

## Wearable System for Prolonged Cooling and Dehumidifying of PPE in Hot Environments

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**Abstract :** While personal protective equipment (PPE) prevents the healthcare personnel from exposing to harmful surroundings, it creates a barrier to the dissipation of body heat and perspiration, leading to severe heat stress during prolonged exposure, especially in hot environments. It has been found that most of the existed personal cooling strategies have limitations in achieving effective cooling performance with long duration and lightweight. This work aimed to develop a lightweight (<1.0 kg) and less expensive wearable air cooling and dehumidifying system (WCDS) that can be applied underneath the protective clothing and provide 50W mean cooling power for more than 5 hours at 35°C environmental temperature without compromising the protection of PPE. For the WCDS, blowers will be used to activate an internal air circulation inside the clothing microclimate, which doesn't interfere with the protection of PPE. An air cooling and dehumidifying chamber (ACMR) with a specific design will be developed to reduce the air temperature and humidity inside the protective clothing. Then the cooled and dried air will be supplied to upper chest and back areas through a branching tubing system for personal cooling. A detachable ice cooling unit will be applied from the outside of the PPE to extract heat from the clothing microclimate. This combination allows for convenient replacement of the cooling unit to refresh the cooling effect, which can realize a continuous cooling function without taking off the PPE or adding too much weight. A preliminary thermal manikin test showed that the WCDS was able to reduce the microclimate temperature inside the PPE averagely by about 8°C for 60 minutes when the environmental temperature was 28.0 °C and 33.5 °C, respectively. Replacing the ice cooling unit every hour can maintain this cooling effect, while the longest operation duration is determined by the battery of the blowers, which can last for about 6 hours. This unique design is especially helpful for the PPE users, such as health care workers in infectious and hot environments when continuous cooling and dehumidifying are needed, but the change of protective clothing may increase the risk of infection. The new WCDS will not only improve the thermal comfort of PPE users but can also extend their safe working duration.

**Keywords :** personal thermal management, heat stress, ppe, health care workers, wearable device

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