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ΤΙΤΛΟΣ:

Οι επιδράσεις του υφάσματος Dri-Fit σε δείκτες απόδοσης και φυσιολογίας κατά την διάρκεια ποδηλασίας σε διαφορετικές θερμοκρασίες περιβάλλοντος.

(Effects of Dri-Fit clothing on performance and physiological indices during cycling in different environmental temperatures.)

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ABSTRACT

The aim of this study was to investigate the effects of Dri-fit clothing on performance and physiological indices during cycling in different environmental temperature. Three healthy men exercised on hot environmental temperature 33°C, a condition where he was wearing no shirt, a condition where he was wearing a regular cotton shirt, and a condition where he was wearing a Dri-FIT shirt. The cotton and Dri-FIT shirts were provided by the experimenters and was the same for all participants. Participants performed to cycle for a total of 60 min on a cycle ergometer while maintaining a rating of perceived exertion (RPE) of 14 on a 6–20 scale, which corresponds to an intensity between 'somewhat hard' and 'hard'. At baseline and every 10 minutes, perceived exertion thermal comfort and thermal sensation, as well as overall tiredness were assessed using standardized questionnaires. RESULTS: Analysis of variance demonstrated no statistically significant differences between sessions in urine specific gravity, percent body fat, as well as total work produced ($p>0.05$). Multivariate analysis of variance with session and time used as factors demonstrated no statistically significant differences in subjective questionnaires for thermal comfort, thermal sensation, overall tiredness, and heart rate, as well as esophageal, shin, quadriceps, arm, and forehead temperature ($p>0.05$). The same analysis revealed statistically significant effects on abdominal ($p=0.034$) and chest ($p=0.037$) temperatures. Post hoc t test incorporating a Bonferroni correction revealed significant differences in abdominal temperature between the Dry-FIT and the No-shirt sessions ($p=0.03$) as well as in chest temperature between the Cotton-shirt and No-shirt ($p=0.026$). The same analysis demonstrated that chest temperature in the Dry-FIT session was almost statistically significantly different from the Cotton-shirt session (p=0.07). CONCLUSIONS: There is no statistically significant differences between the two fabrics and without t-shirt, apart from abdominal and chest temperature.

ΠΕΡΙΛΗΨΗ

Ο σκοπός αυτής της έρευνας ήταν να εξετάσει τις επιδράσεις του υφάσματος Dri-FIT σε δείκτες απόδοσης και φυσιολογίας κατά την διάρκεια ποδηλασίας σε διαφορετικές θερμοκρασίες περιβάλλοντος. Τρεις υγιείς άντρες έκαναν άσκηση σε θερμό περιβάλλον, 33 βαθμούς κελσίου, σε κατάσταση που ήταν χωρίς μπλουζάκι, σε βαμβακερό μπλουζάκι με κοντό μανίκι, και σε Dri-FIT, με τυχαία σειρά. Επίσης, τα βαμβακερά και τα Dri-FIT που δόθηκαν στους συμμετέχοντες ήταν τα ίδια για όλους. Οι συμμετέχοντες ασκήθηκαν για 60 λεπτά σε κυκλοεργόμετρο διατηρώντας στην κλίμακα υποκειμενικής προσπάθειας στο 14, μιας κλίμακας από το 6-20 το οποίο αντιστοιχεί σε μια ένταση «κάπως σκληρά» με «σκληρά». Από την αρχή της άσκησης και κάθε 10 λεπτά, οι συμμετέχοντες απαντούσαν στα στάνταρ ερωτηματολόγια για την θερμική αίσθηση και την θερμική άνεση καθώς και για την συνολική κόπωση. Η ανάλυση διακύμανσης δεν έδειξε στατιστική σημαντική διαφορά μεταξύ των ούρων, το ποσοστό σωματικού βάρους, καθώς και το συνολικό έργο που παράγεται ($p<0.05$). Η πολυπαραγοντική ανάλυση διακύμανσης με την συνεδρία και τον χρόνο που χρησιμοποιούνται δεν έδειξαν στατιστικά σημαντικές διαφορές σε υποκειμενικά ερωτηματολόγια για θερμική άνεση και θερμική αίσθηση, την συνολική κόπωση, το καρδιακό ρυθμό καθώς επίσης και τις θερμοκρασίες του οισοφάγου, της κνήμης, του τετρακέφαλου του χεριού και του μετώπου ($p<0.05$). Η ίδια ανάλυση έδειξε στατιστική σημαντική διαφορά στην κοιλιακή χώρα ($p=0.034$) και το στήθος

($p=0.037$). Η post hoc ανάλυση t με την ενσωματωμένη διόρθωση Bonferroni αποκάλυψε σημαντικές διαφορές στην κοιλιακή χώρα μεταξύ της συνεδρίας Dri-FIT και της συνεδρίας χωρίς μπλουζάκι ($p<0.03$), καθώς και της θερμοκρασίας του θώρακα μεταξύ της συνεδρίας με το βαμβακερό μπλουζάκι και της συνεδρίας χωρίς μπλουζάκι ($p=0.026$). το στήθος. Εν κατακλείδι, δεν υπάρχουν στατιστικές σημαντικές διαφορές ανάμεσα στο ύφασμα Dri-FIT και στο βαμβακερό ύφασμα. Η ίδια ανάλυση έδειξε ότι η θερμοκρασία του θώρακα στην συνεδρίαση με το ύφασμα Dri-FIT ήταν περίπου σημαντική η διαφορά τους από την συνεδρίαση με το βαμβακερό ύφασμα ($p=0.07$).

Introduction and Literature Review

Heat and moisture transport through garments involve complex process involving evaporation, condensation, sorption and desorption of moisture (15). The moisture retained in garments is often from sweat accumulate during and following exercise (16). During exercise, active muscles and environmental factors, such as ambient temperature, relative humidity and wind velocity, combine to produce heat stress which increases core and skin temperature and may impair exercise performance (17). Exercising at a mild to moderate work rate in a warm environment causes whole body loses sweat losses of 0.8- 1.4 L/h. (18). Simple evaporation of sweat from the body the surfaces allows for heat loss during exercise (15). It seems that the clothing with a good evaporation, properties would be advantageously during exercise in a warm environment.

Evaporative heat loss from the skin represents the most powerful thermoregulatory mechanism available to counteract an excessive increase in core temperature during exercise or environmental stress (3, 5, 12).

The cotton fabric has a good water-absorbing property, absorb moisture from the skin more effectively than do synthetic fibers, and is generally more comfortable (15,19). Increased skin wetness can also affect thermal comfort. Clothing acts as a barrier that obstructs evaporation and decrease convective heat loss by reducing air circulation near the skin. The manufactures a new line of fabric with improved evaporative characteristic. It has been suggested that these improved evaporative characteristic relate to vapor permeation, which should lead to increase sweat evaporation, lower core and skin temperature, and reduce evaporative water loss (19). These sportswear garment increase evaporation but do not improve physiological, thermoregulatory or comfort sensation during warm environmental condition.

In recent years, athletic apparel manufacturers have introduced the Dri-FIT fabric, a microfiber, polyester fabric that is designed to move sweat away from the skin and to the fabric surface (figure 1). Based on this, manufacturers claim that Dri-FIT keeps athletes dry and comfortable and use this fabric in a variety of Nike products, including shirts, socks, pants, shorts, sweatshirts, sleeves, hats, gloves and more.

In contrast to the manufacturers' claims, the concept of Dri-FIT goes against the fundamental principles of thermoregulation which state that the heat loss effect of evaporation occurs as a result of the liquid-to-vapor phase-change of accumulated moisture on the skin surface (3, 5, 12). This endothermic reaction results in the release of approximately 2427 $kJ \cdot kg^{-1}$ of water for the typical range of skin temperatures (12). Thus, a sweat rate of 2 $g \cdot min^{-1} \cdot m^{-2}$ is capable of ~80 $W \cdot m^{-2}$ heat loss to the local environment.

Despite the above-mentioned capacity of sweat, the heat loss effect of sweat evaporation arises only when the phase-change from liquid to vapor occurs on the surface of the skin. Therefore, Dri-FIT fabrics – that are made to "...move sweat away from the skin and to the fabric surface" – may lead to significant sweating "inefficiency" and adversely affect this heat loss mechanism resulting in increased body temperature. Given the detrimental effects of increased body temperature on cycling performance, the proposed study will be the first to examine if the Dri-FIT fabrics affect heat dissipation from the body and whether this can affect performance during a simulated race in different environmental temperatures.

In this study, we compared the responses to exercise in a warm environment in subject wearing cotton, Dry-Fit fabrics and no shirt. Dry-Fit shirts used widely in sportswear garment because they are thought to provide superior water evaporation and to retain less sweat. However it's not clear whether the different sportswear fabrics induce differences in the thermophysiological and perception sensation during the high intensity exercise for one hour in the warm environment. We hypothesized that the important physiological and perception variables affected by the high intensity aerobic exercise from the hot environment (e.g skin temperature, visceral temperature, heart rate, body mass and body fat, urine sampling procedure, thermal sensation, environmental sensation, tiring sensation) when the subject wore shirts from different fabrics. (14)

Methodology

Experimental Groups and Sample Size

Participants were randomly assigned to the following one group: HOT based on the (i.e., 33°C) environmental temperature observed during the last four competitions of the Tour de France, respectively. Each participant was undergo three sessions in a random order separated by a minimum of seven days: a condition where he was wearing no shirt, a condition where he was wearing a regular cotton shirt, and a condition where he was wearing a Dri-FIT shirt. The cotton and Dri-FIT shirts were provided by the experimenters and was the same for all participants. The remaining procedures were identical across sessions.

Based on sample size calculation using a previously published study (8), a total of 3 participants were recruited for participation to reach a power of 95%.

An initial meeting and discussion about the experiment were organized with each participant to ensure complete understanding of the protocols and procedures, benefits and associated risk of the study prior to the intervention; during this meeting, written consent were acquired from participants. Participants were instructed to fast for 13 hours, and abstain from alcohol, coffee, and passive smoking for at least 15 hours before the experiment. On the experiment day participants were asked to arrive to the laboratory at 9am. Participants were also permitted ad libitum water ingestion prior to the initiation of the exercise protocol to promote euhydration.

Participants

Healthy young (18-30 years old) male adults were invited to participate in this study. Exclusion criteria will include: smoking, recent muscle/joint/bone problems or injuries, previous ear drum perforation or sweat gland dysfunction, current ear infection, recent ulcerative colitis or Crohn's disease, previous heat illness, recent sleeping problems, upper respiratory illness or gastroenteritis, current medications or stimulants including aitidepressants, diuretics, antihypertensives, antihistamines, Ma Huang, ephedra, or psuedoephedrine.

Environmental exposure and exercise protocol

All experimental sessions were conducted in a controlled environmental chamber. Relative humidity were maintained at 50% throughout the session, to match the average value observed during the last four competitions of the Tour de France. Using the same data, a head wind speed of 35 km·h^{-1} were used throughout the session, measured at the height of the participant's head.

Participants were asked to cycle for a total of 60 min on a cycle ergometer while maintaining a rating of perceived exertion (RPE) of 14 on a 6–20 scale, which corresponds to an intensity between ‘somewhat hard’ and ‘hard’ (2). The cycle ergometer allow for an open mode of exercise intensity in which participants were had free control of both resistance and cadence, and therefore power output. The main display monitor were shielded from both the participants and the experimenters during the session to remove feedback and experimental bias, and the only feedback the participants received during the experimental session were a reminder at approximately 5 min intervals to maintain an RPE of 14.

Body Mass and Percent Body Fat

Body mass (accurate to the nearest 0.001 kg) were measured using a precision weighing instrument (CHARA; EK3052 LIBRA) before and immediately after cycling to calculate total sweat loss. Percent body fat (to the nearest 0.1%) was assessed with a body composition analyser (Tanita BF522W, Tokyo, Japan).

Subjective questionnaire:

At baseline and every 10 minutes, perceived exertion (1, 2), thermal comfort and thermal sensation (6), as well as overall tiredness (7, 13) were assessed using standardized questionnaires.

Skin Temperature:

Body heat storage were measured non-invasively using partitional calorimetric techniques, standardized in our laboratory (8). Mean skin temperature and heat flow were be quantified using probes placed on the forehead, abdomen, forearm, hand, quadriceps, shin and foot surfaces.

Urine sampling procedures:

Sample urine void (80 mL) were collected in polyethylene specimen jars or through high degree of transparent disposable urine cups before and immediately after cycling. Samples were analyzed using a refractrometer (Atago, Tokyo, Japan) for the determination of urine specific gravity. Euhydration were defined as urine specific gravity <1.02 according to internationally accepted standards (9).

Heart Rate:

Participants were outfitted with a heart rate chest strap, and HRV data were sampled for 15 minutes through short-range telemetry at 1,000 Hz with a Polar RS800CX (Polar Electro , Kempele, Finland). The heart rate monitor signal were transferred to the Polar Precision Performance Software (release 3.00; Polar Electro Oy).

Results

Analysis of variance demonstrated no statistically significant differences between sessions in urine specific gravity, percent body fat, as well as total work produced ($p>0.05$). Multivariate analysis of variance with session and time used as factors demonstrated no statistically significant differences in subjective questionnaires for thermal comfort, thermal sensation, overall tiredness, and heart rate, as well as esophageal, shin, quadriceps, arm, and forehead temperature ($p>0.05$). The same analysis revealed statistically significant effects on abdominal (p=0.034) and chest (p=0.037) temperatures. Post hoc t test incorporating a Bonferroni correction revealed significant differences in abdominal temperature between the Dry-FIT and the No-shirt sessions (p=0.03) as well as in chest temperature between the Cotton-shirt and No-shirt (p=0.026). The same analysis demonstrated that chest temperature in the Dry-FIT session was almost statistically significantly different from the Cotton-shirt session (p=0.07). These results are illustrated in Figure 3, 4.

Figure 3

Figure 4

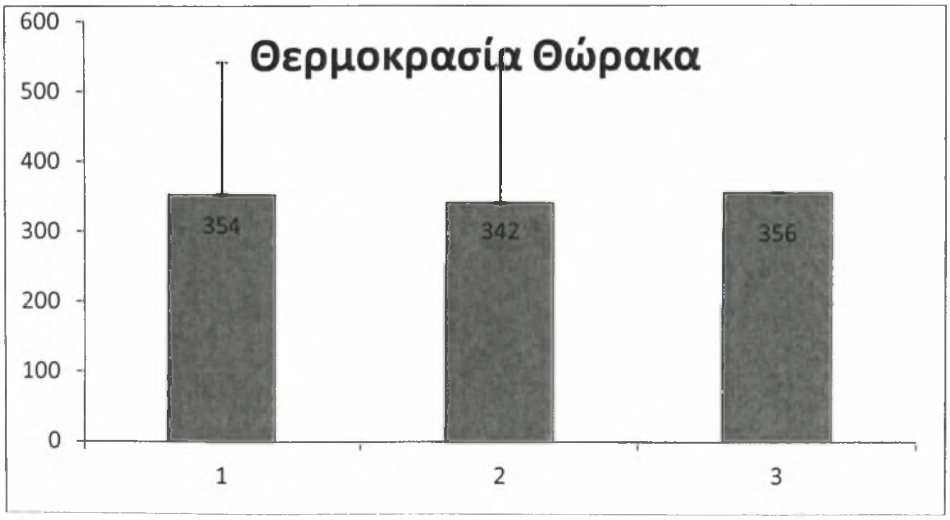
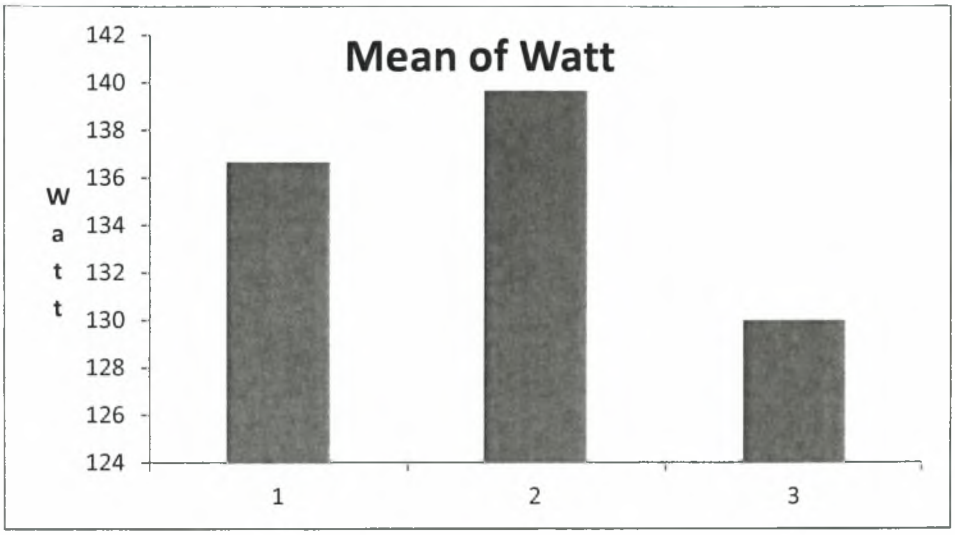


Figure 5



Discussion

The purpose of this study was to examine the effects of Dri-FIT on performance and physiological indices during cycling in warm environmental temperature. This experiment is the first to examine the effects of Dri-FIT on performance and physiological indices. The result provide new knowledge, because although that there is no statistically significant differences between sessions in urine specific gravity, percent body fat, as well as total work produced ($p>0.05$), in subjective questionnaires for thermal comfort, thermal sensation, overall tiredness, and heart rate, as well as esophageal, shin, quadriceps, arm, and forehead temperature ($p>0.05$), but the same analysis revealed statistically significant effects on abdominal ($p=0.034$) and chest ($p=0.037$) temperatures. Post hoc t test incorporating a Bonferroni correction revealed significant differences in abdominal temperature between the Dry-FIT and the No-shirt sessions ($p=0.03$) as well as in chest temperature between the Cotton-shirt and No-shirt ($p=0.026$). The same analysis demonstrated that chest temperature in the Dry-FIT session was almost statistically significantly different from the Cotton-shirt session ($p=0.07$).

In summary, it need further studies because seems to have statistical differences between abdominal and chest, and with more samples and examine more indices to valid the effects of Dri-FIT t-shirt on performance, physiological and thermoregulation.

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