

California Drought, Adolescent Mental Health, and Academic Achievement:
A Neuroscience-Informed Literature Review

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Abstract

Drought stress in California is considered an agricultural, economic, and water-management issue, but a psychosocial and neurodevelopmental stressor for adolescents. The purpose of this literature review is to examine recent peer-reviewed literature in the last decade (2017-2026) to answer the hypothesis that the effects of drought on the mental health and academic performance of California high school students are negative. The evidence is not conclusive enough to support a causal argument about the link between the lack of rain and depression/grades. Instead, there is a potentially more nuanced pathway: the stress of a drought leads to uncertainty, water insecurity, health issues, wildfire smoke, financial pressures on the family, and impacts of climate change, which can lead to chronic stress. Research on the effects of chronic stress on the adolescent brain has shown that it can disrupt the processes of the brain that mediate emotion regulation, working memory, attention, and learning. Stress, depression, hot weather, and other environmental factors have been shown to impact academic motivation and performance in education research. As a whole, the literature is consistent with the proposed hypothesis. It shows a critical need: There has been limited research that provides direct links between California high school students' perceptions of drought, dry air, mental health, and school performance. This gap provides a strong rationale for student survey research.

Keywords: California drought, adolescent mental health, academic achievement, chronic stress, neuroscience, climate anxiety, water insecurity

Introduction

Drought has become a reality in California for many of the students, as many of them have experienced more than one drought in the last several years. The major indicators of drought for adolescents might be dry air, brown landscapes, wildfire smoke, planning for bills and/or conservation, and concerns about the future, in addition to a lack of rain, reservoir levels, soil moisture, and water restrictions. This literature review will assess whether exposure to drought could offer a potential explanation for mental health stress in adolescents and the potential effects on academic functioning. The central hypothesis was that high school students in California are worse off in terms of their mental health and academic performance due to drought. The review focuses on environmental perception and potential neurobiological mechanisms because the survey examined how the absence of rain and overly dry air affected the students' mental well-being and academic performance.

Recent literature does not provide a definitive conclusion that depression or academic decline is due to drought alone. Drought, however, is thought to function as a chronic environmental stressor whose impact is moderated by perceived threat and insecurity, family and community stress, exposure to heat and smoke, sleep disturbance, and loss of cognitive resources. An important distinction for a student's research paper is that the evidence does not allow a causal claim, but it does show that the hypothesis has a scientific basis. Knowledge gained from a literature review using the lens of neuroscience is particularly important, as this is a developmental time when the brain systems that are highly sensitive to stress are very plastic.

Scope and Approach

The literature analyzed and integrated refers to the most recent publications (2017-2026), the majority of which were published in the past 10 years. The sources are selected from climate

science, environmental health, adolescent mental health, neuroscience, and education science. Emphasis was placed on peer-reviewed empirical studies, systematic reviews, meta-analyses, and large-scale studies on the link between climate stressors and mental health or learning. This review is represented thematically as the research question is interdisciplinary. Thematic structure allows for comparison and integration of drought science, adolescent neurobiology, water insecurity, and school outcomes rather than having each as a different topic.

Drought as an Environmental and Social Stressor

Drought in California and in the southwestern United States in recent years has been documented in the recent climate literature, and is not unique to these areas but is part of a general pattern of aridification. Williams, Cook, and Smerdon (2022) determined that the 2000-2021 southern North American megadrought was the driest over the last 22 years in the region since at least 800 CE, and they estimate that some human-induced climatic trends increased the drought's intensity. More recent studies indicate that the chance of drought recovery across the western United States has been decreased by climate change, making drought more persistent and severe (Williams et al., 2024). These studies are not mental health studies, but they do provide a compelling reason why students may view drought as a permanent state, rather than a temporary inconvenience in California.

Public health research in California can be seen as a reflection of the human impacts of drought. In 2015, during the California drought, Barreau et al. (2017) conducted a study on the effects of the drought on households in two counties. They reported effects on water access, finances, physical health, peace of mind, and acute stress. The significance of Barreau et al. lies in the way it brings drought from being an abstract environmental variable into our daily lives. The study, however, focused on households rather than high school students. It is suggested that

droughts can create stress in a family and/or a community, but not that droughts directly cause students' depression or academic decline.

Evidence of drought in adults also helps to provide some context for possible pathways of stress. Berman et al. (2021) pointed to increased occupational psychosocial stress among US farmers under drought conditions, highlighting that drought can place a mental strain on farmers via both economic and role-related pressures. This evidence is not directly related to teens; however, it is relevant because teens live within family systems. When the financial stress, increased stress from parents or community fears, is due to drought, students may pick up some of that stress in the home, through a lack of stability, or concern about the family's livelihood. The limitation is that it cannot be taken for granted that a stress that is experienced during adulthood will necessarily be passed on to adolescent mental health; it has to be assessed in adolescent students.

Water Insecurity, Climate Anxiety, and Adolescent Mental Health

One of the links between drought and mental health is water insecurity. Kimutai et al. (2023) conducted a systematic review and meta-analysis, which revealed that water insecurity and poor sanitation were considerable factors associated with poor mental health. The pathways of drinking-water insecurity could operate similarly, as a lack of WASH services could cause mental impacts, such as worry, shame, and loss of control, and social stress, as explained by Toivettula et al. (2023). In a context of climate change, Padrón-Monedero et al. (2024) also considered drought as an important mental and behavioral health issue. Such reviews are important as they involve several settings and demonstrate that water problems are psychological rather than physical hazards. However, these findings are context-sensitive: A lot of water insecurity data is from areas in which water availability is more of a problem than in many

communities in California high schools. Thus, in the context of California students, it may be less about a complete lack of water and more about perceptions of scarcity, household limitations, concerns about future water availability, or concerns about climate-related water issues.

Another impact of drought on adolescents could be climate anxiety. A survey of 10,000 youths in 10 countries conducted by Hickman et al. (2021) showed that there was significant concern, sadness, anger, and betrayal among youths over climate change. This study, while not on drought specifically, does show how young people can experience an environmental change as a threat to the future and an emotional experience. Proulx and Daelmans (2024) summarized the evidence on how children and adolescents' mental health and safety, learning potential, and family connectedness can be impacted by climate-related events. Meherali et al. (2024) also mapped adolescent climate-health evidence and identified research gaps in particular hazards like drought and wildfire. These reviews all reinforce the notion that exposure to drought in California likely impacts students directly, as well as indirectly by rumination or worry over the future.

The most direct evidence on drought and mental health affecting children specifically is from Sewell et al. (2024), which looked at the link between drought and pediatric mental health. Their spatial analysis demonstrated that pediatric emergency department presentations clustered more strongly during drought and drought-heatwave periods, particularly for suicide-related and mood-disorder presentations. This is a valuable study because it illustrates how adverse mental health outcomes for children can be related to drought-related climate conditions beyond adult mental health. Meanwhile, admissions to the ED are limited to severe cases and do not reflect the stress in everyday life, depressive feelings, or academic drive. This type of school survey may

therefore serve to fill in a smaller, but important, gap by quantifying students' perceptions of their mental health and school impacts at an earlier stage, before the problem reaches a clinical crisis level.

Neuroscience Pathways: Chronic Stress, the Adolescent Brain, and Learning

The literature in neuroscience provides clues as to why drought-induced stress might be more significant for adolescents than for other age groups. Repeated physiological adaptation to stress is called allostatic load and is thought to be caused by chronic stress, which can dysregulate the hypothalamic-pituitary-adrenal axis, as outlined by McEwen (2017). For a high school student, drought may involve multiple repeated experiences may involve repeated experiences over time, including background stress from dry weather, conservation messaging, family stress, and wildfire risk. The usefulness of McEwen's framework is that stressors are especially relevant when they are frequent, intense, and difficult to control.

Various parts of the brain that process emotion, memory, and executive functions continue to develop during the Adolescence. According to Romeo (2017), stress influences the functioning of brain regions during adolescents, such as the amygdala, hippocampus, and prefrontal cortex (PFC). These parts perform significant functions in fear processing, memory, attention, planning, and emotion regulation. This does not imply direct effects of drought on the adolescent brain, however. Rather, a more cautious reading would be that drought-induced stress can add to the emotional burden and decrease cognitive capacity for students who are already at risk of difficulties due to academic, social, and/or family stressors.

This pathway is backed by research relating to the relationship between stress, working memory, and academic achievement. Almarzouki (2024) reviewed the literature on neuroscience research and identified that the impact of stress on prefrontal and hippocampal systems can affect

working memory and academic performance. Working memory is key to reading comprehension, mathematical functioning, note-taking, test-taking, and multi-step instructions. Stress can increase worry and/or physical discomfort in a student caused by the drought, which can lead to fewer cognitive resources for learning, given the same intelligence and motivation. This is particularly important for the author's survey, as students may perceive academic decline as a lack of concentration, fatigue, or lack of motivation rather than as a decrease in grades.

Academic Achievement and Environmental Conditions

The research on stress and school outcomes is supported by the field of education research. Pascoe, Hetrick, and Parker (2019) conducted a review of evidence that found academic stress has been linked to decreased educational achievement, reduced motivation, and poorer well-being in secondary and higher education students. In a systematic study and meta-analysis of 50 studies, Wickersham et al. (2021) concluded that children and adolescents with depression have an association with decreased later educational attainment. The results in this study are not drought-related, but they illustrate the connection between mental health and academic achievement. The stress or depressive symptoms that can be caused by drought may indirectly affect children's and adolescents' academic performance of children and youth in terms of their concentration, attendance, motivation, and persistence.

Other physical environmental changes (due to drought) can also impact academic achievement. Park et al. (2020) found that heat exposure negatively affects learning and that reducing heat exposure by using school air conditioning can have a beneficial effect. This is frequently correlated with hot and dry conditions that could result in some sense of thermal discomfort, dehydration, fatigue, and poor sleep at the end of the school day due to drought-related factors. Liu et al. (2021) showed that the indoor air temperature and relative humidity can

have a significant impact on learning performance, indicating that the dryness of indoor air may have a negative impact on comfort and attention. Because Liu et al.'s study was conducted with undergraduates rather than high school students, it should be interpreted with caution.

Drought also indirectly affects students' outcomes through the impact of wildfire smoke. Wildfire smoke exposure is linked to negative effects on learning outcomes (Wen & Burke, 2022), and drought may contribute to higher exposure levels of wildfire smoke. Wildfire smoke can affect children's attendance at school, bring their activity outside the home to an early close, impair sleep, affect breathing, and concentration. This pathway is important for California because students do not just have to suffer from drought when it is dry; they can also suffer from drought when it is smoky, when activities at school get altered, or when they have anxiety about fire risk. Wildfire smoke and drought are not the same phenomenon, however, and research designs should distinguish between the effects of drought, water scarcity, smoke, and heat.

Synthesis and Gaps in the Literature

While the multi-step link between drought and student well-being is consistently supported in the literature, there is less support for a one-step link. Based on climate science, there is no shortage of research on drought in the western US; environmental health research reveals the link between drought and stress; neuroscience research indicates that chronic stress can have an impact on adolescent emotion and learning systems; and education research indicates that drought or water insecurity, as well as heat, humidity, and smoke, can have an impact on learning. The best interpretation then is subject to qualification: drought will affect high school students most when it feels beyond their control, when it strains families and communities, when it happens during hot and smoky days, and when students have less available coping resources.

This survey is justified by a number of weaknesses in the literature. First, much of the research focuses on severe clinical manifestations, on adults as a whole, or on households instead of typical high school students. Second, a number of studies of "water-insecure" situations are from settings more extreme than encountered in California, and may not be as directly relevant without adaptation. Thirdly, most anxiety studies on climate change do not have a specific focus on drought. Fourth, academic studies frequently examine heat or smoke, but not students' subjective experience of a lack of rain or dry air. These gaps suggest that a California high school survey could help by directly inquiring about how drought-related conditions are affecting mood, stress, concentration, and academic performance.

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