Adverse Childhood Experiences and their Connection to Chronic Traumatic Encephalopathy

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Abstract

Adverse Childhood Experiences (ACEs) have lasting physical and mental effects into a person's adulthood leading to increased early death risk factors, increased neurocognitive disorders and diseases, and increased neurodegenerative biomarkers. This research project synthesized findings from studies and other peer-reviewed papers to find a linkage between ACEs and CTE. After a literature-based analysis, research showed that ACEs cause increased levels in many key neurodegenerative biomarkers that can lead to neurocognitive diseases like CTE. Additionally, research showed that CTE and Alzheimer's Disease (AD) share similar neurodegenerative pathways linked to the accumulation of phosphorylated tau protein (p-tau). Increased levels of p-tau lead to more severe cases of CTE. These findings suggest that ACEs can have a role in the severity of CTE symptoms, ultimately leading to new avenues for predictive measures and preventive treatments.

Background and Introduction

Adverse Childhood Experiences (ACEs) are described as, typically repeated, traumatic events that occur during childhood (ages 0-17) in direct and/or indirect forms including, but not limited to, physical abuse, emotional abuse, sexual abuse, and neglect. Due to the physical, mental, and emotional importance of childhood development, hindrances to such processes, like ACEs, have become an avenue for research linking early-life causes to later-life adulthood effects. These effects can present as a variety of symptoms, diseases, and disorders. ACEs have been linked to increased early death risk factors such as diabetes, heart disease, and cancer. Aside from physical health, the effects of ACEs are also seen to cause harm neurologically; many studies have shown a linkage between ACE exposure and increased neurodegenerative blood biomarkers. Such increased biomarkers (like p-tau, GFAP, and NfL) lead to increased neurocognitive disorders and mental disorders. With ACE exposure showing possible predictive abilities regarding adult-age physical and mental health, there's an opportunity to seek its possible correlation, and effect, on one of the most popularly researched topics in the field of sports medicine that is currently difficult to predict: Chronic Traumatic Encephalopathy (CTE).

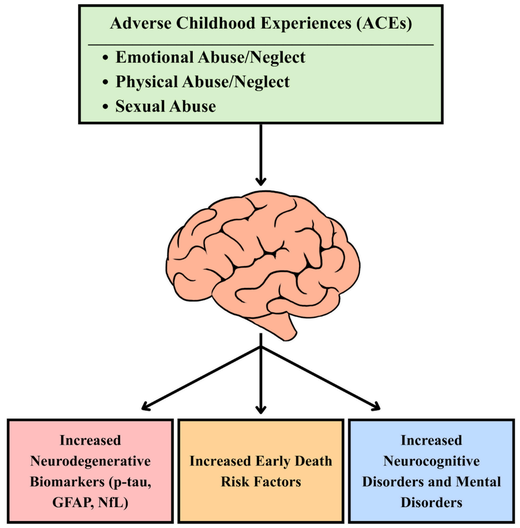

Figure 1. Flowchart illustrating the effects of ACEs.

Materials and Methods

We conducted a systematic review of available literature, compiled useful and beneficial data, and conducted a meta-analysis. The literature search and collection phase was primarily conducted using the PubMed and Google Scholar databases. The search strategy relied on using keywords and phrases, individually or in combination, pertaining to the research question. Collected literature was read, analyzed, annotated, and organized into online file collections based on key points, relevance, and usefulness. Some pieces of literature were selected as "key papers" that helped with the framing of the research. As literature accumulated, selection criteria were created and refined, and all papers were cross-referenced to these criteria to maintain consistency. Selection criteria were applied to studies with relevant data on ACEs and blood biomarkers, while papers used for contextual or background information were given similar but more general criteria. This differentiation allowed broader familiarity with the main topic and its pathways, while also allowing for the compilation of strong numerical data for statistical analysis. After internal approval against the criteria, quantitative data from ACE-related studies were analyzed. Information was organized by: Paper Name, Sample Size, Name of ACE, ACE Number, ACE Number Percentage, ACE Score, ACE Score Number, and ACE Score Percentage. The total qualified sample size across studies was 21,300 individuals. Using the available ACE score and ACE number data, we then conducted a Student's t-test on all ACE combinations.

Results

The Student's T-test was used in comparison of the 3 major ACE categories: Emotional Abuse/Neglect, Physical Abuse/Neglect, and Sexual Abuse. After applying the T-test, all combinations gave a p-value which was >0.05. Typically, the use of p-values are to show the statistical significance of a group of data, with values <0.05 being significant and showing the data is unlikely due to random chance. However, our values were found to be insignificant (value > 0.05), this allowed for us to confirm that none of the ACE categories, and their respective scores and numbers, were correlated with one another, thus showing that there is not one single ACE category that significantly causes negative effects later in life.

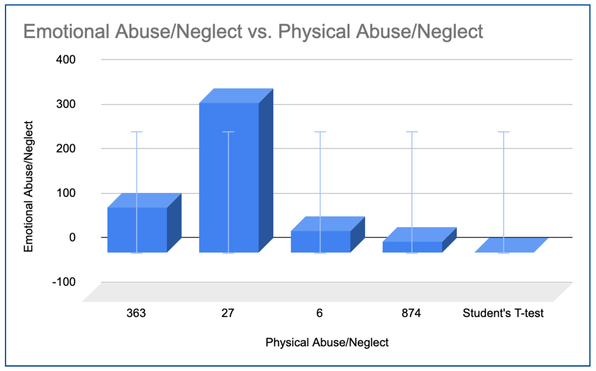

Figure 2. Student's T-test Bar Graph between Emotional Abuse/Neglect and Physical Abuse/Neglect.

Discussion

Exposure to ACEs and how their effects can connect to CTE brought about various avenues of exploration. CTE can only be diagnosed post-mortem, making it extremely difficult to research and treat. Having to delay diagnosis till after a person dies means that during life, medical professionals and researchers mostly focus on the common symptoms that present with CTE. Since CTE is a progressive disease that cannot be reversed, rather than treatment of symptoms after onset of the disease, preventative and predictive measures should be of priority. CTE is most prominently connected to physical, repetitive brain trauma, typically occurring during sports. In fact, the majority of research available on CTE, rightfully so, focuses on physical brain trauma and its correlation to CTE. Thus, preventative measures for reducing physical brain trauma include head protection and teaching about proper techniques and sport-specific rules.

ACEs introduce a unique pathway for both predictive measures and preventative measures if correlation is true. ACE scoring and prevalence could possibly predict if a person is more susceptible to having CTE. Research showed that ACEs increase p-tau. Increased p-tau levels are not only a key biomarker for CTE, but it's levels often correlate to the CTE level of severity a person is diagnosed with. Research also showed that CTE and AD have similar pathways.

Conclusion

The literature review and numerical analysis showed information and data that not only suggests that all ACEs are equally dangerous to causing negative effects later in life, but that there is possible correlation between ACEs and CTE, due to connections in pathways and biomarkers. Understanding what this correlation is can allow for more predictive measure in the future to possibly understand if a person is more or less susceptible to CTE, and to what severity. In addition to prediction, ACE treatment methods could potentially reverse p-tau levels, ultimately lowering a person's risk of contracting CTE.

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