

# Coaching an Endangered Sport: Climate Change Concerns and Coaching Burnout in Youth Cross-Country Skiing

By Hans-Peter B. de Ruiter<sup>1</sup>, Samantha J. Adler, MS<sup>1</sup>, and Sarah M. Kaja, PhD<sup>1</sup>

<sup>1</sup>Department of Pediatrics, University of Minnesota, Twin Cities

**Abstract: Purpose:** The purpose of this study was to explore cross-country ski coaches' concerns regarding climate change, symptoms of coaching burnout, and relationships between the two. **Methods:** Participants were cross-country ski coaches ( $N = 116$ ) from Michigan, Minnesota, and Wisconsin with a variety of coaching roles and experience levels. A quantitative, observational, cross-sectional design was used. Coaches completed a survey with items measuring concerns about climate change's current and future impacts on cross-country skiing and items from the Coach Burnout Questionnaire (CBQ). Descriptive statistics, correlation analyses, and post-hoc tests were conducted. **Results:** Coaches reported concerns about the impacts of climate change on cross-country skiing now and in the future. Coaches' concerns about climate change and their degree of coaching burnout were significantly and positively correlated ( $r = 0.37-0.42, p < .001$ ). That is, coaches who perceived climate change to be more disruptive to youth cross-country skiing felt more exhausted, less accomplished, and less invested in coaching. **Conclusions:** Concerns about climate change associate with worse well-being among cross-country ski coaches. As environmental challenges increasingly disrupt cross-country skiing, supporting coaches will be important. Future research and practical interventions should evaluate and aim to mitigate potential impacts of climate-related stressors and explore strategies to promote resilience and equity within the sport.

## Introduction

Cross-country skiing (also referred to as “Nordic skiing”) holds deep historical and cultural significance in the Upper Midwestern United States. Cross-country skiing is both a physical activity and a cultural tradition, connecting individuals to the natural beauty of

winter landscapes (Theyerl, 2022). Thousands of people cross-country ski throughout Michigan, Minnesota, and Wisconsin; ski trails have long served as backdrops for community connection and athletic excellence during the region's long, snowy winters (Dunleavy, 1981). Cross-country skiing has served as a tool for promoting

physical and mental well-being, encouraging youth and adults to stay active during the winter months while embracing a sport deeply tied to the rhythm of seasonal change (Bernard et al., 2021). Many youth learn to ski in the Upper Midwest every year, participate on recreational and competitive teams, and build relationships and skills that keep them returning to the sport each winter (Theyerl, 2022). However, the youth cross-country skiing community faces mounting challenges as they navigate increasing pressures of climate change on coaches and long-standing barriers to equitable participation (Gastón & Higson, 2023; Maslach & Leiter, 2016; Scott et al., 2022; Theyerl, 2020).

During the 2023–2024 winter, warm temperatures and a lack of snowfall caused widespread disruptions to cross-country skiing in the Upper Midwest (U.S. Department of Commerce, 2024). Cross-country skiing is uniquely vulnerable to the effects of climate change due to its dependence on consistent, snowy winter conditions and cold temperatures. As winters in the Upper Midwest grow warmer, the frequency of seasons with unreliable snow increases (U.S. Environmental Protection Agency, n.d.). Ski seasons become shorter, and teams rely more heavily on artificial snow production than in previous years. These issues limit access to the sport and raise the costs for youth and families, as they need to travel farther to access ski trails and pay for passes on trails using expensive snowmaking equipment (Falk & Vanat, 2016). Furthermore, there is reason to suspect that the effects of climate change on youth cross-country skiing will not be felt equally by all participants.

Historically, cross-country skiing has been concentrated in predominantly White

communities with expansive park spaces, where trail systems and skiing infrastructure were established. High costs accompany cross-country skiing even in seasons with optimal weather: participants must pay for equipment, travel, and race participation (Theyerl, 2020). During warmer seasons, the need to travel to snowmaking sites increases costs, making participation more expensive. This disproportionately impacts lower-income participants, which further exacerbates the economic and systemic barriers already present in the sport (Tandon et al., 2021). Worsening conditions will likely make it harder for teams and programs to expand access and reach new skiers. Resources may be redirected to simply maintain existing opportunities. Over time, these challenges could make cross-country skiing even more insular, leaving fewer opportunities for participation and growth (Steiger et al., 2020). Addressing the intersections of climate change and equity in the sport is essential for ensuring its sustainability and fostering a more inclusive future. Previous research has shown that climate change poses significant challenges to winter sports, particularly regarding access and sustainability, though no work in the United States has examined cross-country skiing specifically (Scott et al., 2022).

Climate issues and barriers to entry for diverse communities likely make it harder for coaches to sustain and grow cross-country skiing. Coaches are linchpins in cross-country skiing communities, acting as mentors and leaders who sustain the sport by developing the next generation of skiers while fostering a sense of connection among their athletes (Vella et al., 2012). With an array of climate- and equity-

related challenges experienced by youth and families, coaches' responsibilities extend far beyond merely implementing training programs. Cross-country ski coaches' responsibilities regularly include organizing transportation, maintaining fleets of ski equipment, modifying plans to account for potential weather disruptions, and generally sustaining and growing the sport in the Upper Midwest. In warm or low-snow winters, they need to identify more sources of funding, purchase additional equipment, coordinate more travel to snow, create season plans that are readily modifiable, develop strategies to teach new skiers to ski on little or no snow, and support skiers' fitness, training, and competition goals (Kaja et al., 2024). The increasing demands of dealing with the challenges of working in a sport so reliant on consistent winter conditions may heighten the risk of burnout among coaches (Larner et al., 2017).

Athletic coach burnout is defined as coaches feeling emotionally exhausted and less accomplished in their work (Lundkvist et al., 2014; Raedeke & Smith, 2001). They can also experience depersonalization (i.e., a sense of detachment from their athletes and communities) and devaluation (i.e., lost interest in their sport or greater resentment towards coaching; Lundkvist et al., 2014; Raedeke & Smith, 2001). Prolonged exposure to stressors contributes to and exacerbates burnout (Maslach & Leiter, 2016). Coach burnout is a growing concern in many sports, with common causes including long hours, high expectations, difficulties with work-life balance, lack of perceived control, and limited resources (Maslach et al., 2001; Oglesby et al., 2020). Concerningly, coaches may not feel as though

they can show vulnerability by seeking help or treatment for burnout, resulting in the suppression of symptoms (Olusoga et al., 2019). Without discussion of burnout or help available, coaches may recognize when their symptoms are beyond functional, normative fatigue. Across performance contexts and roles, heightened, untreated burnout leads to health concerns (e.g., substance use, depression) and poorer coaching performance (Maslach et al., 2001; Oglesby et al., 2020). Very few, mostly dated studies have examined athletes' responses to coach burnout, but findings suggest coach burnout can lead to differences in coaching styles or behaviors (e.g., providing athletes less social support), which can lead to negative psychological outcomes and burnout among athletes (Jiahao & Jing, 2024; Price & Weiss, 2000; Vealey et al., 1998).

In sum, there is reason to be concerned about American youth cross-country skiing and coaches' levels of burnout as climate change progresses (Intergovernmental Panel on Climate Change [IPCC], 2021). The effects of climate change are accelerating, creating added stress to the day-to-day operations of coaching (Scott et al., 2022). Cross-country ski and other winter sport coaches are grappling with the potential deterioration of sports in which they are highly invested (Lawrance et al., 2022). The added toll of worrying about unstable conditions—on top of already demanding coaching roles—will likely exacerbate cross-country ski coaches' feelings of burnout, thwarting them from supporting and expanding the sport to diverse communities. While burnout among coaches has been explored in other contexts, there is minimal understanding of how existential concerns about climate change may influence burnout

among those in climate-dependent sports (Lundkvist et al., 2014; Raedeke & Smith, 2001).

### Study Purpose

This study had three purposes involving youth cross-country ski coaches in the Upper Midwest. The first was to evaluate coaches' perceptions of the impacts of climate change on cross-country skiing. The second was to examine youth cross-country ski coaches' levels of burnout. The third was to explore relationships between coaches' perceptions of climate change and their level of burnout. The research team hypothesized coaches with heightened concerns about the impacts of climate change would report higher burnout.

### **Methods**

#### Participants

Data came from cross-country ski coaches who completed a survey examining their perceptions of the 2023–2024 ski season in the Upper Midwestern United States. Eligible participants were adults who coached at least one skier who was 18 years old or younger and who coached during the 2023–2024 season in Michigan, Minnesota, or Wisconsin. The research team recruited coaches through various methods, including sending e-mails to cross-country ski clubs and teams, posting flyers on cross-country ski websites and at ski shops, and reaching out to local organizations directly.

#### Measures

##### *Climate Change Concerns*

Five items assessed coaches' concerns about current and future impacts of climate change on cross-country skiing. Each item asked coaches to indicate their level of agreement with

a presented statement, using a 5-point Likert scale with responses ranging from Strongly Disagree (scored as 1) to Strongly Agree (scored as 5). The five items were: (1) "I am concerned that changes in weather, snow, and temperature patterns are currently impacting the weather and snow conditions that my youth skiers train and compete in"; (2) "I am concerned that in the future, changes in weather, snow, and temperature patterns will impact conditions that my youth skiers train and compete in"; (3) "Changes in weather, snow, and temperature patterns are placing Nordic skiing and future generations of skiers in the Upper Midwest at risk"; (4) "Changes in weather, snow, and temperature patterns may make it harder for Nordic ski teams in the Upper Midwest with fewer financial resources to be competitive"; (5) "Changes in weather, snow, and temperature patterns may make it more difficult to include diverse communities in Nordic skiing in the Upper Midwest." The first three items emanate from Scott et al.'s (2022) study on perceptions of the risks of climate change among Olympic-level winter sports coaches and athletes. The three items were modified slightly to be appropriate for youth cross-country ski coaches (given the lack of existing measures and research in the sport). Items 4 and 5 were purpose-built by the research team, to address the inclusion of diverse communities.

##### *Coaching Burnout*

The extent to which coaches experienced burnout was measured with the 15-item Coach Burnout Questionnaire (CBQ; Lundkvist et al., 2014). The CBQ is an adapted version of the Athlete Burnout Questionnaire (ABQ; Raedeke & Smith, 2001), modified for a coaching

context. The CBQ includes items regarding three different elements of coach burnout, with five questions focusing on each of the following elements: reduced sense of accomplishment (e.g., “It seemed no matter what I did, I didn’t coach as well as I should have”), emotional/physical exhaustion (e.g., “I felt ‘wiped out’ from coaching”), and devaluation (e.g., “I felt less concerned about being successful in coaching than I used to”). Coaches responded to each of the 15 items using a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree. The ABQ—from which the CBQ was adapted—has demonstrated sufficient factorial validity and scale reliability, with McDonald’s omega reliability estimates for the three burnout elements ranging from 0.77 to 0.85 (Grugan et al., 2024). Regarding the coaching population specifically, Lundkvist et al. (2014) conducted comparisons between three coach burnout measures, and deemed the CBQ to be the most optimal tool, based on psychometric evaluation and appropriate theoretical considerations. These previous studies support the use of the CBQ as a robust measure of coach burnout. As demonstrated in previous studies, coaches’ scores were averaged across all 15 items to use in analyses, with higher scores indicating a greater degree of burnout (Lundkvist et al., 2014; Raedeke & Smith, 2001).

### *Coach Characteristics*

Coaches were asked to indicate whether they were head coaches, assistant coaches, or served another role for a ski team; how many years of ski coaching experience they had; what city and state they coached in; and the type of team they coached (i.e., a school-affiliated team;

not school-affiliated club team; or collegiate varsity or collegiate club team).

### Data Analysis

First, the research team calculated descriptive statistics to explore the sample, including calculating frequencies and percentages of all coach characteristics. Next, the team examined frequencies and percentages of coaches’ responses to climate concern items. After that, mean burnout scores were computed for all coaches.

After exploring the data, the research team calculated Pearson correlation coefficients to assess the relationship between each climate concern item and coaches’ average burnout scores. The direction and strengths of correlations were interpreted based on their correlation coefficients (Akoglu, 2018). For post-hoc tests, the team computed *t*-statistics and corresponding *p*-values to determine whether correlations were statistically significant at  $p < .05$ , given the exploratory nature of this study.

### **Results**

The results of this study are presented in four parts: (1) characteristics of coach participants, (2) coaches’ concerns on the current and future impacts of climate change on cross-country skiing, (3) burnout among coaches, and (4) relationships between coaches’ climate concerns and burnout.

### Characteristics of Coach Participants

Table 1 (below) summarizes demographic characteristics and professional experience of the 116 participants. Forty-eight percent ( $n = 56$ ) were head coaches and 46%

were assistant coaches. Some held other roles, such as manager or team president. Most participants coached in Minnesota (79%,  $n = 92$ ) and in the Twin Cities Metro Area. Over 70% had coached cross-country skiing for at least four years, with 29% ( $n = 22$ ) having 15 or more years of experience.

**Table 1.** Characteristics of Cross-Country Ski Coach Participants ( $N = 116$ )

	<b><i>n</i> (%) of Sample</b>
<b>Coaching Position</b>	
Head Coach	56 (48.28%)
Assistant Coach	53 (45.69%)
Other Coaching Roles (e.g., Manager, Team President)	7 (6.04%)
<b>Years of Coaching Experience</b>	
1–3 Years	23 (19.83%)
4–6 Years	26 (22.41%)
7–9 Years	11 (9.48%)
10–14 Years	23 (19.83%)
15 or More Years	33 (28.45%)
<b>State</b>	
Michigan	4 (3.45%)
Minnesota	92 (79.31%)
Wisconsin	20 (17.24%)
<b>In Twin Cities Metro Area</b>	50 (43.10%)

*Note.* Twin Cities Metro Area (in Minnesota) includes Anoka, Carver, Dakota, Hennepin, Ramsey, Scott, and Washington Counties.

### Coaches' Concerns Regarding Impacts of Climate Change on Cross-Country Skiing

Overall, the majority of coaches were concerned that changes in weather, snow, and temperature patterns are and will continue to impact youth cross-country skiing in the Upper

Midwest, as shown in Table 2 (on following page). Mean scores on items regarding concerns about climate change ranged from 4.08 to 4.51 (out of a possible score of 5). This indicates that, on average, coaches trended toward strong agreement with statements about concerns related to climate change. The strongest levels of agreement were observed for concerns about financial challenges for less-resourced teams ( $m = 4.51$ ,  $sd = 0.85$ ), with 106 coaches (91%) somewhat agreeing or strongly agreeing that climate change would make it more difficult for less financially resourced teams to remain competitive. Similarly, coaches agreed that they were concerned that climate change will impact youth skiers' training and competition in the future ( $m = 4.44$ ,  $sd = 0.91$ ), with 88% of coaches somewhat agreeing or strongly agreeing. Most coaches also strongly agreed that climate change will put future generations of youth cross-country skiers at risk. Concerns about barriers to the inclusion of diverse communities in skiing showed slightly more variability ( $m = 4.08$ ,  $sd = 1.01$ ), with 41% of coaches strongly agreeing and 16% neither agreeing nor disagreeing.

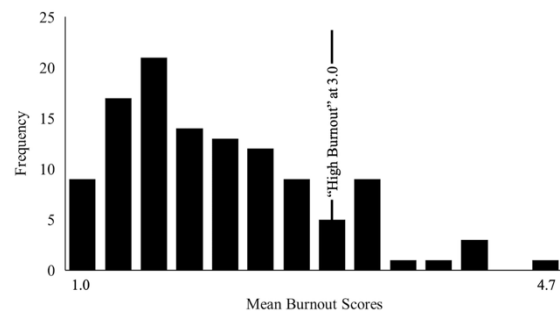
**Table 2.** Coaches' Concerns Regarding the Impacts of Climate Change on Cross-Country Skiing ( $N = 116$ )

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree	
<b>Climate change...</b>	<b><i>n</i> (%)</b>					<b>Mean (sd)</b>
Currently Impacts Training & Competition	67 (57.78)	39 (33.6)	4 (3.45)	2 (1.72)	4 (3.45)	4.41 (0.91)
Will Impact Future Training & Competition	76 (65.52)	26 (22.41)	7 (6.04)	3 (2.59)	4 (3.45)	4.44 (0.97)
Puts Future Generations at Risk	68 (58.62)	34 (29.31)	5 (4.31)	5 (4.31)	4 (3.45)	4.35 (1.00)
Make it Hard for Teams with Financial Challenges	76 (65.52)	30 (25.86)	6 (5.17)	1 (0.86)	3 (2.59)	4.51 (0.85)
Make it More Difficult to Include Diverse Communities	47 (40.52)	43 (37.07)	18 (15.52)	4 (3.45)	4 (3.45)	4.08 (1.01)

*Note.* All climate change items ranged from 5 (Strongly Agree) to 1 (Strongly Disagree). Median for all items was 5, except for “may make it more difficult to include diverse communities”, which was 4.

### Burnout Among Cross-Country Ski Coaches

Responses to the CBQ (Lundkvist et al., 2014; Raedeke & Smith, 2001) are summarized here. One coach did not complete the CBQ and was removed from related analyses. Out of a total possible score of 5, the average coach burnout score was 2.1 ( $sd = 0.8$ ), with scores ranging from 1.0 to 4.7. Per Lundkvist et al. (2014) and Raedeke and Smith (2001), coaches with an average burnout score of 3.0 or greater were classified as having high burnout. Nineteen coaches (16.4%) in this study had scores classified as high burnout. The distribution plot of the burnout scores in Figure 1 (on the right) illustrates variability in burnout scores, showing that while most coaches did not meet the threshold for high burnout, a sizable minority did experience high burnout.



**Figure 1.** Distribution of Cross-Country Ski Coaches' Burnout Scores ( $N = 115$ )

### Relationships Between Climate Change Concerns and Burnout Among Cross-Country Ski Coaches

Pearson correlation coefficients examining associations between coaches' concerns regarding the impacts of climate change and their degree of coaching burnout are reported in Table 3. Though a subset of coaches reported “high” burnout (i.e., average scores of 3.0 or higher), the research team decided to treat burnout scores continuously in correlation

analyses, as has been done in previous research using the CBQ (Lundkvist et al., 2014; Gerber et al., 2018). Positive and statistically significant correlations were observed between each of the five climate change concern items and burnout scores. That is, stronger agreement with statements about concerns related to climate change were associated with a higher degree of burnout among cross-country ski coaches. All correlation coefficients were moderate in strength, ranging from 0.37 to 0.42. The strongest correlation occurred between coaches' concerns about the risks of climate change affecting cross-country skiing for future generations and coach burnout ( $r = 0.42$ ).

**Table 3.** Correlations Between Cross-Country Ski Coaches' Concerns Regarding Climate Change and Coaching Burnout ( $N = 115$ )

Climate Change Concern	$r$
Currently Impacts Training & Competition	0.37
Will Impact Future Training & Competition	0.39
Puts Future Generations at Risk	0.42
Make it Hard for Teams with Financial Challenges	0.40
Make it More Difficult to Include Diverse Communities	0.39

*Note.*  $r$  = Pearson correlation coefficient with coaching burnout. Each correlation was statistically significant (all  $p < .001$ ).

## Discussion

This study examined cross-country ski coaches' concerns regarding climate change and their coaching burnout. Results demonstrated that coaches with stronger concerns about climate change threatening current and future youth cross-country skiing, posing financial burdens to ski teams, and limiting diversity in cross-country skiing reported higher levels of coaching burnout. As this is the first known

study to investigate perceptions of the effects of climate change and burnout among cross-country ski coaches in the United States, our findings encourage future research and action. In addition to continued efforts to mitigate global warming, work supporting the infrastructure of cross-country skiing and the well-being of coaches and athletes will be needed as climate change progresses (Falk & Vanat, 2016; Bernard et al., 2021).

Overall, coaches expressed relatively consistent concern about the current and future impacts of climate change on their sport. These findings were anticipated by the research team and coincide with our hypothesis. Similar findings have been observed among coaches and athletes in other winter sports (Scott et al., 2022). Among Olympic and elite-level winter sport coaches, Scott et al. (2022) found widespread apprehension about the future of their respective winter sports under worsening climate conditions. They emphasized financial concerns and access to reliable snow. Scott et al.'s (2022) findings mirror those from the current study, as coaches believed climate change would make it harder for teams with fewer financial resources to remain competitive and to include diverse communities in skiing.

While weather disruptions are central challenges to youth cross-country skiing, barriers to including diverse communities in cross-country skiing extend beyond weather (Theyerl, 2020). Most coaches in the current study suggested that climate change will exacerbate barriers to diverse communities participating in cross-country skiing, though coaches' responses to this item were more variable than items assessing other concerns. Coaches recognize multifaceted barriers to

cross-country skiing, such as high costs for equipment, travel, and race participation, as well as a lack of representation and difficulty in recruiting and retaining participants from diverse backgrounds (Gastón & Higson, 2023). Inclusivity challenges to cross-country skiing have existed independently of weather-related disruptions and could be exacerbated by climate change (Lawrance et al., 2022; Scott et al. 2022). A broader body of literature indicates that the consequences of climate change, including on physical activity participation and health, are not borne equally (Berberian et al., 2022; Bernard et al., 2021). Racial, socioeconomic, and geographic disparities exist, though most equity-driven climate change research has focused on extreme heat and weather events, rather than winter sports (Berberian et al., 2022; Bernard et al., 2021). There is simultaneous need to address climate-driven impacts on cross-country skiing and inequities limiting access to the sport; compounding barriers will require innovation. Overall, the research team found that cross-country ski coaches are concerned about growing the sport in underreached communities and maintaining the sport in general.

The research team anticipated that more coaches would report a “high” degree of burnout (Gerber et al., 2018; Westfall, 2018). That is, a greater number of coaches were expected to experience pronounced emotional exhaustion, devaluation, and reduced personal achievement after a season characterized by record-high temperatures and low snow. However, the research team observed that coaches who indicated a higher level of concern about climate change also reported stronger symptoms of burnout, as initially hypothesized. Previous studies in other sports have found that

most coaches report moderate rather than high burnout, though even moderate levels of burnout are concerning and interindividual differences exist (Olusoga et al., 2019; Westfall et al., 2018).

Extant research has also posited that coaches with more years of experience may be more resilient to burnout (Olusoga et al., 2019; Westfall et al., 2018). Coaches in the current sample were quite experienced. They may have developed strategies to adapt in previous winters, albeit with less unfavorable conditions than in 2023–2024. Less experienced coaches, who could have been more vulnerable to burnout, might have been underrepresented in this sample (Olusoga et al., 2019; Westfall et al., 2018). There is also the possibility that coaches who had higher burnout left coaching before the end of the season (or before the survey was distributed) and therefore might not have been included. Timing may also have played a role in these results, as coaches completed this study’s survey one to three months after the ski season ended. Coaches may have recovered from season-related burnout before completing the survey.

#### *Implications for Future Research and Practice*

The findings from this study underscore the need for proactive measures to support coaches as they face climate-related challenges and potential emotional and professional strain. Researchers and practitioners should collaborate to design, test, and refine coach support programs for cross-country ski coaches. Few interventions have been designed specifically for coaches, but research suggests they should target both the individual (e.g., help coaches establish relaxation strategies and coping skills) and

organizational components (e.g., providing regular assessments of burnout; Schaffran et al., 2016). Addressing burnout requires a multifaceted approach, including providing resources to support coaches' mental health and working to mitigate climate change's impact on skiing. Making youth cross-country skiing more affordable and accessible could reduce coach burnout and help recruit and retain skiers from diverse backgrounds, ensuring more young athletes can experience the sport's physical and social benefits while fostering a deeper connection to the outdoors (Gastón & Higson, 2023; Theyerl, 2020).

Further research is needed to understand these dynamics better and inform targeted interventions. Additional research endeavors should explore long-term effects of climate concerns on burnout through longitudinal studies and expand the scope to include more geographically diverse populations of coaches. Additionally, studies should investigate interventions to mitigate burnout, such as mental health resources, community support systems, and adaptive strategies for coaching in unpredictable conditions. Developing validated tools tailored to cross-country skiing would also enhance the precision of future findings.

### *Strengths and Limitations*

In addition to contributing new insights to multiple underexplored areas of research, the present study involved several methodological strengths. Importantly, the members of the research team all possess personal experience with cross-country skiing or coaching in the Upper Midwest. Two of the researchers have further educational training and expertise in sport psychology, youth development, and

burnout. Having multiple perspectives was valuable for developing the study materials and revising the paper. Additionally, the research team used items developed in previous studies of winter sports (i.e., Scott et al., 2022) and a validated measure of coach burnout (i.e., Lundkvist et al., 2014; Raedeke & Smith, 2001). Coaches hailed from three states with shared weather patterns during 2023–2024.

Despite these strengths, several study limitations should be considered. As a cross-sectional study, causal links between climate change concerns and coach burnout cannot be determined. While 116 coaches were successfully recruited, the use of convenience sampling introduces potential sampling bias, making it unclear how representative this sample is of the broader population of cross-country ski coaches in the Upper Midwest (e.g., in terms of total population size, geographical distribution, years of experience, etc.). Coaches with severe burnout could have been less likely to participate in the survey (Olusoga et al., 2019). Even though these items were adapted from existing research and used a validated questionnaire to measure burnout, no measurement tools have been explicitly validated with cross-country ski coaches, potentially limiting their accuracy in this context. Future studies that examine a broader population sample should leverage inferential statistics to account for demographic and other differences in analyses. In spite of these limitations, this novel study provides a foundation for understanding relationships between climate change concerns and coach burnout in cross-country skiing, allowing subsequent work to build on these results.

## Conclusion

This study provides some of the first insights into associations between climate change concerns and burnout among cross-country ski coaches. Our findings suggest a connection between existential climate concerns and symptoms of coaching burnout, underscoring how climate change not only threatens the sport's physical infrastructure but also its human foundation.

Supporting cross-country ski coaches in the Upper Midwest amidst accelerating climate change will be critical to the persistence of the sport in the region. Last year, Minnesota hosted the first International Ski and Snowboard Federation (FIS) Cross Country World Cup on American soil in more than two decades after navigating substantial weather challenges. Community members described the event as

“captivating Minneapolis and the world” (Bentley, 2024a, title). Olympic and World champion Jessie Diggins, as well as multiple other members of the U.S. Cross Country Ski Team, learned to ski from coaches in the Upper Midwest (Bentley, 2024b). Multiple state, regional, and national organizations have explicit missions to address financial barriers, increase access, and expand cross-country skiing to reach underrepresented populations of young people (e.g., The Loppet Foundation, n.d.; Share Winter Foundation, 2023). Coaches play central roles in these competitive and equity-focused pursuits, and they are doing so as climate change reshapes winters in the Upper Midwest. Our findings serve as a call to action for stakeholders to invest in the resilience of cross-country skiing—and the coaches who facilitate it—in an era of accelerating climate change.

## References

- Akoglu, H. (2018). User's guide to correlation coefficients. *Turkish Journal of Emergency Medicine*, 18(3), 91–93. <https://doi.org/10.1016/j.tjem.2018.08.001>
- Bentley, L. (2024a, February 21). *Historic weekend of World Cup ski racing captivates Minneapolis and the world*. U.S. Ski & Snowboard. <https://www.us Skiandsnowboard.org/news/historic-weekend-world-cup-ski-racing-captivates-minneapolis-and-world>
- Bentley, L. (2024b, September 11). *2024-25 Stifel U.S. Cross Country Ski Team announced*. U.S. Ski & Snowboard. <https://www.us Skiandsnowboard.org/index.php/news/2024-25-stifel-us-cross-country-ski-team-announced>
- Berberian, A. G., Gonzalez, D. J. X., & Cushing, L. J. (2022). Racial Disparities in Climate Change-Related Health Effects in the United States. *Current environmental health reports*, 9(3), 451–464. <https://doi.org/10.1007/s40572-022-00360-w>
- Bernard, P., Chevance, G., Kingsbury, C., et al. (2021). Climate change, physical activity, and sport: A systematic review. *Sports Medicine*, 51, 1041–1059. <https://doi.org/10.1007/s40279-021-01439-4>
- Dunleavy, J. E. (1981). Skiing: The worship of Ullr in America. *Journal of American Culture*, 4(3), 75–85. [https://doi.org/10.1111/j.1542-734X.1981.0403\\_75.x](https://doi.org/10.1111/j.1542-734X.1981.0403_75.x)

- Falk, M., & Vanat, L. (2016). Gains from investments in snowmaking facilities. *Ecological Economics*, 130, 339–349. <https://doi.org/10.1016/j.ecolecon.2016.08.003>
- Gastón, L., & Higson, P. (2023). Diversity and inclusion in sport leadership: A longitudinal review of the United States Olympic and Paralympic Committee. *Managing Sport and Leisure*, 1–11. <https://doi.org/10.1080/23750472.2023.2282586>
- Gerber, M., Gustafsson, H., Seelig, H., Kellmann, M., Ludyga, S., Colledge, F., Brand, S., Isoard-Gautheur, S., & Bianchi, R. (2018). Usefulness of the Athlete Burnout Questionnaire (ABQ) as a screening tool for the detection of clinically relevant burnout symptoms among young elite athletes. *Psychology of Sport and Exercise*, 39, 104–113. <https://doi.org/10.1016/j.psychsport.2018.08.005>
- Grugan, M. C., Olsson, L. F., Vaughan, R. S., Madigan, D. J., & Hill, A. P. (2024). Factorial validity and measurement invariance of the Athlete Burnout Questionnaire (ABQ). *Psychology of Sport and Exercise*, 73, 102638. <https://doi.org/10.1016/j.psychsport.2024.102638>
- Intergovernmental Panel on Climate Change (IPCC). (2021). Climate change 2021: The physical science basis. Retrieved from <https://www.ipcc.ch/report/ar6/wg1/>
- Jiahao, L., & Jing, L. (2024). Examining the link between coach-athlete relationship and athlete burnout among college soccer players: The mediating role of training satisfaction. *Frontiers in Psychology*, 15, 1409609. <https://doi.org/10.3389/fpsyg.2024.1409609>
- Kaja, S. M., Adler, S. J., & de Ruiter, H.-P. B. (2024). *Navigating Evolving Conditions: Youth Nordic Ski Coaches' Reflections on the 2023–2024 Season and Future Forecasts*. <https://drive.google.com/file/d/1-pEdRcU7D8Q80DozMzAFdftChKIRGMR2/view>
- Larner, R. J., Wagstaff, C. R. D., Thelwell, R. C., & Corbett, J. (2017). A multistudy examination of organizational stressors, emotional labor, burnout, and turnover in sport organizations. *Scandinavian Journal of Medicine & Science in Sports*, 27(12), 2103–2115. <https://doi.org/10.1111/sms.12833>
- Lawrance, E. L., Thompson, R., Newberry Le Vay, J., Page, L., & Jennings, N. (2022). The impact of climate change on mental health and emotional wellbeing: A narrative review of current evidence, and its implications. *International Review of Psychiatry*, 34(5), 443–498. <https://doi.org/10.1080/09540261.2022.2128725>
- Lundkvist, E., Stenling, A., Gustafsson, H., & Hassmén, P. (2014). How to measure coach burnout: An evaluation of three burnout measures. *Measurement in Physical Education and Exercise Science*, 18(3), 209–226. <https://doi.org/10.1080/1091367X.2014.925455>
- Maslach, C., & Leiter, M. P. (2016). Understanding the burnout experience: Recent research and its implications for psychiatry. *World Psychiatry*, 15(2), 103–111. <https://doi.org/10.1002/wps.20311>
- Maslach, C., Schaufeli, W. B., & Leiter, M. P. (2001). Job burnout. *Annual Review of Psychology*, 52, 397–422. <https://doi.org/10.1146/annurev.psych.52.1.397>
- Maxwell, S. E., & Cole, D. A. (2007). Bias in cross-sectional analyses of longitudinal mediation.

- Psychological Methods*, 12(1), 23–44. <https://doi.org/10.1037/1082-989X.12.1.23>
- Oglesby, L. W., Gallucci, A. R., & Wynveen, C. J. (2020). Athletic trainer burnout: A systematic review of the literature. *Journal of Athletic Training*, 55(4), 416–430. <https://doi.org/10.4085/1062-6050-43-19>
- Olusoga, P., Bentzen, M., & Kenttä, G. (2019). Coach burnout: A scoping review. *International Sport Coaching Journal*, 6(1), 42–62. <https://doi.org/10.1123/iscj.2017-0094>
- Price, M. S., & Weiss, M. R. (2000). Relationships among coach burnout, coach behaviors, and athletes' psychological responses. *The Sport Psychologist*, 14(4), 391–409. <https://doi.org/10.1123/tsp.14.4.391>
- Raedeke, T. D., & Smith, A. L. (2001). Development and preliminary validation of an athlete burnout measure. *Journal of Sport & Exercise Psychology*, 23(4), 281–306. <https://doi.org/10.1123/jsep.23.4.281>
- Schaffran, P., Altfeld, S., & Kellmann, M. (2016). Burnout in sport coaches: A review of correlates, measurement, and intervention. *Deutsche Zeitschrift für Sportmedizin*, 67(5), 121–125. <https://doi.org/10.5960/dzsm.2016.232>
- Scott, D., Knowles, N. L. B., Ma, S., Ruttly, M., & Steiger, R. (2022). Climate change and the future of the Olympic Winter Games: Athlete and coach perspectives. *Current Issues in Tourism*, 26(3), 480–495. <https://doi.org/10.1080/13683500.2021.2023480>
- Share Winter Foundation. (2023). *About us*. <https://sharewinterfoundation.org/about-us/>
- Steiger, R., Posch, E., Tappeiner, G., & Walde, J. (2020). The impact of climate change on demand of ski tourism: A simulation study based on stated preferences. *Ecological Economics*, 170, 106589. <https://doi.org/10.1016/j.ecolecon.2019.106589>
- Tandon, P. S., Kroshus, E., Olsen, K., Garrett, K., Qu, P., & McCleery, J. (2021). Socioeconomic inequities in youth participation in physical activity and sports. *International Journal of Environmental Research and Public Health*, 18(13), 6946. <https://doi.org/10.3390/ijerph18136946>
- The Loppet Foundation. (n.d.). *The mission*. <https://www.loppet.org/about/mission/>
- Theyerl, B. (2020, August 27). Why is the US Nordic skiing community so white? *FasterSkier*. <https://fasterskier.com/2020/08/why-is-the-us-nordic-skiing-community-so-white/>
- Theyerl, B. (2022, July 22). Nordic skiing is growing fast in the United States. How is the largest youth ski organization in the country keeping up? *FasterSkier*. <https://fasterskier.com/2022/07/nordic-skiing-is-growing-fast-in-the-united-states-how-is-the-largest-youth-ski-organization-in-the-country-keeping-up/>
- United States Environmental Protection Agency. (n.d.). Climate change indicators: Snowfall. Retrieved December 30, 2024, from <https://www.epa.gov/climate-indicators/climate-change-indicators-snowfall>
- United States Department of Commerce. (2024, February 11). Winter 2023-24 outlook. *National Weather Service*. <https://www.weather.gov/arx/winter2324outlook>
- Vealey, R. S., Armstrong, L., Comar, W., & Greenleaf, C. A. (1998). Influence of perceived coaching behaviors on burnout and competitive anxiety in female college athletes.

*Journal of Applied Sport Psychology*, 10(2), 297–318.

<https://doi.org/10.1080/10413209808406395>

Vella, S. A., Oades, L. G., & Crowe, T. P. (2012). The relationship between coach leadership, the coach–athlete relationship, team success, and the positive developmental experiences of adolescent soccer players. *Physical Education and Sport Pedagogy*, 18(5), 549–561.

<https://doi.org/10.1080/17408989.2012.726976>

Westfall, S., Martin, E. M., & Gould, D. (2018). The association between the coach-athlete relationship and burnout among high school coaches. *Journal of Sport Behavior*, 41(1), 107–126. Retrieved from [https://scholarworks.boisestate.edu/kinesiology\\_facpubs/157/](https://scholarworks.boisestate.edu/kinesiology_facpubs/157/)