A Systematic Review: Does Neck Strength Play a Role in the Prevention of Sports Related Concussion?

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Background

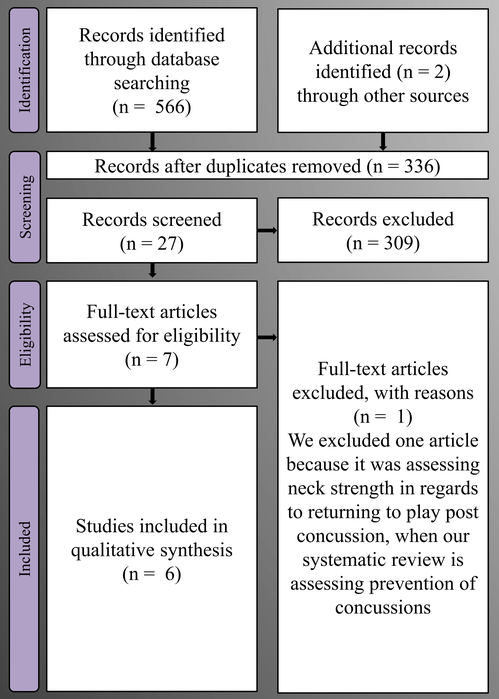
Sports related concussions are a growing epidemic impacting youth, collegiate and professional sports alike. Participation in high-risk sports like football, ice hockey and soccer account for nearly half of all observed concussions. A rotational acceleration component is thought to be a predominant component of the concussion mechanism as opposed to direct impact. It has been theorized that factors related to neck strengthening may mitigate the acceleration and deceleration forces of the head and therefore may play a positive role in limiting the onset of sports related concussions.

Purpose

The purpose of this systematic review is to determine the role that neck strength plays in prevention of sports related concussions.

Methods

Study design was a systematic review of recent literature to identify relevant evidence related to the clinical question. The search was completed by utilizing EBSCOhost search engine. A PRISMA search strategy utilizing key words identified 568 articles. After applying screening criteria 6 articles were included for data extraction and analysis. Two reviewers assessed quality of evidence using the quality checklist developed by Downs and Black. A neutral third reviewer was utilized to resolve disagreements leading to a consensus quality rating of good, fair, or poor.



Summary of Findings

Year & Lead Author	Participants	Total N	Intervention	Outcome Measures	Results/Findings	Downs & Black
2013 Dezman	NCAA Div. 1 and 2 collegiate soccer players	16 8=men 8=women	Heading a ball in a controlled environment.	-Head acceleration measured by a 14-camera Vicon MX3 Motion Capture -Neck strength measured via string type clinical dynamometer	Players were served the ball at a mean velocity 4.29 m/s. Players returned the ball to the server using a heading maneuver at a mean velocity of 5.48 m/s. Mean neck strength difference was positively correlated with angular head acceleration (r = .497, p = .05)	15 (Fair)
2014 Eckner	Male and Female contact sport athletes	46	Maximum isometric strength was measured. A loading apparatus applied impulsive forces to athletes' heads in flexion, extension, lateral flexion, and axial rotation during baseline and anticipatory cervical muscle activation conditions.	Maximum isometric strength during anticipatory activation of cervical muscles	Greater isometric neck strength and anticipatory activation were independently associated with decreased head peak linear and angular velocity.	17 (Fair)
2014 Gutierrez	Female varsity high school soccer players from the same school team	17	Subjects completed ImPACT neurocognitive test, then had neck strength assessed. Directional order was randomized between subjects, each direction was tested 3 times. Next, the subjects were equipped with the accelerometer and time switches. Heading protocol was conducted to mimic regular header drills performed in practice. Fifteen acceptable headers were collected in total (5 each direction). After the drill the ImPACT test was completed again.	-ImPACT neurocognitive test -Neck strength -Heading drills with accelerometer	ImPACT test results found no significant differences between pre- and post-heading neurocognitive performance. Moderate, consistent negative correlations were found for all directions of neck strength tested and resultant head acceleration in the header drills. The key findings of this study indicate that increased neck strength was related to decreases in the magnitude of impacts during heading. The hypothesis that neck strength would be related to header impact was confirmed.	18 (Fair)
2005 Mansell	NCAA Div. 1 collegiate soccer players	36 17=men 19=women	The resistance training group underwent an 8-week cervical resistance training program that consisted of 3 sets of 10 repetitions of neck flexion and extension at 55% to 70% of their 10-Rep max 2 times a week.	-Head-neck segment kinematics and stiffness -Electromyographic activity of the upper trapezius and sternocleidomastoid muscles during force application to the head -Neck flexor and extensor isometric strength	No kinematic, electromyographic, or stiffness training effects were seen. The posttest resistance training group isometric neck flexor strength was 15% greater compared to pretest. Isometric neck extensor strength in the female resistance training group was 22.5% greater posttest. Women's neck girth increased 3.4% over time regardless of training group. Women exhibit 7% less head-neck segment length and 26% less head-neck segment mass than men. Despite increases in isometric strength and girth, the 8-week isotonic cervical resistance training did not enhance head-neck segment dynamic stabilization during force application in collegiate soccer players.	24 (Good)
2011 Mihalik	Ice hockey players	37	Participants were equipped with accelerometer instrumented helmets to collect head impact biomechanics throughout an entire playing season. Before the season, isometric cervical muscle strength was measured for the anterior neck flexors, anterorlateral neck flexors, cervical rotators, posterolateral neck extensors, and upper trapezius.	-Linear and rotational head acceleration -Cervical strength data were categorized into tertiles, creating groups with high, moderate, and low strength -Strength measures were averaged and normalized to body mass.	Significant differences in cervical muscle strength existed across strength groups. No differences were observed in linear or rotational acceleration across strength groups for the anterior neck flexors, anterolateral neck flexors, cervical rotators, posterolateral neck extensors, or upper trapezious. The hypothesis that players with greater static neck strength would experience lower resultant head accelerations was not supported.	18 (Fair)
2014 Schmidt	High school and collegiate American football players	49 34=high school 15=collegiate	A preseason cervical testing protocol was completed, which included measures of cervical isometric strength, muscle size, and response to cervical perturbation. Head impact biomechanics were captured for each player using the Head Impact Telemetry System. The odds of sustaining moderate and sever head impacts were computed against the reference odds of sustaining mild head impacts across cervical characteristic categorizations.	A median split was used to categorize players as either high or low performers for each of the following outcome measures: -Isometric strength -Muscle size -Response to cervical perturbations	Stronger linemen had approximately 1.75 times increased odds of sustaining moderate head impacts rather than mild impacts compared with weaker linemen. Players who developed extensor torque quicker had 2 times the odds of sustaining severe head impacts rather than mild. However, players with greater cervical stiffness had reduced odds of sustaining both moderate and severe head impacts compared to those with less stiffness. Findings showed greater cervical stiffness and less angular displacement after perturbation reduced the odds of sustaining higher magnitude head impacts, However, findings did not show players with stronger and larger neck muscles mitigate head impact severity.	20 (Good)

Results

Quality of articles were determined to be 2 good and 4 fair. 201 subjects were included across the sports of soccer, football and ice hockey. Participants in the treatment groups were assessed using accelerometers and dynamometers on various perturbations of heading a ball or actual game/practice forces. None of the studies directly linked the cervical strength, stiffness or sustained external forces to the actual presence of a diagnosed concussion. The analyzed reports produced inconclusive results. 3 studies produced no significant results such that increased cervical strength/girth of the neck directly mitigated observed angular forces. The remaining 3 studies related significant results linking increased cervical strengthening to reduced forces transmitted through the head and neck. It was suggested that other factors such as non-dynamic structures related to stiffness may play a greater role in force attenuation.

Conclusions

There is not clear evidence to either support or reject the notion that cervical strengthening regimes will directly lessen concussion producing forces on an athlete. It is demonstrated and supported that neck strengthening is a modifiable activity with measureable gains observed; however, the gains may not directly relate to the intended outcome. More evidence is needed to clearly link measured gains in functional neck strength to actual sustained external forces during game/practice conditions resulting in onset of fewer concussions.

Clinical Relevance

As the concussion epidemic gains momentum in the professional literature and with the general public, the search for modifiable behaviors and traits are desired to lessen both the negative short term and long term impact of the injury. Conventional wisdom would dictate that strengthening of the neck would lead to reductions in observed concussion rates; however, based upon this systematic review we can neither support nor reject that claim.

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