies item by item. The 266 individuals who provided responses to all items were included in the regression are included in the analytic results. Bolded values indicate a statistically significant finding. Edu, educational level; HS, high school; IQR, interquartile range; OR, odds ratio; ref, reference.

public. Two teams had winning records in the previous competitive season. The within-team response rate ranged from 64% to 100%. Not all athletes completed all questions; complete case analysis was used to handle missing data (~1%), which varied minorly by covariates included in the model.

Just under half of participating athletes were White (48%; n = 140) (Table 1). The majority had a mother (64%; n = 185) and/or father (61%; n = 171) who had attained a college degree or higher. Participating athletes had played football for a mean of 11 years and had sustained, on average, 1 suspected concussion (Table 1).

Beliefs About CTE, AD, and Dementia

Of the 292 athletes who responded to the beliefs about CTE, AD, and dementia, 195 (66.8%) thought it unlikely that they would get CTE, AD, or dementia from playing football, 67 (22.9%) were unsure, and 30 (10.3%) thought it was likely (mean ± SD, 2.79 ± 1.39).

Demographic Features Associated With Belief That Incurring Football-Related Dementia Is Likely

Athletic, but not demographic, characteristics of football players were associated with the belief that incurring football-related dementia later in life was likely (Table 1). For each additional suspected concussion in an athlete's career, his odds of believing football-related dementia was

TABLE 2

Association Between Believing Football-Related Dementia Is Likely and Beliefs About Other Football- and Non-Football Related Risks^a

	Mean ± SD	OR	95% CI
Model 1: football-related risks			
Likelihood of future football injury	14.1 ± 5.6	1.16	1.04-1.30
Likelihood of chronic health problems	3.7 ± 1.7	3.54	2.24-5.57
Severity of future football injury	8.6 ± 4.3	1.03	0.91-1.15
Severity of chronic health problems	2.1 ± 1.3	0.42	0.22-0.82
Severity of football-related dementia	1.6 ± 1.1	2.63	1.36-5.07
Model 2: football-related risks vs benefits			
Short-term risks vs benefits	5.7 ± 1.4	1.35	0.94-1.94
Long-term risks vs benefits	5.1 ± 1.6	0.67	0.48-0.94
Health risks vs benefits	4.3 ± 1.7	0.79	0.60-1.04
Model 3: nonfootball health-related risks			
DOSPERT risk	28.3 ± 7.1	1.02	0.97-1.08
DOSPERT likely	21.8 ± 7.6	1.06	1.00-1.12^b

^aBolded values indicate statistical significance. DOSPERT, Domain-Specific Risk-Taking Scale; OR, odds ratio.

^bLower bound of 95% CI <1.00 but rounds to 1.00.

likely increased by 24%. Compared with linemen, skill players had 0.35 times the odds of believing football-related dementia was likely. Adjusting for other factors, athletes on team 3 had lower odds of believing football-related dementia was likely (Table 1).

Football Player Risk Perceptions and Their Association With the Belief That Incurring Football-Related Dementia Is Likely

A number of football-related risk perceptions were associated with athletes' beliefs that football-related dementia was likely (Table 2, model 1). Athletes' perceived likelihood of future football-related injury, perceived likelihood of future chronic health problems from football, and perceived severity of football-related dementia were all positively associated with the belief that football-related dementia was likely. However, their perceived severity of chronic health problems from football was negatively correlated with the belief that football-related dementia was likely.

An athlete's belief that, in the long term, the benefits of playing football outweighed the risks was inversely correlated with his belief that football-related dementia was likely (Table 2, model 2). That is, the more strongly athletes agreed that the long-term football benefits outweighed the risks, the lower the odds that they believed they would incur football-related dementia in the future. On the other hand, short-term and health-specific risk-benefit beliefs were not associated with beliefs about football-related dementia.

Athletes' perceptions of their likelihood of engaging in non-football risky health-related behaviors was associated with their belief that football-related dementia was likely.

Athletes who reported being more likely to engage in these risky behaviors were more likely to believe that football-related dementia was likely (Table 2, model 3). However, athletes' perceptions of how risky these behaviors were to them were not associated with their football-related dementia risk posture.

An athlete's ability to switch from fast, reactive thinking to slow, deliberative thinking, as measured by his score on the cognitive reflection test, was positively associated with his odds of believing football-related dementia was likely (OR, 1.57; 95% CI, 1.12-2.21). That is, the more able an athlete was to switch to deliberative thinking, the higher the odds he believed football-related dementia was likely in his future.

DISCUSSION

In this study, we evaluate factors associated with football players' perception that football-related dementia is likely in their future. We found that athletes who hold this view also hold measurably different views on football-related risks, and health-related risks beyond football, than their peers. Compared with their peers who perceive that football-related dementia is not likely in their futures, football players who believe future football-related dementia is likely also perceive a greater likelihood of future acute football injury and chronic non-dementia football-related health problems. Summarily, there appear to be 2 profiles of the risk perceptions of college football players. One is that football is viewed as generally riskier, with a comparatively greater perceived likelihood of acute and chronic health problems from football. The other is that football is viewed as generally less risky, across acute and chronic health risks. It is unclear what underlies these 2 divergent views, although this study provides insights as to individual-level factors that may contribute.

Suspected Concussion History

One informing factor is an individual's history of suspected concussions. Football players with a history of more suspected concussions are more likely to believe that they will get football-related dementia in the future. This finding is consistent with previous work in a different cohort of college football players.² Interestingly, suspected concussion, rather than diagnosed concussion, is associated with perceived risk of future football-related dementia. This relationship may be due to issues associated with concussion underreporting and underdiagnosis,²⁷ resulting in the possibility that an athlete's perceived RHI burden is more accurately represented by his number of suspected concussions versus the number of diagnosed concussions. An additional or alternative explanation is that athletes who tend to see football as riskier may have more accurate recall of their concussions, perhaps because of the greater emotional valence carried by injuries. Finally, athletes who tend to see football as riskier may have actually experienced more concussions due to individual style of play or other factors. The underlying mechanism responsible for this

relationship between concussion and football-related dementia cannot be determined by this study.

Long-Term Outlook

Athletes' beliefs about football-related dementia were associated with their long-term outlook on the risks and benefits of football. Perceived likelihood of football-related dementia was inversely related to the belief that the benefits of football outweighed the risks in the long term. Given that dementia would not affect an athlete until decades later, the lack of association between football-related dementia and beliefs about the short-term risk-benefit ratio is unsurprising. Interestingly, there was also no association between an athlete's views on football-related dementia and his view on the health-specific risk-benefit ratio. Notably, despite some athletes' thinking that football-related dementia was likely, and thus that the risks of football may outweigh the benefits in the long term, all the athletes were currently participating in football. Thus, this long-term outlook does not appear to have a meaningful impact on athletes' willingness to participate in the present. Alternatively, and perhaps more likely, survivorship bias means that the people who made the calculus not to play were not captured by the present study inclusion criteria. This may also be related to the well-documented features of human decision-making, such as present-bias³² and hyperbolic or quasi-hyperbolic discounting.²¹ These theories posit that individuals put greater weight on present or near-term risks and benefits and heavily discount risks and benefits that occur in the future. Further, these biases are even more prevalent in adolescence and early adulthood.¹⁵ Future research could expand on our work by evaluating when and to what extent perceptions about the riskiness of football affect decisions to begin or continue football participation.

Cognitive Reflection

Athletes' abilities to switch from fast, reactive decision-making to slow, deliberative decision-making (cognitive reflection) were associated with increased odds of believing they would develop football-related dementia in the future. Previous research found no association between athletes' scores on the cognitive reflection test and their willingness to report a concussion or other injury to a medical professional.⁴ Performance on the cognitive reflection test has been associated with individuals' delay-discounting behavior.^{14,46} Delay-discounting is the well-established decision-making phenomenon of individuals discounting the subjective value of future events.⁹ Individuals who are more able to switch to slow, deliberative decision-making tend not to discount future events as much as those who are less able to make this switch. This may underly the finding in this study; athletes who score high on the cognitive reflection test are less likely to discount the possibility that they may incur football-related dementia in their future. It may also be that the sports environment rewards factors undergirding this association: fast, reactive thinking and minimizing injury. However, factors such as previous exposure to the cognitive

reflection test¹⁷ or other features of cognition associated with the cognitive reflection test, such as numeracy, may confound or contribute to this finding.^{14,45} Based on this finding, risk communication strategies that focus on deliberative risks (e.g., probabilities of an outcome) are less likely to be successful in this population than risk communication strategies that convey experiential risks (eg, gut or “gist”-based assessments).^{11,42}

Health- and Football-Related Risk Postures

This study finds that some athletes view a range of acute and chronic health outcomes from football as likely, while their teammates view this same range of outcomes to be less likely. The internal consistency in risk perception within football-related outcomes is in line with the broader literature, which suggests that individuals tend to be consistent in their risk postures within a domain. Interestingly, although some athletes view football as riskier, all athletes were actively participating in college football. This suggests that despite differences in risk perceptions, risk tolerance (willingness to engage in risky behavior) may be higher among those who saw the game as riskier. Alternatively, risk tolerance may be uniformly high across all athletes, despite differences in risk perception. Because individual factors can influence athletes’ personal risks of injury and chronic health outcomes from football, we cannot say which of these broad positions is more accurate. However, ensuring that athletes understand the risks of participation is an important obligation of universities fielding athletic teams.

Risk Communication

Using best practices in health risk communication²⁴ may help relevant university stakeholders, such as sports medicine clinicians, communicate these risks to athletes. However, more research is needed to understand the type of risk communication that is most effective in collegiate football settings. Such work should consider the specific challenges of risk communication in this context, including the limits of risk communication to empower informed participation and injury disclosure decisions among individuals who have already elected to participate in football for many years. Team-level variation in football-related dementia likely raises the possibility that institutional practices in risk communication may be influential, although this is a speculative rationale. More broadly, as clinicians, researchers, and other stakeholders move forward with athlete risk communication and educational endeavors, they should attempt to incorporate factors from other fields that illuminate how people learn, communicate, and make decisions about their short- and long-term health as well as the known pitfalls to be avoided.

Limitations

This study was based on a one-time, cross-sectional survey, which limits our ability to establish temporal relationships or explore causation. Only 4 football teams participated in

this study, which may affect generalizability; however, participating and non-participating teams were similar across a range of observable characteristics,³ and within-team individual-level participation was quite high. The associations outlined in our analysis cannot be generalized beyond male college football players to other sports, levels, or female athletes. Survey responses are also subject to self-reporting biases. Athletes were not provided with a definition of concussion, which may mean they had differing conceptualizations when answering concussion-related questions.³⁶ This study evaluated deliberative risk perceptions only; future research should consider additionally evaluating experiential and/or affective risk perceptions.¹¹ Furthermore, this study did not evaluate numeracy; future work evaluating numeracy in conjunction in this population is warranted given recent work highlighting the role it plays in cognitive reflection⁴⁰ and decision-making.

CONCLUSION

The present study finds that some athletes view football as generally riskier, while others view football as generally less risky, across acute and long-term outcomes. These risk postures are informed by athletes’ self-reported concussion history as well as their ability to switch from fast, reactive thinking to slow, deliberative thinking. Despite these differences in risk perception, all participants were current football athletes. Ensuring that athletes have a reasonable understanding of the risks of football participation as well as knowledge of what to do if they incur a football-related injury, is an important responsibility for all colleges with a football team. As information about the risks of acute and chronic football-related health outcomes improves, this information should be clearly communicated to athletes.

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