

INTISARI

Pekerjaan di luar ruangan (*outdoor*) berisiko mengalami *heat-related illness* akibat paparan panas ekstrem dari sinar matahari secara langsung. Salah satu upaya yang dapat dilakukan adalah dengan menerapkan *cooling intervention* di sela-sela aktivitas kerja (*interactivity cooling*). Akan tetapi, penelitian mengenai metode *cooling* yang paling efektif masih sangat terbatas. Oleh karena itu, diperlukan eskplorasi lebih lanjut mengenai kombinasi pendinginan internal (*cold water ingestion*) ataupun pendinginan eksternal (*forearm immersion*, *wet towel*) dengan menggunakan kipas angin guna menentukan strategi *body cooling* yang optimal bagi pekerja *outdoor*.

Penelitian ini melibatkan 12 subjek laki-laki (usia $24,17 \pm 0,76$ tahun) yang melakukan aktivitas fisik di atas *treadmill* dengan intensitas setara 70% HR_{max} selama 90 menit dengan menggunakan *coverall*. Protokol eksperimen terdiri atas lima fase: *baseline* (10 menit), *activity 1* (30 menit), *interactivity cooling* (10 menit), *activity 2* (30 menit), dan *post cooling* (10 menit). Kondisi lingkungan disimulasikan menyerupai lingkungan kerja *outdoor* dengan suhu udara $33,4 \pm 0,01^{\circ}C$; kelembapan udara $70,4 \pm 0,01\%$; WBGT $29,37 \pm 1,04^{\circ}C$; *thermal radiation* $635,08 \pm 53,86 W/m^2$; dan kecepatan angin 0,23 m/s. eksperimen ini mencakup kondisi berupa konsumsi air mineral dengan suhu $28^{\circ}C$ sebanyak ± 7 ml/kg massa tubuh (CON), *cold water ingestion* yang dikombinasikan dengan kipas angin (CWI+FAN), *forearm immersion* yang dikombinasikan dengan kipas angin dan konsumsi air mineral dengan suhu $28^{\circ}C$ sebanyak ± 7 ml/kg massa tubuh (FI+FAN), dan *wet towel* yang dikombinasikan dengan kipas angin dan konsumsi air mineral dengan suhu $28^{\circ}C$ sebanyak ± 7 ml/kg massa tubuh (WT+FAN).

Hasil penelitian menunjukkan bahwa ketiga metode *body cooling*, CWI+FAN, FI+FAN, dan WT+FAN efektif dalam menurunkan *heat strain*. Meskipun demikian, FI+FAN memberikan hasil yang lebih konsisten karena tidak hanya mampu menurunkan *heat strain* saat fase *interactivity cooling* dan *post cooling* tetapi juga menjaga stabilitas tubuh pada fase *activity 2* ($p < 0,05$). Sementara itu CWI+FAN dan WT+FAN hanya menurunkan *heat strain* pada fase *interactivity cooling* dan *post cooling* ($p < 0,05$). Hasil tersebut mengindikasikan bahwa *forearm immersion* yang dikombinasikan dengan kipas angin dan konsumsi air mineral dengan suhu $28^{\circ}C$ sebanyak ± 7 ml/kg massa tubuh dapat menjadi alternatif terbaik untuk menurunkan *heat strain* selama *beristirahat/pemulihan* dan membantu mempertahankan kondisi fisiologis saat melakukan aktivitas di lingkungan pekerjaan *outdoor*.

Kata kunci: *outdoor workers*, *heat strain*, *interactivity cooling*, *post cooling*, *forearm immersion*, *cold water ingestion*, *wet towel cooling*

ABSTRACT

Outdoor work carries a risk of heat-related illness due to direct exposure to extreme solar radiation. One potential mitigation strategy involves implementing cooling interventions during work breaks (interactivity cooling). However, research on the most effective cooling methods remains limited. Therefore, further exploration is necessary to determine the optimal body cooling strategy for outdoor workers, considering combinations of internal cooling (cold water ingestion) and external cooling (forearm immersion, wet towel) with the use of a fan.

This study involved 12 male subjects (age 24.17 ± 0.76 years) who performed physical activity on a treadmill at an intensity equivalent to 70% HR_{max} for 90 minutes while wearing coveralls. The experimental protocol consisted of five phases: baseline (10 minutes), activity 1 (30 minutes), interactivity cooling (10 minutes), activity 2 (30 minutes), and post-cooling (10 minutes). Environmental conditions were simulated to resemble outdoor work environments with an air temperature of $33.4 \pm 0.01^\circ\text{C}$; relative humidity of $70.4 \pm 0.01\%$; WBGT of $29.37 \pm 1.04^\circ\text{C}$; thermal radiation of $635.08 \pm 53.86 \text{ W/m}^2$; and air speed of 0.23 m/s. The experiment included conditions of mineral water consumption at 28°C with a volume of $\pm 7 \text{ ml/kg}$ body mass (CON), cold water ingestion combined with a fan (CWI+FAN), forearm immersion combined with a fan and mineral water consumption at 28°C with a volume of $\pm 7 \text{ ml/kg}$ body mass (FI+FAN), and a wet towel combined with a fan and mineral water consumption at 28°C with a volume of $\pm 7 \text{ ml/kg}$ body mass (WT+FAN).

The results of this study demonstrated that all three body cooling methods, CWI+FAN, FI+FAN, and WT+FAN, were effective in reducing heat strain. Nevertheless, FI+FAN yielded more consistent results as it not only reduced heat strain during the interactivity cooling and post-cooling phases but also maintained body stability during the activity 2 phase ($p < 0.05$). In contrast, CWI+FAN and WT+FAN only reduced heat strain during the interactivity cooling and post-cooling phases ($p < 0.05$). These findings suggest that forearm immersion combined with a fan and mineral water consumption at 28°C with a volume of $\pm 7 \text{ ml/kg}$ body mass can be the most suitable alternative for reducing heat strain during rest/recovery periods and helping to maintain physiological conditions during activity in outdoor work environments.

Keywords: outdoor workers, heat strain, interactivity cooling, post cooling, forearm immersion, cold water ingestion, wet towel cooling