

Review of the Literature • Pediatric Concussion

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Effect of Exercise Recommendation on Adolescents with Concussion

Stumph J, Young J, Singichetti B, et al. *J Child Neurol* 2020;35(2):95-101.

Concussions are considered to be mild traumatic brain injuries with acute symptoms including headaches, balance impairment, and cognitive defects. After a concussion, it is imperative that all risks for another head injury are reduced, such as being taken out of play from a sport. Returning to play after a concussion has been a serious concern within the adolescent athletic community and can have serious implications if another concussion is sustained before the individual has healed from the first. Physical and cognitive rest have been the standard of care after an acute concussion and have been thought to reduce the stress on the brain after injury. Recently, research has questioned the benefits of strict physical and cognitive rest after injury. New research suggests that adolescent patients should continue light activity, as long as new symptoms are not aggravated, in order to decrease their healing time. While various studies have confirmed the benefits of incorporating light activity into concussion treatment, these studies have primarily analyzed adult populations. It is the goal of this study to determine the benefit that this treatment could have on adolescents who have sustained a sports-related concussion.

Adolescents included in this study were separated into two groups. The first group was instructed to refrain from strenuous physical or cognitive activity, essentially following the previous belief of strict rest. The second group was instructed to continue non-contact, sub-symptom exacerbation early-exercise activity, which refers to the exclusion of any physical activity that would put the patient at risk for any further head injuries or increase their concussion symptoms. These groups were then compared to determine whether one group had a faster recovery time than the other. Patients were placed in one group or another based solely on their physician's recommendation; there was no strict guideline for separation of patients into either group. The

ABSTRACT

Concussion is defined as a mild traumatic brain injury with symptoms typically lasting days to weeks after the initial injury. Increased concern regarding the lasting effects of a concussion has prompted researchers to critically evaluate differences in recovery, treatments, and other factors in pediatric populations. Age-specific studies of concussion are currently lacking; adult guidelines for treatment after a concussion are being applied to pediatric populations. Current research has challenged the traditional treatment of strict rest in younger individuals after a concussion, evaluated the adherence to management protocols, and assessed the financial burden of taking care of a child after a concussion. Understanding the differences between adult and pediatric populations after a brain injury is essential in determining the proper treatment for the individual. It is the goal of these article reviews to highlight research in the field of pediatric concussion today.

hypothesis was that early exercise would not affect the duration of concussion symptoms compared to non-exercise.

Resolution of symptoms was reached by both groups within previously established time lines. The median post-concussion symptom score did not differ between the two groups. However, the early-exercise group took approximately 4.5 days longer for symptom resolution than the non-exercise group. This increase in recovery time was still considered to be within the normal recovery time limits for an acute concussion. Gender and time to recovery were also evaluated. It was found that males in the exercise group had a longer recovery time than females. Females in the exercise group tended to reach recovery stages at a similar time point to the non-exercise group.

Post-concussion symptoms reported in previous literature include fatigue, depression, and anxiety and are thought to be attributed to strict bed rest enforced by previous treatment measures. While these symptoms were not explicitly assessed in this study, the reduction of these symptoms could potentially outweigh the slightly longer recovery time of those in the exercise group. This is an important factor in recovery that must be considered and should be factored into any future studies.

A significant limitation of this study is that adherence to physician recommendations and treatment plans was not taken into account. It is possible that the exercise group may have participated in contact activities when they were instructed not to. It is also possible that the non-exercise group resumed their regular activities without letting their physician know.

Overall, the recommendation for noncontact, sub-symptom exacerbation early exercise did not affect the ultimate patient outcome. Females in this group tended to recover at a faster pace than males. This fact brings into question whether gender should be a factor in treatment following a concussion. More research is necessary in refining the types of exercise that should be included during recovery time, along with research into the compliance of adolescents to treatment protocols.

Evaluating Adherence to Return to School and Activity Protocols in Children After Concussion

DeMatteo CA, Lin CYA, Foster G, et al. *Clin J Sport Med* 2019; <https://pubmed.ncbi.nlm.nih.gov/31876794/>

A vital aspect of concussion treatment is adherence to management protocols after injury. If an individual sustains a second concussion before the first has healed, severe neurological impairments can occur. Canadian emergency department records have demonstrated a rise in reported pediatric concussions in recent years. Due to the increasing incidence of reported concussion in children from ages 5 to 18, it is imperative that compliance and adherence to concussion protocols are evaluated to better treat patients within the pediatric population. The research article under review uses the CanChild Protocols for Concussion Management for children and youth. These guidelines include Return to Activity (RTA) and Return to Study (RTS) protocols and represent a graduated, symptom-based method in returning a child back to everyday life. To evaluate compliance with these protocols, Post-Concussion Symptom Scales (PCSS) are used in combination with RTS/RTA measures in determining the child's adherence. Other concussion-related studies have published reports of compliance in pediatric populations, but these studies have only used self-reporting measures in their analysis. The current study not only uses self-reported PCSS questionnaires but also evaluates the child's and parent's knowledge of protocols and the researcher's estimation of the participant's compliance.

There were three important hypotheses being put to the test with this study. The first hypothesis was that as a child progresses through the RTS/RTA protocol stages, their PCSS score declines. A lower PCSS score means fewer symptoms. The second hypothesis estimated that approximately 60% of the children in this study would remain compliant with protocol measures. This compliance expectation primarily stems from previously reported literature demonstrating a 60% adherence rate with their participants. The final hypothesis of this study compared the child's and parent's knowledge of protocols and various other factors (such as the child's age, gender, etc.) with their adherence to the RTS/RTA protocols.

A promising finding was that as patient PCSS score declined, the RTS/RTA stage increased. This means that as symptoms from the initial concussion subsided, the child was able to complete the RTS/RTA protocols

successfully. The correlation of decreased PCSS scores and increased RTS/RTA stages supports this study's initial hypothesis and provides a starting point in the evaluation of adherence to concussion protocols within the pediatric population.

Non-compliance to protocols was defined as a child either over- or under-exerting themselves at any stage of the CanChild protocols. For each stage of the RTS/RTA protocols, there is a general guideline as to how symptomatic the child should be. To determine whether the participants were following the guidelines as instructed, PCSS scores were compared to the stage of RTS/RTA reported by the child and the child's parents. These comparisons revealed a 50% compliance rate with protocol measures. Previous literature demonstrates a higher compliance rate than what was established here, but researchers in this current study attribute these discrepancies to the fact that they were using more than a self-reporting measure in evaluating a patient's compliance.

Results from this study showed that children who had a better understanding of the RTS/RTA protocols and the importance of adhering to them were more compliant with treatment measures overall. No other variables beyond sufficient understanding of treatment protocols, such as differences between gender or age, seemed to influence compliance. This finding exemplifies the need for proper concussion education if we want to improve compliance among pediatric populations.

While there were some promising findings demonstrated with this study, there were still limitations. One limitation in particular was that participants knew that they were being monitored. This knowledge could have led to increased compliance with treatment measures, artificially inflating the 50% compliance rate reported by the study. Another potentially significant limitation is the academic accommodations expected from the schools that the children in the study attended. The RTS protocols included several in-school modifications, such as preferential seating and avoidance of classes that were too stimulating, for the children during recovery. Not all schools may have been compliant with these accommodations; therefore, this must be considered as a limitation.

The CanChild Protocols for Concussion Management for children and youth are promising treatments for children after a concussion as assessed with PCSS scores. One of the best ways to improve compliance with treatment is the proper education

of children and parents on protocol methods and expectations. Proper education about concussion management has the potential to decrease recovery time and ultimately get children back to their everyday lives.

Family Hardship Following Youth Concussion: Beyond the Medical Bills

Graves JM, Moore M, Kehoe L, et al. *J Pediatr Nurs* 2019; 51:15-20.

Having to care for a child after a mild traumatic brain injury such as a concussion can be emotionally and financially taxing to a family. With almost two million children experiencing concussions every year, the burden of the child's recovery on the entire family must be considered. Previous studies have demonstrated the economic burden on families after a moderate or severe traumatic brain injury, but literature seems to be lacking about mild cases. It is the goal of this study to demonstrate the significant impact that caring for a child or adolescent with a concussion can have on not only the child, but on their parents as well.

Researchers in this study interviewed children and adolescents who had been clinically diagnosed with a concussion, along with their parents. Open-ended questions centered around cost, time, and burden of the concussion were asked of all participants involved. Information regarding finances were organized into several categories, including direct and indirect monetary costs, distance and time driving to appointments, and missed work/school time. All of these factors were considered to be contributors to increased financial and emotional stress for both the children and their parents.

A common theme among those interviewed was the stress of determining insurance coverage for medical care. A large portion of direct costs came from copays and from alternative therapies (such as chiropractic visits), which were not always covered by insurance plans. To add to this direct financial burden, other more indirect costs were required of some families. This included paying for a tutor to regain their child's academic standing after missing a significant number of school days. One parent in the study noted how this unexpected cost seemed to be the most stressful financial burden for their family.

The amount of missed school after a concussion ranged from one day to one month, with most missed days being due to necessary follow-up appointments

with the child's doctor or because the child wasn't feeling well. It can put a significant amount of stress on parents for their child to miss school and to drive them to and from appointments continuously. Parents on average reported missing anywhere from one to four full days of work to care for their child after their concussion. It was not clear from this study whether parents used paid time off or took time off without pay. Previous literature approximates that 10% of individuals who take time off to care for their sick child will end up losing their job. This statistic alone illustrates the need for proper treatment of concussion in order to reduce recovery time within the pediatric population and to lessen family stress.

While many families in this study reported increased stress in dealing with the financial burden of caring for a child after a concussion, the children involved seemed sheltered from this burden. Children included in this study did not report any concerns about cost or finances involved with their recovery. This economic impact on the family did not appear to affect the child's quality of care, and no parent reported the inability to care for their child due to financial concerns.

There were several limitations of this study, including a small sample size, not following each individual over time to see the long-term financial impact, and the self-reporting measures used to obtain data. Future studies will need to address these factors in order to further our understanding of the economic impact that families deal with after their child sustains a concussion.

When treating pediatric patients after a concussion, any challenges facing the child's family must be considered when recommending treatment plans. Many of the financial burdens voiced by participants in this study align with previous literature regarding the impact of other childhood injuries and illnesses such as asthma and influenza. It is important that the discussion of concussion and its financial impact be included with these statistics due to the fact that the incidence of concussion within pediatric populations is on the rise. Ultimately, reducing financial stress on a family should be focused on the prevention of concussion so that these burdens do not end up affecting the well-being of families.

Early Subthreshold Aerobic Exercise for Sports-Related Concussion: A Randomized Clinical Trial

Leddy JJ, Haider MN, Ellis MJ, et al. *JAMA Pediatr* 2019;173(4):319-25.

The standard of care after a concussion traditionally includes both physical and cognitive rest. Currently, the theories underlying the efficacy of these treatments have been brought into question. The primary reason for questioning traditional treatments is simply that the mechanism of exercise intolerance after a concussion is unknown. Researchers have previously postulated a few possible mechanisms causing exercise intolerance in concussed patients, including reduction of cardiac stroke volume, impaired control of cerebral blood flow, and dysregulation of the patient's autonomic nervous system. It has been proven that aerobic exercises have the ability to benefit all of these similar functions, with the addition of increasing brain neuroplasticity. The potential benefits of aerobic exercise in those who have been concussed encouraged researchers in this study to determine whether recovery time would be reduced in those who included exercise in their treatment plans. Approximately 30% of children and adolescents continue to be symptomatic one month after sustaining a sports-related concussion. This is a considerably longer recovery time than what has been reported in adult populations and has motivated researchers to focus primarily on younger populations and the impact that exercise can have on their recovery times. Researchers hypothesized that early sub-threshold aerobic exercise would speed up the recovery time in adolescents after a sports-related concussion. Sub-threshold aerobic exercise is defined as any aerobic exercise that doesn't exacerbate any concussion-related symptoms.

Patients aged 13 to 18 years were separated into two groups, a placebo stretching group and an aerobic exercise group. Each group was instructed to report their symptoms every day, throughout the day. Physicians monitoring the patients were blinded to group assignments. Aerobic exercise activities included either a stationary bike or walking on a treadmill at home or at the gym, either with or without supervision. Patients in both groups were given heart rate monitors to help track their activity levels, and each person received daily text messages to encourage compliance.

After following participants for 30 days, researchers found that the group instructed to incorporate aerobic

exercise into their concussion treatment plan recovered slightly faster than the placebo stretching group. The exercise group recovered on average around 13 days after injury, and the stretching group recovered in 17 days. Recovery for this study was defined as having resolution of concussion-related symptoms for at least three consecutive days. Concussion-related symptoms were evaluated based on the post-concussion symptom scale, which is a previously established concussion grading system that has been used in a multitude of studies. Between these two groups, there were no differences in compliance level as tracked by the patients' daily symptom reports.

The findings presented with this study demonstrated the beneficial impact that aerobic exercise can have on recovery time in adolescents who have sustained a sports-related concussion. However, as with any study, certain limitations must be considered before making any final conclusions. Some of these limitations included a small sample size of only 103 participants, the fact that patients included in this study were not blinded to what treatment they were receiving, and the fact that this study did not specifically look at any of the hypothesized mechanisms of exercise intolerance (as previously mentioned) after a concussion.

This study is the first to establish the safety and efficacy of incorporating aerobic exercise into the concussion treatment plan in adolescents. Adolescents who have sustained a concussion have been shown to have an increased recovery time compared to adult populations, exemplifying the need for better treatment methods for younger populations. While this study had some promising findings, it is important that research continues with larger populations of individuals before any extreme measures are made in altering the post-concussion standard-of-care protocols.

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