

Effects of regional airflow from dual- and single-column fan-integrated carseat on body cooling under a comparable resting skin-temperature environments

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Rising global temperatures have increased the use of vehicle cabin air conditioning, raising fuel and electrical power consumption. Localized airflow cooling, which requires less power, is a potential alternative for maintaining occupant comfort. Fan-integrated car seats, with ventilation fans embedded in the backrest and the seat cushion, have been reported to shift whole-body thermal comfort toward the comfortable range at both 30°C and 33°C; however, previous configurations used up to ten fans per seat. Reducing the number of operating fans is one approach to lowering power consumption while maintaining thermal comfort, but its effect on thermal comfort and thermoregulatory responses has not been examined. This study compared the effects of the number of operating fans on thermoregulatory responses and thermal comfort under 30°C and 33°C conditions.

Twelve healthy young men participated. Environmental conditions were controlled at 30°C and 33°C, each at 60% relative humidity. The dual-row configuration used ten fans (three in the backrest and two in the seat cushion on each of the left and right sides). The single-row configuration used five fans positioned along the seat centerline at the corresponding heights, halving the required power. Four airflow modes were tested in a Latin square design to control for order effects: no airflow (CON), and both (BOTH). Participants walked on a treadmill at 5 km/h for 10 min, followed by 20 min of seated cooling under each condition. Rectal temperature and mean skin temperature were monitored continuously, and whole-body thermal comfort was assessed every 5 min.

Changes in rectal temperature (ΔT_{re}) and mean skin temperature ($\Delta m\bar{T}_{sk}$) showed no significant differences between the single-row and dual-row configurations at any time point, in either the 30°C or the 33°C environment ($p \geq 0.99$), indicating that halving the number of fans altered neither the core nor the skin thermal response.

At baseline during walking, thermal comfort showed no significant difference between the single-row and dual-row configurations at either 30°C or 33°C (Fig.1, $p \geq 0.99$). During seated cooling, thermal comfort in the BOTH condition tended toward the comfortable range, but no significant differences were found between the single-row and dual-row configurations at any time point ($p \geq 0.99$). Because thermal comfort is governed by thermal input from the skin and body core, the absence of a configuration difference in thermal comfort during cooling was consistent with the absence of a difference in either mean skin temperature or rectal temperature.

In conclusion, this study compared single-row and dual-row automotive seat fan configurations regarding thermoregulatory responses and thermal comfort in 30°C and 33°C environments. Results showed no significant differences in rectal temperature, mean skin temperature, or thermal comfort between configurations across any temperature or airflow condition. Therefore, under these experimental conditions, a single-row configuration with a reduced number of fans remains a viable candidate for seat designs, maintaining thermal comfort while lowering power consumption.

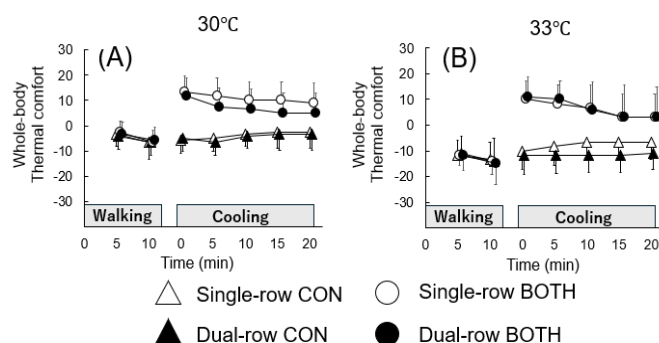


Fig. Changes in whole-body thermal comfort in 30°C (A) and 33°C (B) under CON and BOTH conditions, comparing single-row and dual-row configurations.