

How Climate Change Affects Young People's Mental Health in Southern China

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Abstract: We analyze the adverse impacts of extreme weather events, which frequently occur under the influence of climate change, on adolescents' mental health issues in Southern China. Further analyses on the effects of a tornado in Yancheng, Jiangsu province and posttraumatic stress disorder (PTSD) on adolescents are discussed in the paper. Potential solutions for treating mental illness include environmental improvements to upgrade psychological problems and psychological treatments to provide methods to decrease the impact of extreme weather events. The future implication and the expectation are discussed.

Keywords: Climate Change, Mental Health.

1. Introduction

Global climate change is a severe problem that threatens humans on Earth with the deterioration of the environment. Carbon dioxide concentration has risen to 421 parts per million, accompanied by an increase in global temperature of 1.01 °C since 1880 and melting ice caps [1]. However, due to the aggravation of climate change caused by various human activities, a mental health crisis is also emerging as one of the by-products of these environmental changes.

Climate change has a direct adverse impact on human mental health problems. Since some researchers have indicated that mental health problems are related to factors such as low socioeconomic status, climate-change-related impacts are often neglected [2]. Still, these impacts should be a concern because mental health issues, including anxiety, post-trauma stress, and depression, are related to global warming, trauma from extreme weather, and loss of livelihood [3]. Extreme weather events are one of the main factors that trigger mental health issues, and their occurrence in higher frequency synchronizes with climate change [4]. The high number of patients is attributed to extreme heat, flooding, droughts, etc., affecting the population vulnerable to traumatic events [4]. Those events expose the death of relatives, loss of properties, and social instability to the population, significantly increasing the rate of anxiety, depression, and PTSD worldwide [3]. Compared to adults, adolescents are more likely to display posttraumatic stress symptoms [5]. Due to the inability to escape danger and be independent, people under 18 face more significant threats from disastrous situations, causing mental health issues such as depression and anxiety [6]. Moreover, according to American Psychiatry Association, younger people are more vulnerable to the events since they are more likely to have continuous traumatic symptoms [7]. Although the group will

demonstrate resilience to some extent, long-term chronic stress's effects still need to be considered [7].

China, particularly, suffers from climate change, which leads to a high possibility of a greater extent of mental illness among teenagers. With a population that has reached 1.4 billion in 2022 and rapid economic growth in the past few decades, climate change is particularly significant in China [8,9]. The annual temperature steadily increases to 7.85 °C until 2020 (Figure 1). This amount to a roughly 1.2 °C increase in average temperature in China over the past 120 years.

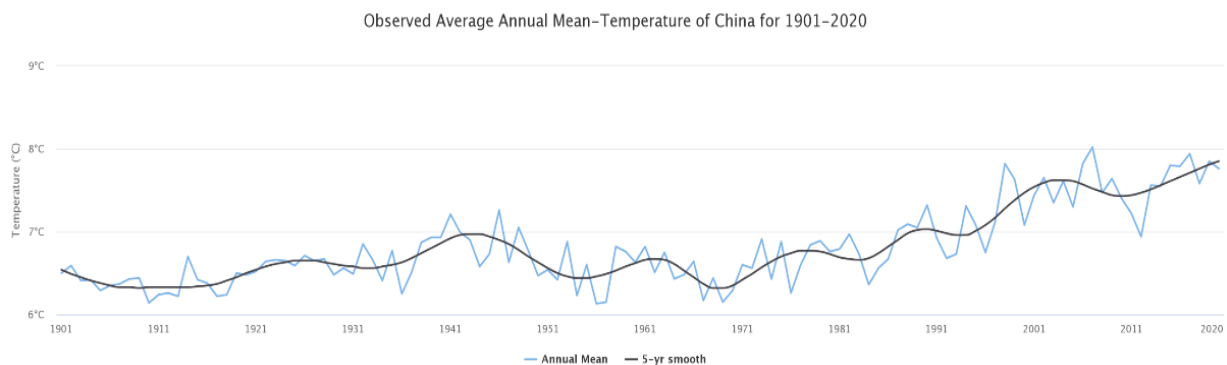


Figure 1: Average annual mean-temperature of China for 1901-2020 from Climate Change Knowledge Portal. The annual mean-temperature increased from 6.64 °C to 7.85°C.

The effect of climate change is especially severe in Southern China due to the tropical climate in this region [10]. Extreme weather events have also taken place in Southern China in these years. More frequent large-scale precipitation events are expected because of the consequences of climate change [11]. In 2020, severe flooding in the Yangtze River occurred, which caused 142 people's death and around 116 billion RMB in direct economic loss [11]. In the same year, 37 severe rainstorms occurred in China, where the southern part was significantly affected by over-precipitation [12]. Additionally, the extreme temperature in the southern area lasted over ten days, with over 33 weather monitoring stations displaying the highest recorded data [12]. Since the trend of rising probability of catastrophic weather events is happening in Southern China, an extreme weather event and a prevalent mental health issue that happened to youth will be specified in the rest of the paper, following with the potential therapy to solve the problem.

2. Analysis

In southern China, the most common climate change is tornadoes and hail. In recent years, according to the survey, [13] from the perspective of the spatial distribution of tornadoes, Jiangsu presents the distribution characteristics of central and eastern, northwestern, western, and southwestern. The tornado high incidence center in The Jianghuai region moved southward from Huai'an and Yangzhou to the middle of the Yangzhou-Taizhou region, and the high incidence center in the eastern coastal region moved northward of Yangcheng. Yancheng is the city with the highest number of tornado occurrences in Jiangsu province, followed by Xuzhou and Yangzhou. Suqian, Lianyungang and Changzhou, Zhenjiang, the four cities have no tornado records. From 2006 to 2018, the average annual number of tornado days in Jiangsu was 2.1, and the average annual number of tornado events was 3.2. In 2010, the number of tornado days and the number of tornado events were the least, which was only one day, and there was one tornado event. The number of tornado days in 2008 and 2011 was the highest, with four days. In addition, the Jiangsu tornado mainly occurs in spring and summer, with the most frequent occurrence in July and August. According to the data, July had the largest number of tornadoes, and 25 tornadoes occurred in 15 tornado days in that month, indicating that July

was the month with many tornado events. August followed with nine tornado days producing 12. This is also due to the local plum rain season. After that, Jiangsu will enter the middle of summer, along the Yangtze River and southeast China, tornados are often located on the edge of subtropical high, while tornados are mostly located in the convective system along the edge of subtropical high, which also leads to Yangzhou, Taizhou, Yancheng and other cities becoming the areas with a high incidence of tornados. Most of the tornadoes in Jiangsu are weak, below the EF2 level, but there has been an unprecedentedly large tornado event in recent years.

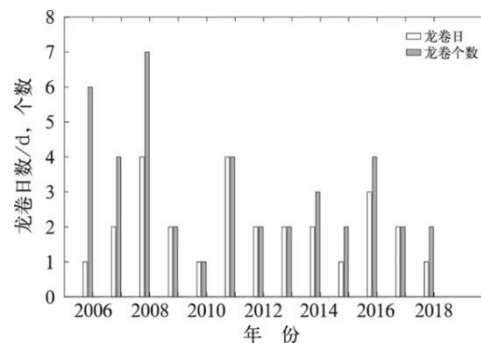


Figure 2: Histogram of the numbers of tornado days and tornado events in Jiangsu from 2006 to 2018 (x-axis is years, white area is tornado day, the black area is tornado event).

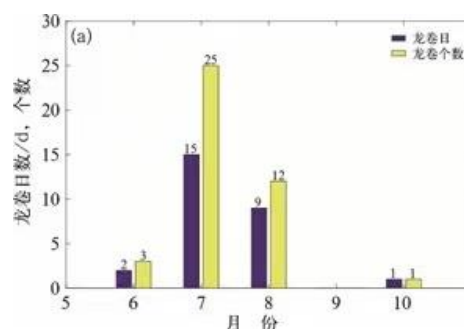


Figure 3: Monthly distribution of the number of tornadic days and the number of tornadic events (the blue area is tornado day, the yellow area is tornado event).

The most severe extreme weather event in southern China in recent years was a tornado in Funing County, Yancheng City, Jiangsu Province, on June 23, 2016. A severe hailstorm and a tornado hit Yancheng, East China's Jiangsu province, at 14:30. Through expert analysis, the tornado was rated EF4 level, wind scale of more than 17, (The maximum EF level is 5, and the maximum wind scale is 17) it also became the worst tornado in decades in southern China. The cause of the huge tornado events is high temperature in the Yangtze-Huaihe region, humidity is big, and there is a cold vortex in the sky, and cyclone appears on the ground. There is cold air in the rear and very strong wind shear in the middle and high levels, which are good conditions for tornadoes and hailstorm. According to the on-site investigation, 1347 houses were damaged, two primary schools, 8 companies, and the agricultural area was 48,000 mu. As of June 26, a total of 99 people died and 846 were injured, which undoubtedly caused great harm to the social economy and people's physical and mental health.

Most of the survivors of these massive natural disasters have suffered severe psychological effects. Studies have shown that the physical and mental health effects of these major natural disasters are more severe and lasting, and posttraumatic stress disorder (PTSD) is the most common psychological reaction. PTSD is a long-term mental disorder caused by an unusually threatening event or trauma that can last up to a month. At the same time, the likelihood of depression will also increase. To study

adolescents with PTSD after 3 months of this natural disaster, researchers used a subset of local middle school students to score on the CPSS and CES-DC. CPSS is a measure that can assess adolescents with PTSD for intrusive symptoms, avoidance symptoms, and heightened alertness [14]. The CES-DC score is a 20-item assessment of the depressed self.

| Variable | Total | PTSD | | Depression | |
|----------------------------------|-------|-----------|----------|------------|----------|
| | | No. (%) | χ^2 | No. (%) | χ^2 |
| Overall | 247 | 142(57.5) | | 145(58.7) | |
| Gender | 247 | | 0.43 | | 0.95 |
| Male | 100 | 60(60.0) | | 55(55.0) | |
| Female | 147 | 82(55.8) | | 90(61.2) | |
| Age | 247 | | 7.31** | | 4.73* |
| 12 to 14 | 170 | 88(51.8) | | 92(54.1) | |
| 15 to 17 | 77 | 54(70.1) | | 53(68.8) | |
| Grade | 247 | | 18.23*** | | 5.41 |
| 7 | 86 | 54(62.8) | | 53(61.6) | |
| 8 | 101 | 45(44.6) | | 51(50.5) | |
| 9 | 60 | 43(71.7) | | 41(68.3) | |
| Being trapped/injured themselves | 238 | | 10.41*** | | 9.71** |
| No | 224 | 126(56.3) | | 130(58.0) | |
| Yes | 14 | 14(100) | | 14(100) | |
| Parents | 238 | | 1.02 | | 10.08** |
| Trapped | 8 | 5(62.5) | | 7(82.5) | |
| Injured | 10 | 7(70.0) | | 10(100) | |
| Fine | 220 | 121(55.0) | | 125(56.8) | |
| Teachers/classmates | 232 | | 9.12** | | 6.71* |
| Trapped | 19 | 14(73.7) | | 14(73.7) | |
| Injured | 13 | 13(100) | | 12(92.3) | |
| Fine | 200 | 121(60.5) | | 119(59.5) | |
| Relatives/friends | 238 | | 9.64* | | 19.63*** |
| Trapped | 63 | 43(68.3) | | 41(65.1) | |
| Injured | 63 | 43(68.3) | | 45(71.4) | |
| Died | 22 | 16(72.7) | | 19(86.4) | |
| Fine | 90 | 43(47.8) | | 40(44.4) | |
| House/school damage | 236 | | 7.36* | | 5.24 |
| No | 103 | 50(48.5) | | 52(50.5) | |
| Lightly | 88 | 56(63.6) | | 55(62.5) | |
| Badly | 42 | 26(61.9) | | 28(66.7) | |
| Completely | 3 | 3(100) | | 3(100) | |
| The fear of injury/death | 239 | | 6.49** | | 1.11 |
| No | 106 | 52(49.1) | | 59(55.7) | |
| Yes | 133 | 87(65.4) | | 83(65.4) | |

Note. PTSD = Posttraumatic stress disorder.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Figure 4: symptoms of posttraumatic stress disorder, depression associated with demographic. Variables and tornado exposures in adolescents following the 2016 Yangcheng city tornado, China (n=247)

| Variable | PTSD | Depression |
|----------------------------------|----------------------|--------------------|
| | OR (95% CI) | OR (95% CI) |
| Gender | | |
| Male | 1 | 1 |
| Female | 0.84(0.50, 1.41) | 1.29(0.77, 2.16) |
| Age | | |
| 12 to 14 | 1 | 1 |
| 15 to 17 | 2.12(1.23, 3.88)**** | 1.87(1.06, 3.31)* |
| Grades | | |
| 7 | 1 | 1 |
| 8 | 0.48(0.27, 0.86)** | 0.64(0.35, 1.14) |
| 9 | 1.50(0.74, 3.05) | 1.34(0.67, 2.70) |
| Being trapped/injured themselves | | |
| No | 1 | 1 |
| Yes | 6.20(0.98, 39.18)* | 5.76(0.91, 36.40) |
| Parents | | |
| Trapped | 2.73(0.64, 11.66) | 0.69(0.06, 7.59) |
| Injured | 0.39(0.04, 4.34) | 1.83(0.11, 29.69) |
| Fine | 1 | 1 |
| Teachers/classmates | | |
| Trapped | 0.31(0.03, 3.79) | 0.69(0.08, 6.04) |
| Injured | 1 | 1 |
| Fine | 0.17(0.02, 1.65) | 0.30(0.05, 2.02) |
| Relatives/friends | | |
| Trapped | 1.48(0.66, 3.34) | 1.41(0.62, 3.17) |
| Injured | 1.98(1.01, 3.92)* | 2.05(1.03, 4.07)* |
| Died | 6.75(0.09, 491.96) | 6.41(0.09, 467.23) |
| Fine | 1 | 1 |
| House/school damages | | |
| No | 0.13(0.01, 4.29) | 0.14(0.01, 4.63) |
| Lightly | 0.23(0.01, 7.88) | 0.22(0.01, 7.53) |
| Badly | 0.22(0.01, 7.56) | 0.26(0.01, 9.18) |
| Completely | 1 | 1 |
| The fear of injury/death | | |
| No | 1 | 1 |
| Yes | 1.92(1.14, 3.24)* | 1.31(0.78, 2.20) |

Note. PTSD = Posttraumatic stress disorder.

* $p < 0.05$.

** $p < 0.01$.

*** $p < 0.001$.

Figure 5: associations of posttraumatic stress disorder, depression associated with demographic variables and tornado exposures in adolescent following the 2016 Yancheng city tornado, China (n=247)

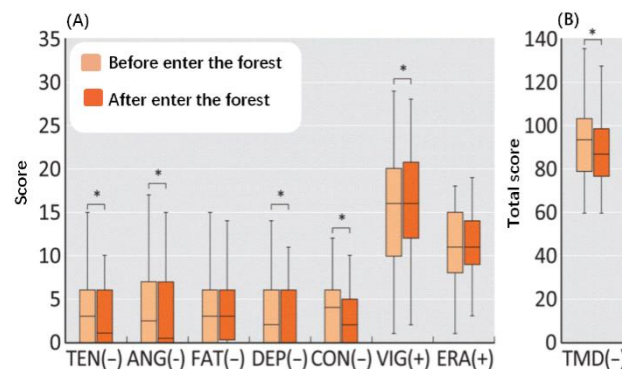
After a final investigation, [15] the researchers used the Chi-square test and multiple logistic regression to determine the associations and independent associations between PTSD and depression with demographic variables and tornado exposure, respectively. The results showed that there was no significant difference between boys' PTSD and girls' PTSD after 3 months, while teens aged 15 to 17 had higher PTSD severity and depression severity than teens aged 12 to 14. And both figures 4 and 5 make it clear that other extras such as being trapped or injured, injury of their teacher or classmate, and the death of a loved one or friend are associated with both symptoms. In table 5, participants with a relative or friend injury were 1.98 to 2.05 times more likely to develop PTSD and depression, while older participants were 1.87 to 2.12 times more likely to develop PTSD than younger participants. The reason for these phenomena may be that older adolescents may have poor cognitive coping and that there is no significant difference between males and females that it occurs shortly after the disaster, and both may not be actively involved in meaning formation. Most of the local teenagers in rural China are left-behind children, and their parents work far away from home and lack long-term communication with their parents. At this time, teenagers will feel depressed when dealing with trauma. In general, the prevalence rate of PTSD and depression was 57.5% and 58.7% respectively after the tornado event, which was higher than the prevalence rate of 5.9%-40.5% among the whole Chinese teenagers, which undoubtedly became a noticeable problem in today's society.

3. Solution

3.1. Environmental Improvements to Upgrade Psychological Problems

Short-term environmental exposure to forests can significantly improve human cardiopulmonary and psychological health, including lower blood pressure, improved lung function, and improved mood.

[16]. A total of 1489 visitors who stayed in the forest park for 0.5 to 8 h were investigated in the study from August to October 2018. Psychological questionnaires were conducted at 2 time points before and after the study participants entered the forest park. The study participants underwent a psychological questionnaire survey, and the Chinese normative "profile of mood states, POMS" with validated reliability and validity was selected to assess mood states, and 7 subscales of tension, anger, fatigue, depression, energy, panic, and self-esteem and total mood disturbance (TMD) scores of mood states were calculated [17].



PS: TEN, ANG, FAT, CON, VIG, and ERA are tension, anger, fatigue, depression, energy, panic, and sense of self-esteem, respectively; (+) and (-) indicate positive and negative emotions, respectively

Figure 6: Change in Mood of Study Participants Before and After Entering the Background Forest Park in August-October 2018 (N=120)

With lower concentrations of air pollutants (except O₃) in the forest park air quality was better. The four subscales of tension, anger, depression, and panic, as well as the total TMD score, decreased in study subjects after entering the forest compared to before entering the forest environment (t tension = 4.432, t anger = 4.104, t depression = 3.462, t panic = 3.829, t TMD = 3.844, all $P < 0.001$), and negative emotions were significantly improved. Meanwhile, positive mood energy scores were elevated (t energy = 2.777, $P = 0.006$).

In conclusion, urban forest environmental exposure was effective in improving mental health levels in the general population.

Noise levels in the park had a significant effect on physiological indicators [18] (diastolic blood pressure, brain waves, distance perception in attention recovery, attractiveness, and compatibility) [19]. Listening to birdsong accompanied by classical music reduces the negative effects on the ego. In the built environment, similar natural sounds (birdsong and running water) are more pleasurable than other sounds, which were found to trigger faster recovery after stress as measured by electrodermal levels.

3.2. Psychological Treatment

3.2.1. Cognitive Behavioral Trauma Therapy (TF-CBT)

Cognitive behavioral trauma therapy has emerged as a promising intervention for counselors to consider [20]. TF-CBT was developed specifically for children and adolescents and has become one of the primary treatments for trauma and PTSD in this population, as well as for co-occurring depression. TF-CBT uses trauma-sensitive interventions, as well as CBT, and is a relatively short treatment approach lasting 12 to 16 weeks. A fundamental principle of TF-CBT is gradually exposing children to traumatic experiences through various therapeutic modalities. The treatment model can be described by the acronym PRACTICE and focuses on the development of coping skills through

activities including psychoeducation, relaxation training, affective coping skills, cognitive reframing, trauma narration, in vivo exposure, conjoint child and parent sessions, and enhancement of future safety [21].

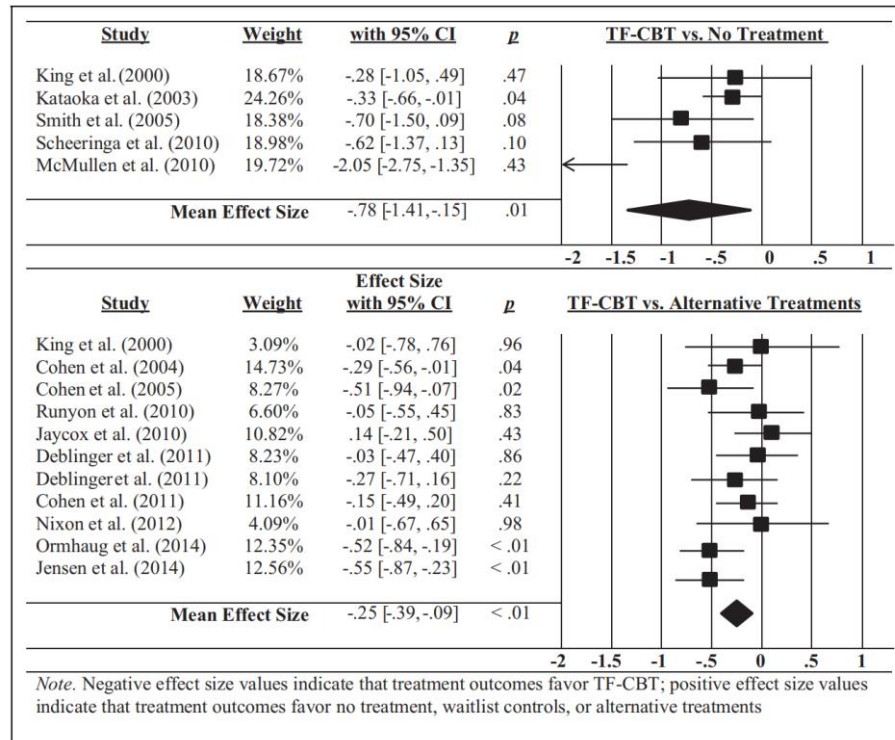


Figure 7: Effect sizes, 95% confidence intervals, and p values for studies evaluating TF-CBT for decreasing PTSD symptoms using no treatment/wait-list and alternative treatment comparison groups. PTSD $\frac{1}{4}$ posttraumatic stress disorder; TF-CBT $\frac{1}{4}$ trauma-focused cognitive behavioral therapy.

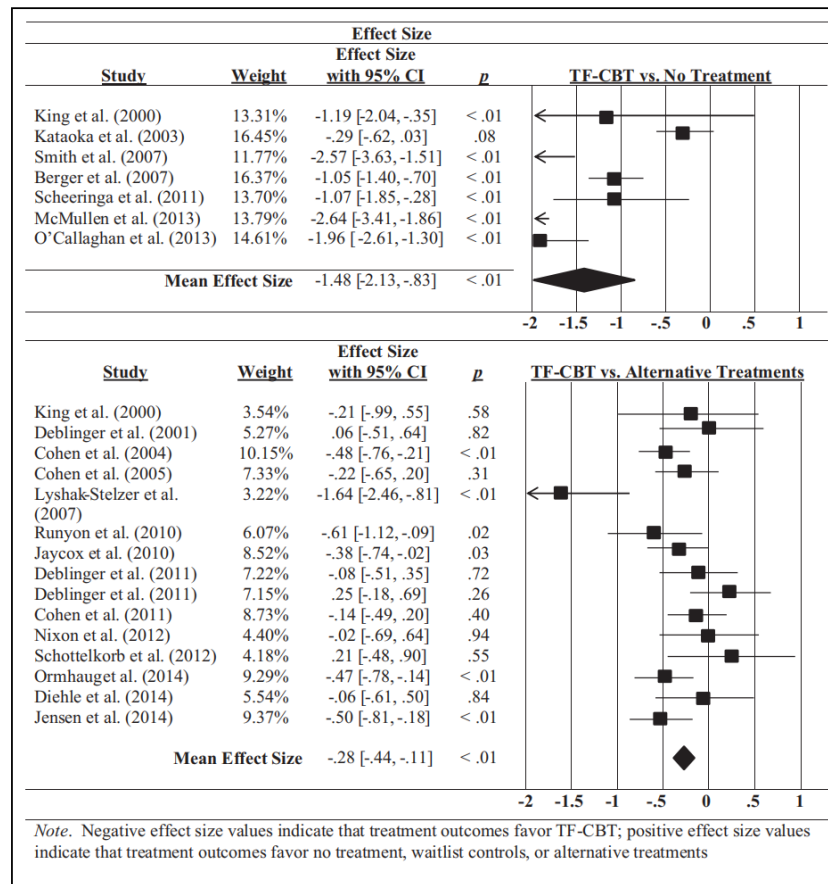


Figure 8. Effect sizes, 95% confidence intervals, and p values for studies evaluating TF-CBT for decreasing symptoms of co-occurring depression using no treatment/wait-list and alternative treatment comparison groups. TF-CBT $\frac{1}{4}$ trauma-focused cognitive behavioral therapy.

In 21 studies evaluating the efficacy of TF-CBT in reducing PTSD, the mean effect sizes indicated that TF-CBT was remarkably superior to no treatment or waitlist comparisons and relatively superior to alternative treatments. 17 studies evaluated the effectiveness of TF-CBT in reducing co-occurring depressive symptoms and showed differential support for TF-CBT compared with a waitlist and alternative treatments. TF-CBT was significantly more effective in studies that implemented waitlist or no-treatment comparisons. The analysis suggests that TF-CBT is a promising intervention in the treatment of PTSD and depressive symptoms in children and adolescents compared to no treatment or alternative therapies.

3.2.2. Outdoor Sports

The mental health level of college students who regularly participate in outdoor sports is significantly higher than those who have never participated in outdoor sports, and outdoor sports have a certain promotion effect on college students' mental health [22]. Outdoor sports have a positive effect on college students' emotional regulation. The independent sample t-test of the depression and the emotional control ability between college students who regularly participated in outdoor sports and those who never participated in outdoor sports showed a significant difference between them. Those students who regularly participated in outdoor sports had higher emotional control ability and showed a lower level of depression than those who never participated in outdoor sports.

4. Conclusion

The rising rate of extreme weather events occurring in China is related to global climate change. We specifically focus on adolescents in Southern China, since posttraumatic stress disorder happens among young people and affect their mental well-being. Thus, this paper provides further analysis on an event and PTSD, a possible solution of using environmental improvements to upgrade psychological problems and psychological treatments, and its feasibility, giving potential future studies an inspiring pathway to focus on. Furthermore, the content might shed light on the severity of adolescent posttraumatic mental illnesses in Southern China. By revealing the relationship between mental health and climate change, and analyzing specific cases, the authors hope to raise attention to this negative influence of climate change.

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Minna Lai, Sze-chi Huang, and Tianen Chen contributed equally to this work and should be considered co-first authors.

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