

# A Study on the Early Warning of Athletes' Safety in Sport Events Based on the "Fusion of Data and Intelligence"

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## Abstract

As there are many safety factors involved in sports events, the uncertainty and complexity of event risks have led to the frequent occurrence of sudden death and injury accidents among athletes. Starting from the analysis of the data in the 522 Gansu Baiyin Cross Country Race accident report, this paper discusses the feasibility and effectiveness of applying big data and intelligent techniques to guarantee the safety of the athletes in sport events, by all-round monitoring the relevant elements during the whole event's process. Real-time warning is accomplished on the basis of intelligent analysis of the monitoring data.

## Keywords

Sport Events, Early Warning Monitoring, Big Data, Artificial Intelligence, Data Analysis

## 1. Introduction

On May 22 2021, a public safety incident occurred during the 4<sup>th</sup> Yellow River Shilin Mountain Marathon 100 km cross-country race in China, in which twenty-one participants were dead and eight injured affected by the extreme weather with sudden cold, precipitation and high winds. Subsequently, the official website of the People's Government of Gansu published the investigation report of this incident (<http://www.gansu.gov.cn/gsszf/c100002/c100010/202107/1643566.shtml>), detailing the occurrence of the incident, the nature of the incident and the analysis of the causes.

Event safety is an important part of sports event evaluation, and ensuring the safety of the participants is a top priority for any sport events. Sport event risk

warning is an important element of risk analysis (Hong, 2014), which can provide more information for risk response and lay a solid foundation for taking effective risk management measures, mainly playing a role of warning, monitoring, diagnosis and accumulation. According to the paper survey, related research on sport event is mainly focused on the identification, classification and preventive measures of risks (Yang & Li, 2010; Li & Liu, 2016; Zhang & Wang, 2017; Ishii & Nakamura, 2021). Few researchers applied traditional methods to construct early-warning models of sport event, such as structural equation model and list arrangement method (Pu & Jia, 2018), fuzzy analytic hierarchy process (An & Huang, 2011), etc. There are also studies about risk prediction model research based on artificial intelligence technology (Zhang et al., 2019). But research on athletes' safety risk monitoring and early warning during the sport event is rare.

This paper, which focuses on the early warning of athlete safety during sports events, discusses the feasibility and effectiveness of real-time early warning of athletes' safety based on intelligent analysis of monitoring data, by applying technical means to monitor relevant risk factors during the whole process of events in a comprehensive and uninterrupted manner. Analysis shows historical emergencies of sports events are mainly caused by human factors, nature factors and social environment factors. Therefore, the monitoring objects of event risk warning are also mainly centered on these three factors.

## **2. Real-Time Monitor of Nature Factors Helps Early Warning of Athletes' Safety**

The investigation report published by the People's Government of Gansu pointed out that the loss of temperature was the direct cause in this incident. Low apparent temperature in event areas affected by high winds and precipitation, in addition with the bad open country environment, thin clothing and other factors, result in the death of athletes due to acute hypothermia. Temperature, humidity and wind are the three main heat conduction manners and also the most common direct cause of hypothermia. Problems are likely to occur if two of the three elements are abnormal. When people are wet all over and the wind is strong, the flowing air constantly takes the heat away from the body surface. This "wind cooling effect" makes the body temperature feel lower than the actual temperature, and finally may make people suffer from serious hypothermia.

Apparent temperatures of the sport event areas with different altitudes at different times on 5.22 can be calculated according to the Figure 4 in the incident investigation report (<http://www.gansu.gov.cn/gsszf/c100002/c100010/202107/1643566.shtml>), by getting correspond points' pixels positions using image processing techniques and the coordinate axis information. Preliminary analysis basis on these data was conducted as shown in the figure below. Three altitudes are involved, 1800 m, 2000 m and No. 3 check-in point (at an altitude of 2230 m), and the time period

is from 11:00 to 15:00 on 5.22, which are high related to most of the dead cases in this incident.

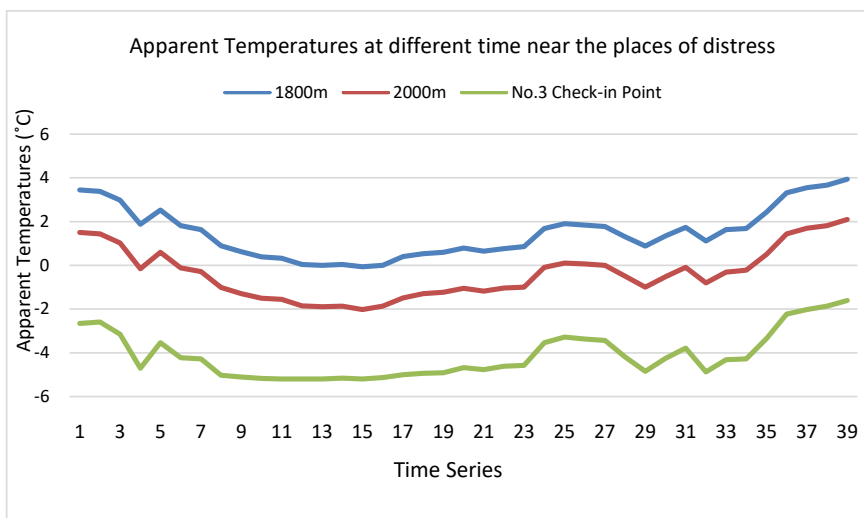
1) The apparent temperatures of the three altitudes at different time points are shown in **Figure 1(a)**, by taking 39 points as time series from 11:00 to 15:00 on 5.22. It shows the apparent temperatures were below 0°C for most of the times.

2) For each altitude, using the following equation to obtain the apparent temperature variation with time.  $T(i)$  represents for the apparent temperature for time point  $i$ . The result is showed in **Figure 1(b)**, which tells the trend were nearly the same for 3 places at different altitudes.

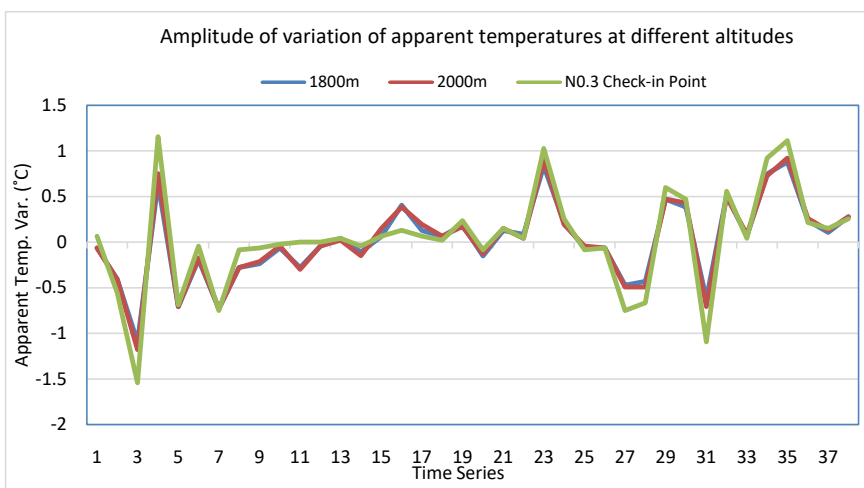
$$\text{Apparent Temp. Var.} = T(i) - T(i - 1) \tag{1}$$

The obvious cooling down at 5<sup>th</sup> time point coincides with the first S.O.S was send at 11:50 which was mentioned in the investigation report.

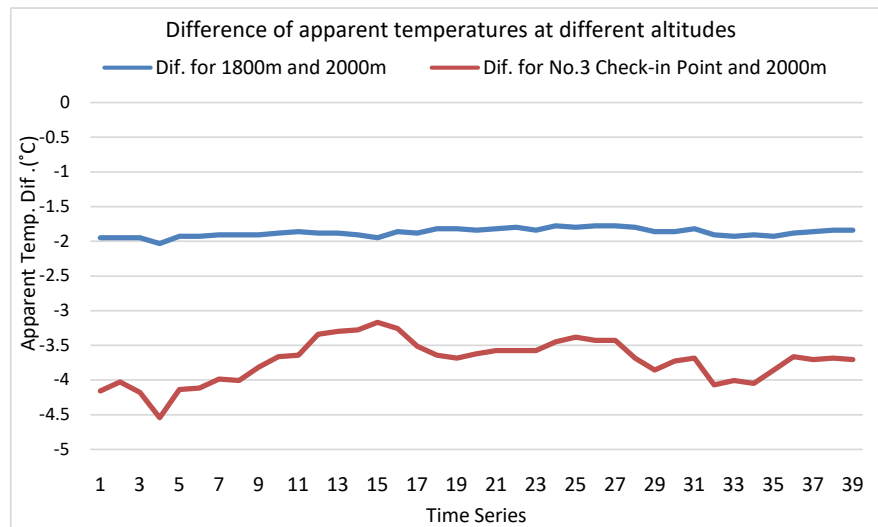
3) For each time point, using Equation (2) to get the different of apparent temperatures of two different altitudes.  $T1(i)$  presents for the apparent temperature of altitude 1 for time point  $i$ .



(a)



(b)



(c)

**Figure 1.** Preliminary analysis Results. (a) Diagram of apparent temperatures at different time near the places of distress; (b) Amplitude of variation of apparent temperatures at different altitudes; (c) Diagram of the difference in body temperature at different altitudes.

$$\text{Apparent Temp. Dif.} = T1(i) - T2(i) \quad (2)$$

The result is shown in **Figure 1(c)**, which tells the apparent temperature difference were nearly fixed at 2°C for a height of 1800 m and 2000 m, and the difference were around 4°C with a variation of 1°C for the height of 2000 m and No. 3 check-in point.

The temperature, humidity and wind of the event area can be obtained in real time during the whole event. In addition, according to the above analysis, there is a certain pattern of difference in body temperature under different altitude conditions, and the model constructed by real-time monitoring data and analysis algorithms can be applied to obtain the apparent temperature. If the apparent temperature continues to be low and accompanied by an obvious drop, an early warning will be triggered to remind the management to pay attention and implement the emergency plan in time. The monitoring system measurement model and warning trigger thresholds are determined in advance by the relevant expert based on experimental and theoretical analysis, which can greatly reduce the possibility of accidents.

### 3. Real-Time Monitor of Human Factors Helps Early Warning of Athletes' Safety

In addition to injuries and deaths of participating athletes caused by natural environmental factors, accidents of sudden death of athletes occur in various sports events. A survey by the Institute of Sports Science of the General Administration of Sports of China shows that the sports with the highest percentage of sudden deaths including marathons, accounting for one-third of the total, followed by

soccer and basketball. Studies have shown that the top three causes of sudden athletic death are sudden cardiac death, traumatic brain injury, and heat shock (Endres et al., 2019), with sudden cardiac death taking up to 90% of cases, and 80% of sudden cardiac deaths occurred during sport events (Corrado et al., 2003). The key to successful resuscitation is early cardiopulmonary resuscitation and resuscitation therapy, namely the golden 4 minutes of resuscitation in cardiac arrest. So timely detection of the problem is critical to prevent accidents from occurring. On 6.13, at the midfield of the Euro Cup in Denmark, Eriksen suddenly lost consciousness and fell to the ground, and fortunately, Eriksen opened his eyes after the team doctors performed CPR for about 15 minutes. With the maturity of Internet-of-Things technology, smart bracelets are cost-controllable and reusable.

1) Customized smart bracelets provide accurate and real-time access to athletes' positioning and basic physical information, including temperature and heart rate without interfering with the competition.

2) Basic physical information data of all the athletes are collected, and the data value as well as data variations are monitored in real time, if any of them reaches the thresholds, there will be an early-warning alarm to remind relevant staffs. The value of alarm threshold should be provided by the relevant medical specialist.

3) Customized smart bracelets can also be equipped with a key distress function, the management can quickly locate the unwell players according to the intelligent warning results and distress signals, timely implementation of emergency rescue measures for the golden rescue time.

At the same time, for marathons, cross-country races and other events with many people, long lines of activity and a wide range of activities, using the smart bracelet to obtain real-time positioning information and basic physical data of athletes, is the most effective means of timely access to the physical condition of the participants.

#### 4. Summary

This paper discusses the feasibility and effectiveness of applying big data and intelligent techniques to guarantee the safety of the athletes in sport events. With the growing maturity of big data and artificial intelligence technology, an intelligent monitoring and early warning system is an effective means to ensure the safety of athletes. The system can obtain the geographic location and basic physical information of each athlete in real time through the customized smart bracelets worn by the athletes during the sport events, it can also obtain the weather data including temperature, humidity and wind in the event area in real time. The system carries out intelligent analysis of the monitored data, displays the trend of typical triggering factors that may impact athletes' safety, reasonably quantifies the warning criteria, therefore professionally predicts athlete safety risks, and gains time for the implementation of emergency plans.

## Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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