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TITLE

Skin temperature and exercise performance after passive rest in a cool environment

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SKIN TEMPERATURE AND EXERCISE PERFORMANCE AFTER PASSIVE REST IN A COOL ENVIRONMENT

Introduction: Warm-up is a vital process for athletes, that activates muscular and metabolic activity prior the game. The existing literature indicates that the substitute basketball players have reduced performance after a “non-specific time” sitting on the bench. However, there is limited information about the duration of the bench time. Therefore, the aim of this study was to investigate changes in mean skin temperature and exercise performance, after 9' and 23' ‘bench time' with and without insulative clothing on basketball players. **Methods:** Six high-level professional male basketball players participated (age: 24.9±4.6 yr.; height: 192.7±7.82cm; body mass index: 25.50±1.84 kg/m^2; body fat: 11.53±2.7 %). The players performed four different trials and every trial started with a 20 min specific warm up. Following that, the players perform specific tests (randomized) before and after the bench time was applied. In each trial clothing and bench time for players were randomly changed: a) 9 min bench time + basketball uniform, b) 9 min bench time + basketball uniform and insulative clothing, c) 23 min bench time + basketball uniform, d) 23 min bench time + basketball uniform and insulative clothing. Before and after the end of the protocols the athletes took part, in random order, in performance tests. During the protocols equipment recorded the basketball arenas temperature and the skin temperature of the players. **Results:** Two-way ANOVA repeated measures, demonstrated a statistically significant main effect in mean Tsk, $F(1.000, 11.000) = 6.845$ $p<0.05$, before and after trial b. Post hoc t tests incorporating a Bonferroni adjustment demonstrated statistically significant differences between pre-height (41.7cm ± 2.2cm) and post-height (38.9cm ± 1.9cm) counter movement jumps at trial b, as well as, at trial d [pre-height (42.7cm ± 2.2cm) and post-height (39.3cm ±

1.9cm)], p<0.05. **Conclusion:** The present study showed that 23’ bench time reduces high intensity players’ performance in both conditions of insulative clothing and basketball clothing only.

KEY WORDS:

skin temperature, bench time, basketball performance, insulative clothing.

ΠΕΡΙΛΗΨΗ

Εισαγωγή: Η προθέρμανση είναι μια πολύ σημαντική διαδικασία για τους παίκτες καλαθοσφαίρισης, καθώς ενεργοποιείται η μυϊκή δραστηριότητα πριν από το παιχνίδι. Η υπάρχουσα βιβλιογραφία δείχνει ότι ο χρόνος στον οποίο οι αναπληρωματικοί παίκτες καλαθοσφαίρισης παραμένουν στον πάγκο μειώνει την απόδοση τους. Ωστόσο, υπάρχουν περιορισμένες βιβλιογραφικές αναφορές σχετικά με τη διάρκεια του χρόνου στον οποίο παραμένουν «εκτός παιχνιδιού». Ως εκ τούτου, ο σκοπός της παρούσας μελέτης ήταν να διερευνήσει τις πιθανές αλλαγές στην θερμοκρασία δέρματος και τις επιπτώσεις της απόδοση ενός συγκεκριμένου χρόνου παραμονής στο πάγκο των αναπληρωματικών παικτών καλαθοσφαίρισης. Μέθοδοι: Συμμετείχαν έξι επαγγελματίες καλαθοσφαιριστές υψηλού επιπέδου (ηλικία 24,9 ± 4,6 ετών, ύψος 192,7 ± 7,82 cm, δείκτης μάζας σώματος: 25,50 ± 1,84 kg / m2, σωματικό λίπος: 11,53 ± 2,7%). Οι παίκτες έλαβαν μέρος σε τέσσερα διαφορετικά πρωτόκολλα (Α. χρόνος πάγκου 9 λεπτά + στολή καλαθοσφαίρισης, Β) χρόνος πάγκου 9 λεπτά + στολή καλαθοσφαίρισης + ισοθερμικός ρουχισμός, Γ) χρόνος πάγκου 23 λεπτά + στολή καλαθοσφαίρισής, Δ) χρόνος πάγκου 23 λεπτά + στολή καλαθοσφαίρισής + ισοθερμικός ρουχισμός). Πριν αλλά και μετά το πέρας των πρωτοκόλλων οι αθλητές πήραν μέρος, με τυχαία σειρά, σε δοκιμασίες απόδοσής. Κατά τη διάρκεια των πρωτοκόλλων ειδικός εξοπλισμός κατέγραφε τη θερμοκρασία του δέρματος των παικτών αλλά και των γηπέδων. Αποτελέσματα: Η στατιστική ανάλυση two way – ANOVA repeated measures έδειξε στατιστικά σημαντική κύρια επίδραση στη θερμοκρασία δέρματος, F (1.000, 11.000) = 6.845 p <0.05, πριν και μετά το πρωτόκολλο Β. Περαιτέρω στατιστικές αναλύσεις (post hoc t- Bonferroni) κατέδειξαν στατιστικά σημαντικές διαφορές μεταξύ των αλμάτων (πριν: 41,7cm ± 2,2cm) και μετά (38,9cm ±

1,9cm) στο πρωτόκολλο Β, καθώς και στο πρωτόκολλο Δ (πριν: 42.7cm ± 2.2cm) και μετά (39.3cm ± 1.9cm). Συμπέρασμα: Η παρούσα μελέτη έδειξε ότι μετά από 23 λεπτά χρόνου παραμονής στο πάγκο η απόδοση των παικτών στο άλμα μειώθηκε και στα δυο πρωτόκολλα με ή χωρίς ισοθερμικό ρουχισμό.

Λέξεις κλειδιά:

θερμοκρασία δέρματος, χρόνος πάγκου, απόδοση, ισοθερμικός ρουχισμός.

Contents

INTRODUCTION

Basketball is a popular sport with more than 450 million people players around the world (Lukosel & Senthilkumar, 2015). On December 21 (1891), Dr. James Naismith published the first rules for the new game using his idea from a "Peach Basket" (Harris, 2014). After 128 years of history, the way of playing basketball has changed through the years (FIBA, 2017). The new rules tend to change the tactics. Thus, basketball over the years becoming faster (less time to perform an offensive play) and more complicated (Ben Abdelkrim, El Fazaa, & El Ati, 2007; Hoare, 2000).

This new way of playing makes the evaluation of the physiological demands of basketball harder, according to (Hoare, 2000). However, some previous studies succeeded in enumerating the different motor activities of a basketball player in “real time” (McInnes, Carlson, Jones, & McKenna, 1995). Furthermore, the duration that each player spends in specific kinetic skill is changing every few seconds (McInnes et al., 1995) and the covered distance during the game varies from 4.5 to 5 km (Crisafulli et al., 2002). Nonetheless, some researchers also observed anthropometrics and physiological differences between the tactical players’ position (Ben Abdelkrim et al., 2007; González-Alonso & Calbet, 2003). The rule of unlimited substitutions on basketball proved to be of great importance. It is a rule that it is not applicable in other sports (e.g. football only allows a total of three substitutions) and yet it seems to positively influence the winning team (Gómez, Silva, Lorenzo, Kreivyte, & Sampaio, 2017). According to FIBA rules, a basketball match duration is divided into four periods, lasting 10 minutes each (FIBA,

2017). During the match at each rule violation (e.g. travelling or personal foul), the time stops (FIBA, 2017). The rules define as ‘game time’, the one that appears at the stopwatch board (4 x 10 minutes) and as ‘real time’ the total duration of the match (FIBA, 2017). Thus, we note that a basketball match lasts more than 40 minutes (Galazoulas, Tzimou, Karamousalidis, & Mougios, 2012). Some researchers invested effort and energy in analyzing how the ‘bench time' (the total amount of time that a basketball player spends sitting on the bench), may affect sport performance (Galazoulas et al., 2012; Mohr, Krustrup, Nybo, Nielsen, & Bangsbo, 2004). A recent study (Hudge, 2017) has shown that on average, coaches rotate the players around the 5th "game time", which roughly translates to ~7 minutes in ‘real time'. On the more extreme side of the spectrum, there have even been a study where athletes have been left inactive (i.e. on the bench) for more than 30 minutes ‘real time' (Crowther, Leicht, Pohlmann, & Shakespear-Druery, 2017). Taking all the above into consideration, along with the fact that, according to (FIBA, 2017) rules, the players are not allowed to warm up before any substitution, someone could argue that prolonged inactivity seems to affect players’ performance (Galazoulas et al., 2012).

Previous studies have shown that the warm-up process is an essential part for the right preparation of the athlete in any sport (David Bishop, 2003). The increment of athletic performance and the reduced possibility of injury are the most common benefits of a proper warm-up process according to previous study (Karvonen, 1992). The above statement is applicable to basketball as well, once basketball is a sport that almost the 1/3 of athletes’ total activity includes high-intensity skills (e.g. sprints) (Narazaki, Berg, Stergiou, & Chen, 2009). Nevertheless, before the game, basketball players have a

specific time-frame to warm up (20 minutes). Considering the above observations, it is fair to wonder if the spending time on warm-up is enough benefit for the substituted players.

An increment of 1°C of muscle temperature (T_m) could lead to better performance by 2%-5% (Racinais & Oksa, 2010). In literature, there are contradicting result concerning the fact that increased T_m before the game is a critical factor in performance (Oliver, Johnson, Wheelhouse, & Griffin, 1979; Racinais & Oksa, 2010). This counter-argument mostly based on the claim that time interruptions (e.g. halftime) can lead to the decrement of T_m and performance (Mohr et al., 2004). A previous study on that matter, performed on Basketball players (12 male and 12 female), presents reduction by 13% on 20-m sprint run performance after warm-up and decreased body temperature (Galazoulas et al., 2012).

In conclusion, warm-up seems to be a critical part of the performance in sports especially at basketball due to frequent interruptions. Finally, it is quite thought-provoking how the time between the warm-up and the participation in the game leads to the reduction in performance and the increment of injuries.

Aim

The main aim of this study was to investigate changes in mean skin temperature and exercise performance, after 9' and 23' ‘bench time' with and without insulative clothing on basketball players.

Null Hypothesis

- The ‘bench time’ (9’ and 23’) will not change the mean skin temperature on basketball players.

Alternative Hypothesis

- The ‘bench time’ (9’ and 23’) will change the mean skin temperature on basketball players.

CHAPTER 2: LITERATURE REVIEW

This literature review provides general information about the sport of basketball, basketball performance and mean skin temperature (T_{sk}). Furthermore, results from previous studies are discussed about the effect of warm-up on the human body and sports performance. To achieve the purposes of the present literature review, one database was included in the searching procedure: Pub Med. Keywords for the searching procedure were: basketball, exercise, warm-up (preheating), sports performance, muscle temperature (T_m), and mean skin temperature (T_{sk}).

Basketball rules

Basketball game are dividing into four periods, lasting 10 minutes each and, are consisting of two teams with 12 players roster in each team. Also, five players of each team can play during the game. Each game is controlled by three referees, the table officials and a commissioner, if present (FIBA, 2017). Between the four periods exists a 15-minute half-time between the second and third periods and 2 minutes between the 1st - 2nd and the 3rd - 4th periods. Before every game, the players have the less time limit (20 minutes) as warm-up period. The winner of the match is the one with the heist score. According with the (FIBA, 2017)s' rules, if the teams are rolled up at the end of the last period, then they have an extra time of five-minute. They can follow countless extra time periods and they stop when one of the teams score more than the other.

Each coach is able to ask for five time-outs (1 minute each one), 2 for the first two periods and 3 for the periods after the half-time and for as much substitutions as he/she wants, during the game.

Physiological demands (aerobic/anaerobic role)

Many studies carried out the last 25 years, trying to investigate the physiological characteristics of basketball. Researchers are confronted with the nature of the sport, which enables them to investigate the effects through a series of prolonged factors such as technique, tactics followed by the coach, frequent player's substitutions and the changes on the rules during the years. The evaluation and categorization of the physiological demands of basketball are the main reasons for these investigations (Ben Abdelkrim et al., 2007). More specifically, a basketball player covering 4.5 – 5 km during the game (Crisafulli et al., 2002). During the match, the majority of the time is spending walking (65.8%) while, the rest of the time (34.1%) is spending to perform moderate or high-intensity motor activities (Narazaki, Berg et al. 2009). Furthermore, high intensity motors skills like sprint and lay-ups seem to cover only the 1/3 of the total game time (Narazaki et al., 2009). Previus studies demonstrated that every two seconds a basketball woman player changes one motor skill and she executes 1.050 kinetic skills during the game (Ben Abdelkrim et al., 2007). Other studies showed that (Hoffman, Tenenbaum, et al., 1996) the good aerobic capacity is an essential element in basketball performance but does not seem to be the main reason (up to 50 ml/kg/min VO2max). In basketball where most players perform moderate (e.g. defense) and high-intensity skills (e.g.

shooting, rebounding, lay-ups) but for a short time, the bibliography seems to rank the sport in the category of the anaerobic metabolic pathway (González-Alonso & Calbet, 2003; McInnes et al., 1995).

Tactic positions

Great interest was shown in the results of researches in which the data collection was made either from protocols sensible to the physiological demands of the basketball game or during the duration of the championship' games. Although the data collection is difficult for the reasons we mentioned above, there were interesting results of physiological demands based on the player's (tactical) position. The results of the research have made clear the empirical coaches' hypothesis that the five different positions (Point, Shooting Guards, Small - Power Forward and the Center) of the players have different requirements based on their role in the game. The Guards have the leading role to organize the game, and score (many times), represent a higher heart rate (190 ± 3 beats/min), than the position of Forwards (184 ± 6 beats/min) that are responsible for post-game and rebounding (González-Alonso & Calbet, 2003) during the Woman Spanish International games and the Woman National Spanish Championship. Differences depending on different playing positions were also presented in the number of jumps and sprints. Another study performed on professional women basketball players mentioned that Guards execute more sprints (n=67) than the Forwards (n=56) and the Centers (n=43, the most power and heavy players), but fewer jumps than the other two positions (G=41, F=41, C=49) (Ben Abdelkrim et al., 2007).

Substitutions (Coaches' role)

In many cases, substitutions are characterized by negative decisions, during the game. Low performance of the players (e.g. no field score), seems to lead the coaches to 'decision making' (Malarranha, Figueira, Leite, & Sampaio, 2013) and do substitution that will lead the team to victory. But the scientists have a different opinion. According to a few studies, the substitutions are not a negative element but are characterized as a winning factor (Ibáñez et al., 2008).

The "nature complex" of basketball (Duarte, Araújo, Correia, & Davids, 2012) lead the basketball coaches to rely on organized strategies that they have to choose to follow through the whole season (Clay & Clay, 2014). A previous study showed that, rosters' (the total number of players included in a team), choice seems to be based on some criteria like the number of the fouls. More specific a player is allowed to do only four personal fouls and not disqualified from the game (FIBA, 2017). Another main reason is the 'home court advantage' which is important, because is the court that they are using for the practice (Clay & Clay, 2014). Under these situations, the basketball coaches have less tolerance, in not scoring, and move more easily to substitutions (Clay & Clay, 2014). However, previous study demonstrates that when the score is the same for both of the teams, coaches choosing to change the tactic of the match and not the players (Sampaio, Ibáñez, Lorenzo, & Gómez, 2006). Another previous study showed that the substitutions during the 1st and the 2nd periods have a primary reason for the winning (Gómez et al., 2017). Basketball coaches prefer to prepare all the players, especially on the last 10-minute period, in order to respond on the main situations of the game (Bar-Eli, Sachs, Tenenbaum, Pie, & Falk, 1996). The choice of a big (use only 9-10 players of the whole

roster) or a small (5-6 players of the whole roster) rotation strategy, can give to a team, better performance in defense (e.g. steals and defense efficiency) and offense (e.g. ball-possessions and better % of shooting), respectively (Clay & Clay, 2014).

Thermoregulation system

The human body tries to keep the functioning of internal organisms (brain, organs and temperature), stable (Toledo-Pereyra, 2009). The human body tries to keep the temperature at ~ 37°C. Every minute, the temperature could be changed for many reasons etc. wind, humidity and the insulation of clothing (Armstrong, 2000). With the assistance of the skin's sensors, the brain hypothalamus perceives that disturbance and activates the thermoregulation system (Jessen, 2011).

Thermoreceptors in the skin known as TRP ion channels (Ahern, 2013) detect the ambient temperature and activating the sympathetic system. It is a complicated system involving the controlling blood flow and the local structures of subcutaneous tissues (Kellogg & Pérgola, 2000). In increased ambient temperature conditions, vasodilation takes place with the increase of blood flow, as opposed to exposure to cold environment leads to vasoconstriction and blood flow reduction (Wallin, 1990). One method of measurement of mean skin temperature is using iBUTTON (van Marken Lichtenbelt et al., 2006), sensors which have been used in animals and humans (Davidson, Aujard, London, Menaker, & Block, 2003). It is a disk-shaped system (Picture 7), that is temporarily applied to the skin by using tape and records the temperature and the time.

The skin temperature measurement as a method of evaluating the thermoregulatory system for medical diagnosis (Hildebrandt, Zeilberger, Ring, & Raschner, 2012), athletic

performance (Ferreira et al., 2008; Formenti et al., 2013; Sawka, Cheuvront, & Kenefick, 2011), and design of clothing (Fournet, Ross, Voelcker, Redortier, & Havenith, 2013).

Exercise and thermoregulation

Exercise, is an example of disturbing homeostasis of humans' body by increasing body temperature. Many studies have pointed out that increased body temperature, is a crucial factor, through exercise performance (Oliver et al., 1979; Racinais & Oksa, 2010). Over the past few years, research has been done on the investigation of the muscle physiology in order to increase sports performance. It has been observed that an increment in temperature of exercise muscle, is one of these factors and also the most important (Racinais & Oksa, 2010). Starting from a local point of view (through metabolic pathways) the muscle, as exercise continues and disrupts the homeostasis of the human organism, other physiological mechanisms are activated.

During the first 3 seconds of muscle contraction, the production of adenosine triphosphate, in the mitochondria, highly increases, followed by production of a large amount of heat at local tissue temperature (González-Alonso & Calbet, 2003). As the exercise continuous, the researchers observed, an inverse relationship between muscle contractions and an increment in muscle temperature. The elevation of body temperature leads to a dangerous rise in core temperature, which leads to vasodilatation and sweating through autonomic nervous system activation in order to maintain heat balance (Flouris, 2011). As a result of exercise, there is an increase in blood flow (via vasodilation) and a linear relation to the skin temperature has been observed, as an indicator of the thermoregulation behavior of the human body (Formenti et al., 2013). Previous studies

investigated the impact of the elevating temperature as a positive impact on performance, but only some of them performed on team sports and even less for basketball sport. In literature is been mentioned that an increment of body temperature by 1°C can lead to better performance 2%-5% (Racinais & Oksa, 2010). In another study that conducted in 12 men, who participate in aerobic performance (45 minutes, 80 rpm, 60% HRmax), had an increased T_m of 0.7°C (Hildebrandt et al., 2012).

The role of warm-up on sport performance

The warm-up is a standard and widely accepted procedure before the game. During warm-up, physiological and metabolic mechanisms are activating and that leads to increasing performance (D. Bishop, 2003).

Two different major categories-techniques characterize warm-up: passive and active. Two different methods which each one has different adaptations on the human body (D. Bishop, 2003). More specific the active warm-up is the most common method in the last years. The physiological and metabolic adaptations achieved by this method seem to activate the athlete with more positive adaptations to performance. A higher metabolic and cardiovascular adaptations achieved through active warm-up than the passive warm-up. The increasing in T_m is achieved by passive warm-up without the greater involvement of energy, but it seems no practical and an expensive method. The two major categories present differences, also, in their perform. Some of the methods they characterize the active warm-up involves calisthenics, jogging and cycling while the passive warm-up includes baths and showers (D. Bishop, 2003).

The increasing on Tm (via active warm-up) affect the performance, increases the functioning of the central nervous system, the oxygen delivery to muscles (Asmussen, Bonde-Petersen, & Jørgensen, 1976) and anaerobic metabolic (Bergström, Hermansen, Hultman, & Saltin, 1967) and constitutes as a prevention factor of injury (Karvonen, 1992). The active warm-up must include physical skills similar to those of each sport (Karvonen, 1992). An active warm-up which is composed of closed skill movements (e.g., callisthenics, running, lunging) improves the sport performance (Fletcher & Jones, 2004). Such kind of motor skills are involved in team sports (e.g. basketball and football), the well-developed physical skills and decision-making are components that lead successfully to the win (Abernethy, 1990). Another study of 10 basketball players performed a simulated game, the body temperature increased after warm-up (1.9%) and the 10-meter sprint test improved by 5.5% and the CMJ by 3.8% (Crowley, Garg, Lohn, Van Someren, & Wade, 1991). Reacting to cognitive stimuli, they perform skills in high intensity at short time (e.g. sprints, change of direction).

Also, the planning of warm-up is not an easy procedure and requires meticulous design to avoid adverse effects. On basketball sport, during the warm-up, (Ramsey, Delling, & Clapham, 2006) observed that the heart rate changes significantly during the different phases of the process. During the first minutes (Karvonen, 1992), the heart rate increases very quickly, of strenuous callisthenics or the selected exercises through the warm-up.

In conclusion, the warm-up is beneficial for sports with requiring high-intensity skills (Gabbett, Sheppard Jm Fau - Pritchard-Peschek, Pritchard-Peschek Kr Fau - Leveritt, Leveritt Md Fau - Aldred, & Aldred; Galazoulas et al., 2012; Mohr et al., 2004).

Warm-up after inactivity

The substitutions are many and an essential part for the outcome of the basketball game (Gómez et al., 2017) presents a long period during which the basketball player coming from the bench is asked to give 100% of his potential on the court. A recent study (Hudge, 2017), has shown that the coaches choose to make the first substitution, close to the 5th "clean" time game, which according to another survey corresponds to ≅ 7 'not clean' time game. Finally, there have been cases where athletes have been left inactive on the bench until they have changed more than 30' (Crowther et al., 2017). The basketball players are not allowed to rewarm-up before the decision-making from the coach (FIBA, 2017).

Studies have shown that the time which the players recovered passively, after warm-up, has a negative impact on high-intensity skills, like sprints or countermovement jumps (CMJ). Scientists argue that the reduction in body temperature of the abstain from the game causes the lowest performance. In accordance with this, (Galazoulas et al., 2012), found that after 10 and 40 minutes of rest after dynamic specific warm-up for basketball players, the jumping capacity reduced by 13% and 20%, respectively. Another study (Mohr et al., 2004), showed that the T_m decreased during the halftime on a soccer game. Specifically, the T_m has decreased by 2°C and also the sprint performance, after 15 minutes of passive recovery (was preceded warm-up). The same study concluded that a re-warm-up period performed the second half, restores muscle temperature to levels similar to those of the first half-time and maintains performance in the sprint. In a study conducted to estimate the frequency of muscle temperature after a maximum anaerobic performance (Wingate test), was observed that for each 1°C the performance decreased by 4%.

Hence, the designing of a specific requirements warm-up for each sport, considered as an essential and beneficial practice before every athletic performance.

Insulative clothing on sport performance

The sports industries, manufacturing clothing specifically for sports activities. The profits of sales (2.13 billions of euros) of these products from large sports brands indicate the frequency of use during the exercise (Mokha, Kicklighter, Edsall, & Martin, 2011). However, the sports clothing helps the body thermoregulation, during exercise?

The main factor for clothing friendly to the human thermoregulation system is not to impede the heat exchange between the skin temperature and the environment (Havenith1a, Smith, & Fukazawa, 2008). During physical activity, the body temperature increases and through vasodilation and the skin temperature too. As the exercise continues, and the need for thermoregulation is increasing, skin temperature > 37.1°C (Wingo et al., 2010), the sweating begins. By evaporating the sweat from the skin, the blood through the systemic circulation is cooled and with blood transfusion decreased the core temperature. In practicing in cold environments, it is necessary to avoid obsessive heat loss, as this can lead the athlete to excessive cooling (Havenith1a et al., 2008).

Two different major categories of insulative clothing exist depending on the ambient temperature of exercises (cold or hot). Some of them cover more body surface and some other much less. The number of factors to be taken into consideration for the right selected of the clothing equipment are big and some of them depended on body motion (Holmér, Nilsson, Havenith, & Parsons, 1999) and the air conditions (Havenith1a et al., 2008).

CHAPTER 3: MATERIALS AND METHODS

Participants

Six professional basketball players competing in the Greek Basket League 2017-2018, A1 Division and A2 Division 2017-2018, (age: 24.9±4.6 yr.; height: 192.7±7.82cm; body mass index: 25.50±1.84 kg/m^2; body fat: 11.53±2.7%) have participated. All the participants were with no history of chronic health problems, and they were under no medication and without any muscle injury. Also, a prerequisite for participating in the study was that the players must participate in a championship of any Greek National Category defined by the HBF (Hellenic Basketball Federation) or any other Championship defined by FIBA in the last five years. All participants were informed verbally about the procedures of the study including possible risks and discomforts. Following their agreement to participate, they signed a written informed consent and completed a medical history questionnaire. The study was approved by the University of Thessaly Ethics Review Board (see Appendix).

Experimental Protocol

The players performed four different trials in four different days: a) 9 min bench time + basketball uniform, b) 9 min bench time + basketball uniform and insulative clothing, c) 23 min bench time + basketball uniform, d) 23 min bench time + basketball uniform and insulative clothing. Every trial started with a 20 min specific warm-up which

is the most common combination for high-level basketball players. We used non-probability sampling clusters to create the participant's group among the research. Players performed a non-specific combination of performance tests (countermovement jump, lay-up drill, back-scratch and sit and reach) before and after time's intervention. Ambient temperature (Kestrel 5400 Heat Stress Tracker) and skin temperature were recorded during the whole protocol.

Measurements included anthropometric data (weight, height, BMI) and were conducted in the morning between 08:00 to 13:30 in basketball arena. Participants were also available ab libitum water during the protocol. All the measurements were held during in-season basketball period 2017-2018.

Measurements

Weight, height and body composition. Body weight was measured in light clothing and shoeless. We measured the height (on the field with a measuring tape), the percentage of body fat and weight was estimated using bioelectric conductivity (Tanita Corporation of America, Inc., Arlington Heights, IL, or Body Composition Monitor, Fresenius Medical Care AG & Co., KGaA D-61346 Bad Homburg, Germany). BMI was calculated as weight in kilograms divided to the square of height in meters (Hu, Tuomilehto, Silventoinen, Barengo, & Jousilahti, 2004).

Warm-up

The warm-up designated specifically for basketball pre-game activation. The players warm-up for total 20 minutes. In particular, the first 5 minutes start dribbling with

right-hand lay-up (2.5 minutes), likewise with the left hand (2.5 minutes). Dynamic stretching lasting 7 minutes, and specific warm-up basketball drills lasting 9 min. The detailed program representing in Picture 1.

Picture 1: Warm-up

Lay-up drill

Two cones were placed on the personal foul line (Picture 2). The basketball players with the 'Go' were starting at the height of the personal line (right side) with the right-hand dribbling and perform right lay-up. After that they were taking the rebound and with the left-hand, they dribbling as fast as they can in the cone on the left side and make a left lay-up. The goal is to score as many points as possible in 60 seconds. The in lay-up recorded as two points and the out lay-up as one point (Bös, 1987).

Picture 2: Lay-up drill

Countermovement jump

Power is a main factor in so many sports and a reliable measure of power in the lowers-limbs (Docherty, Robbins, & Hodgson, 2004). It has been associated with the 30-meter sprint test, and it is believed that who perform better in the CMJ, also perform better in sprint performance (Docherty et al., 2004). We use the OPTOJUMP next (Microgate Corp., Italy) consists of two bars communicated each other (96 LEDs), an optical system of analysis and measurement. Any interruption the system detects, calculates the time flight, the height, the number and time of contacts. The participants performed three CMJ without arm swing, with 30 seconds rest between each jump. The athlete performs the countermovement action with larger countermovement depths before they jump and must

keep his hand on the hips until the contact with the floor. During the flight time, it is essential the extension in the hip, knee and ankle joints and it is also important to land in the same position his has before the jump (Picture 3).

Picture 3: Countermovement Jump

Sit and Reach test

We use the Sit and Reach test to measure the flexibility of lower back and hamstrings muscles (Wells & Dillon, 1952). Athletes removed their shoes and sat on the floor. Their legs stretched out straight ahead, and his soles contact on a specially designed box (Picture 1,2). Both knees were straight to the floor, not bent. With the palms looking straight and hands out in front of the ears, the athletes tried to catch as long as

possible the longest line and hold that position for 2-3 seconds. Two attempts are made between 10 seconds rest. As much as more centimetres the better the score.

Back scratch

We measured the shoulder range of motion with the Back Scratch, the third consecutive articulation that injured in men basketball players (Apostolos & Alexandra, 2007). The participant was standing and place one behind the head, the other one back over the shoulder and try to reaching as far as he can down the middle of his back. The hand that is over the shoulder placed on the outer palm surface in the middle of the back and the other one (behind the head) with the outer surface of the palm (Picture 4). If the fingers overlap estimates as a positive score and we measure (centimeters) the distance between the tips of the middle fingers. If the middles fingers do not touch each other, we measured the distance again and estimated as a negative score. After the first two times of free practicing, we recorded the next two.

Picture 4: Back scratch

Ambient temperature arena

We measured the ambient temperature arena, using the Kestrel 5400FW (Fire Weather Pro WBGT, Nielsen-Kellerman Corp., USA) (Picture 5). Before the begging of the whole protocol, we placed the Kestrel on table officials and commissioner, recording the ambient temperature per second. Through the Kestrel program, we connected with the computer in order to analyze and assess the arena temperature.

Picture 5: Kestrel 5400FW

Mean skin temperature

The skin surface measured using iBUTTON sensors (type DS1921H, Maxim / Dallas Semiconductor Corp., USA). The iBUTTON sensor (Picture 6) is a small disk-shaped system (16 x 6 mm^2) that is temporarily applied to the skin by using a tape strip adhesive and measures and records the temperature in protected memory. Each sensor placed on the middle of the quadriceps and the long biceps brachii. Then the time and temperature data are transferred to a computer to analyze the data to calculate the mean skin temperature [Tsk (0.47* biceps brachii) + (0.38*quadriceps) + 4.56] (Lund, 1974).

Picture 6: i-buttons

Bench time (9 +23 minutes)

We watched a total of 20 games from four different leagues. Specifically, five basketball games for each ABC Liga, Lega Basket Serie A, Euroleague Basketball and Greek Basket League period 2017-2018. We calculate the mean “real time” which the

first substitution occurs in the first period (9') and the second period (23'). We included only the players who participated as substituted players for the first time in the game.

Clothing

According to FIBA regulations, the basketball uniform consists of a jersey (the patch of the team, the name, and the number of the player are mentioned), a short and the athletic shoes with athletic socks. In addition to, the players use to wear a sublimated warm up or shooting shirt (two different names), during the warm-up and when they are sitting as substituted players on the bench. In half of the protocol the participants were wearing the basketball uniform and the shooting shirt (9 and 23 minutes) and 9 and 23 minutes, intervention with insulative clothing. The basketball players were wearing (picture 7) a black training top shirt (Nike Jordan Training Dry 23 Alpha Sleeveless) and an orange dry-fit (Jordan 23 alpha men's ¾) training tights under the usual basketball uniform and the shooting shirt. The players were wearing as basketball uniform the home team typically lighter-colored uniform.

Picture 7: Isothermal clothing

Statistical Analysis

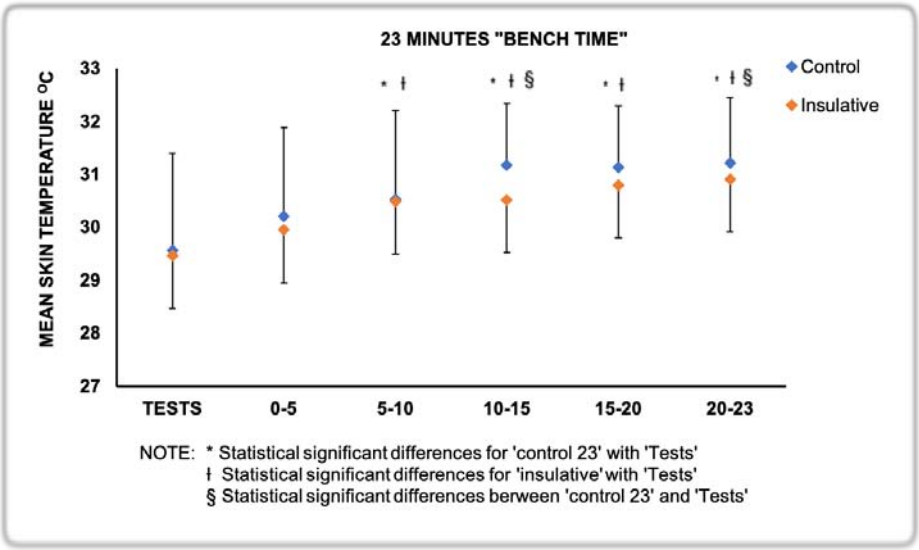
Mixed two-way analysis of variance (ANOVA) was conducted to assess differences between the two bench time points (9'-23'). Therefore, post hoc t tests incorporating a Bonferroni was used to assess statistical differences between group means and the four different interventions. Same analysis was used to determine statistical mean differences in all parameters (countermovement jump, lay-up drill, back-scratch, sit and reach, temperature and humidity) between the different time points. We used (Anova) to assess differences in the mean skin temperature between the last five minutes of the 'tests' period with the whole 23 minutes with and without insulative clothing. Statistical analysis was performed using Statistical Package for the Social Sciences (SPSS, Ver. 21.0, International Business Machines Corporation, New York, U.S.) with significance set at $p<0.05$.

Chapter 4: Results

Two way-Anova were conducted to assess differences between the four different interventions. The results revealed statistically significant differences in mean Tsk temperature ($p<0.05$). Post hoc t tests incorporating a Bonferroni adjustment demonstrated significant statistical difference in mean Tsk, $F(1.000, 11.000) = 6.845$ $p<0.05$, before and after the 23 minutes bench time, without insulative clothing.

We observed a decrease in the last five minutes (paired t-tests) mean Tsk right before the start point of the intervention and a further analysis demonstrated large effect size (≥0.8) of the differences between the first five minutes with the last five [$F(2,15) = 3.750$, $p=0.0.54$] (Figure 1).

Figure 1: Mean skin temperature.

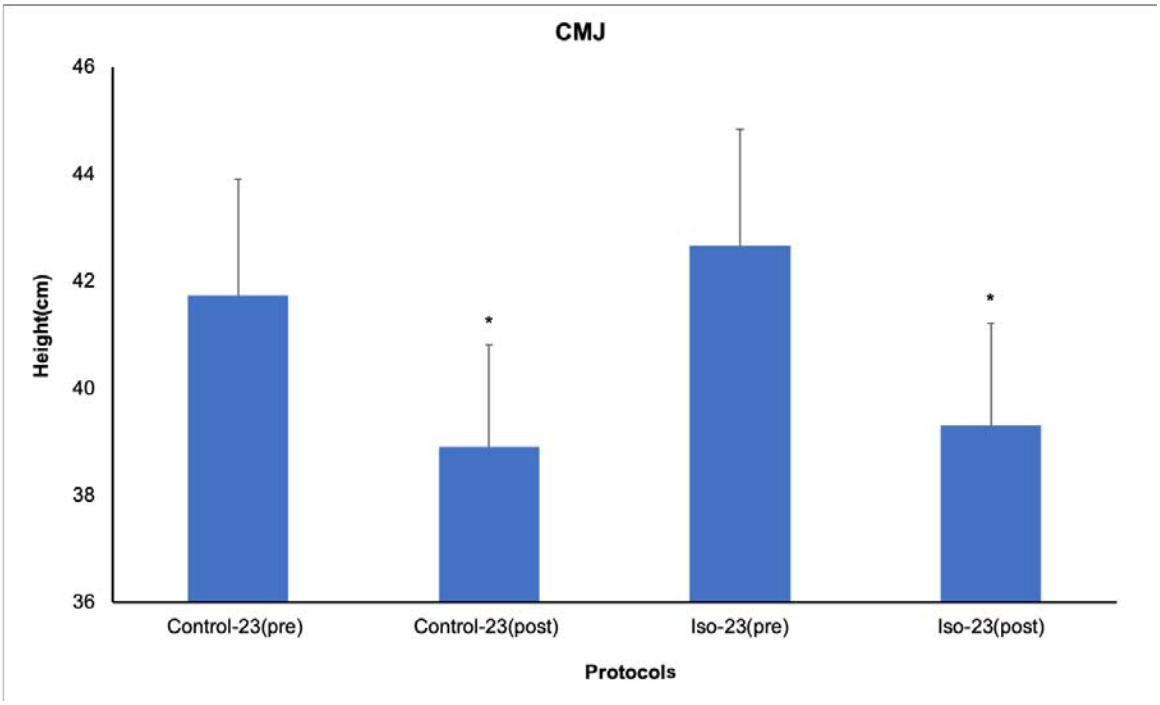


No statistical differences were found of ambient temperature between the three basketball arenas (Figure 2) and the ambient temperature before and after the corresponding interventions of the protocol ($p>0.05$).

Figure 2: Mean ambient temperature during the three basketball arenas.

The results showed that CMJ was significantly influenced by 23' bench time with and without insulative clothing $F(1000, 20.000) = 17{,}319$, $p<0.05$ (figure 3).

Figure 3: Countermovement before-after (23 without insulative clothing).



Non-significant statistical differences were observed between the two time points and the two interventions in Sit and Reach F (1.000, 19.856) = 0.187 p>0.05, lay-up drill F (1000, 20.000) = 2.806, p>0.05 (Figure 4) or Back Scratch F (1.000, 20.000) = 0.163 p>0.05 (Figure 5).

Figure 4: Mean scoring in Sit and Reach and Lay-up tests at all interventions.

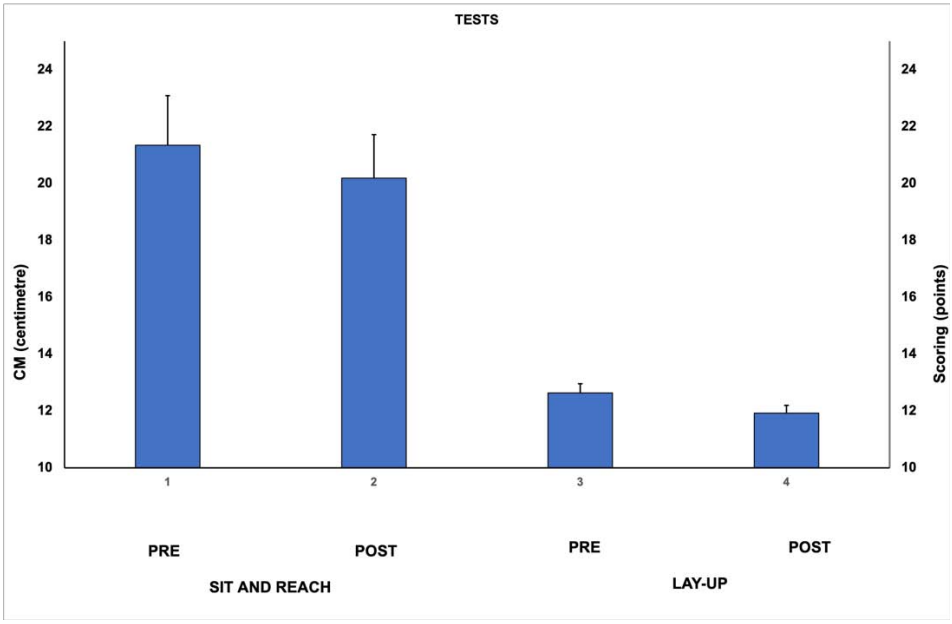
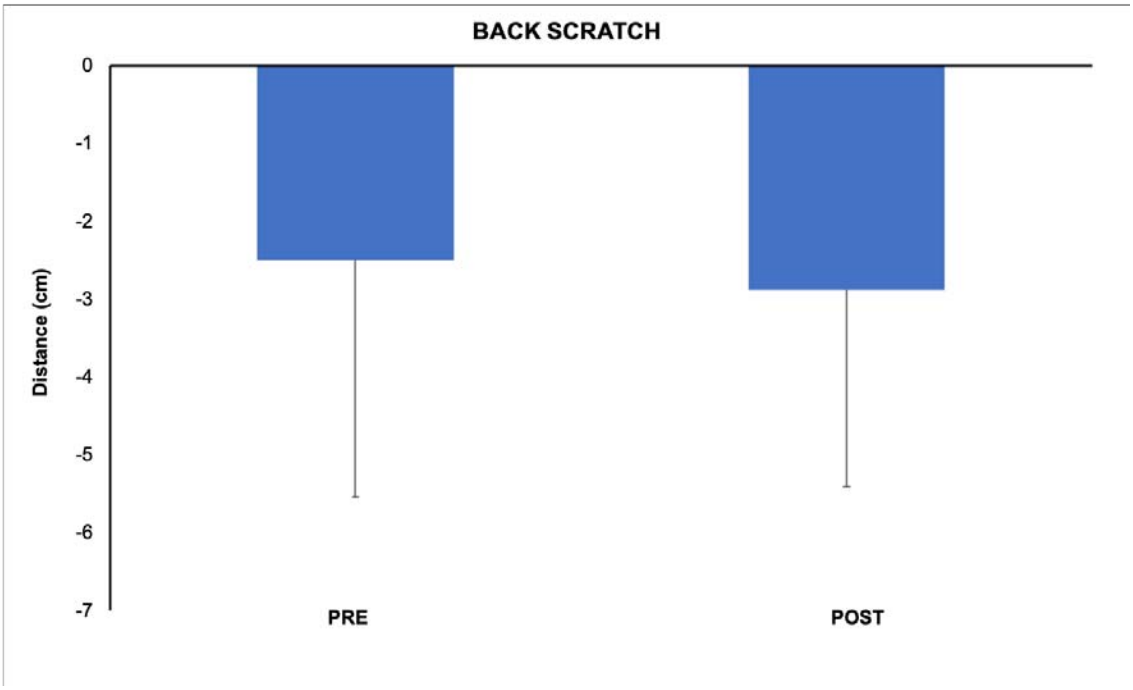


Figure 5: Back scratch score at all interventions.



Chapter 5: Discussion

The aim of this study was to investigate changes in mean skin temperature and exercise performance, after 9' and 23' 'bench time' with and without insulative clothing on basketball players. CMJ was significantly influenced by 23' bench time with and without insulative clothing. The bench time didn't affect the flexibility of the shoulder girdle or the lower back and hamstrings muscles. Also, the mean skin temperature increased during the 23' bench time without insulative clothing.

In this study the CMJ decreased after 23' bench time without insulative clothing by 21%. Similar with these results, (Galazoulas et al., 2012) study, showed a decrease in CMJ, 13% at 10 min of rest to 20% at 40 min of rest. Also, another study (only two subjects participated on a real game) observed a decrease in CMJ (~13%) after 20 minutes bench time (Crowther et al., 2017). The reduction CMJ resulting from inactivity is justified by the correlation between the temperature of the muscle and the ability of the muscle to contraction (Binkhorst, Hoofd, & Vissers, 1977). The performance could be increased by 2%–5% just with a variation of 1^{o}C T_m (Racinais & Oksa, 2010). The dynamic exercise (eccentric contraction) is more depended on temperature than lowest exercise (isometric contractions) (Bergh & Ekblom, 1979). The reduction in specific high-intensity skill (sprint) is confirmed also by (Mohr et al., 2004), with a lowered sprint capacity by 2.4%, corelated with the decline in T_m (39.4 ± 0.2^{o}C to 37.4 ± 0.2^{o}C) after 15 minutes passive recovery.

In addition, the CMJ after 23' bench time with insulative clothing reduced less by 7.9%. The smallest percentage reduction in the case of players wearing insulative clothing is most likely to be applied to the fabric of the garment we used (84% polyester). According to previous research (Ruckman, 2005) polyester is the best clothing

manufacturing material demonstrates the best permeability, after better adaptation on ambient temperatures (Keighley, 1985), helping the thermoregulation system balance the body temperature. Also, (Kraemer et al., 1998) observed that 'compression enhances proprioception and joint position sense' as prophylactic effect reduces 'muscle oscillation after intensity exercise performance' (Doan et al, 2003; Kraemer et al, 1998). The use of garments seems to reduce the soreness of muscles (Kraemer et al., 2010), leading to faster recovery of force production (Kraemer et al., 2001) and reducing the risk of a muscle injury (Kraemer et al., 2010).

The flexibility of the shoulder girdle or the lower back and hamstrings muscles did not influence by bench time. The flexibility requires both the ability of the joints to perform a large kinetic range as well as the strength of the muscles involved in the movement (Ζάκας, 2003). Also, the time of our bench time protocol couldn't affect the flexibility of the shoulder girdle or the lower back and hamstrings muscles due to the low muscle contraction. The stretching during the test, caused low intensity muscle contraction and it is not caused some reflex activity of the muscles, restoring a greater amount of elastin (Nordez, McNair, Casari, & Cornu, 2009). In addition, the increasing elasticity generated by heat production due to exercise is 20% higher in hamstrings than quadriceps (Ciccone, Bratton, Weinstein, & Elias, 2006). At the time of the tests, (23 minutes without isotherm clothing), a decrease in the mean skin temperature was observed. This assumption is due to the low intensity of exercise (during the tests vs the lasts minutes of warm-up) and as a result on a decreased of metabolic heat production (Kenny et al., 2003). In addition, we suspect that the change in body position, during the test (e.g. sit and reach), had changed the muscle contraction and redistribution of blood flow.

We surprisingly found an increase of skin temperature during the 23 minutes bench time (i.e., after the initial warmup and tests) without insulative clothing. This increase may be due to the heat exchange between the core, the tissues and the residual heat load of muscle (Kenny et al., 2003). Previous studies observed an increase on esophageal temperature at post exercise (0.4 – 0.5°C) after dynamic exercise (Thoden, Kenny, Reardon, Jetfe, & Livingstone, 1994; Veicsteinas, Ferretti, & Rennie, 1982). Previous authors (Kenny et al., 2003), suggested that convective heat exchange during rest "is significantly influenced by convective heat transfer between muscle and core". Also, the redistribution of blood flow after exercise from the muscle to peripheral (Clark, Mullan, & Pugh, 1977) may is another reason of increase on peripheral temperature. In addition, the increase in arena ambient temperature during this specific intervention of the protocol (before protocol: 17.65°C, after protocol: 18.02°C, effect size: 0.72) may prevent the athletes from thermoregulating as the ambient temperature had increased.

Our study presents some limitations. The three different basketball arenas which were used demonstrated considerable differences in temperature. Another limitation in our study involves the issue of the season's goals (of major importance games) of the high-level teams that participated in this study, extended the time period of the research into the end of March, leading to better weather conditions.

To our knowledge, this is the first study of includes high-level basketball players through in-period season, in one of the biggest Basketball Championship in Europe. In conclusion, it would appear that a specific designed basketball warm-up doesn't seem to be positive effected during the whole real time of the game. More than 20 minutes bench time of a basketball player, influence the high intensity skills with or without insulative

clothing but not the low intensity skills. In addition, skills which include technical elements, as lay-up, seems to be unaffected by the bench time. Importantly, our results provide evidence for the role of insulative clothing during the game.

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ΠΡΟΤΑΣΗ ΕΡΕΥΝΑΣ

Προς: την Εσωτερική Επιτροπή Δεοντολογίας του Τμήματος Επιστήμης Φυσικής Αγωγής και Αθλητισμού, του Πανεπιστημίου Θεσσαλίας

Τίτλος: Η επίδραση του κρύου περιβάλλοντος σε κύριες κινητικές δεξιότητες της Καλαθοσφαίρισης.

Επιστημονικώς Υπεύθυνος: Ανδρέας Φλουρής, Επίτιμος Διδάσκων στη Φυσιολογία του Ανθρώπου στο Τμήμα Επιστήμης Φυσικής Αγωγής και Αθλητισμού του Παν/μίου Θεσσαλίας και Επισκέπτης Καθηγητής στην Περιβαλλοντική Ιατρική στη Σχολή Επιστήμων Υγείας του Παν/μίου της Ottawa στον Καναδά.

Σχέση με το Πρόγραμμα Σπουδών του ΤΕΦΑΑ:
Μεταπτυχιακή εργασία της Αρετής Καπνιάς φοιτήτριας του ΠΜΣ «Άσκηση και Υγεία», ΣΕΦΑΑ, ΠΘ

1. Σκοπός της έρευνας

Σκοπός της έρευνας είναι να εξετάσει εάν οι θερμοκρασίες που επικρατούν σε Κλειστό Γυμναστήριο Καλαθοσφαίρισης επηρεάζουν την απόδοση των αναπληρωματικών αθλητών καλαθοσφαίρισής σε βασικές κινητικές δεξιότητες του αθλήματος.

2. Σημαντικότητα της έρευνας

Με βάση τα αποτελέσματα της έρευνας θα εκτιμήσουμε τις θερμοκρασίες που επικρατούν σε ένα Κλειστό Γήπεδο Καλαθοσφαίρισης και για τον αν η θερμοκρασία επηρεάζει την απόδοση των καλαθοσφαιριστών-στριών. Τα αποτελέσματα θα δείξουν αν οι προπονητές και οι αθλητές-τριες Καλαθοσφαίρισης πρέπει να υιοθετήσουν στρατηγικές για τη διατήρηση της θερμοκρασίας του σώματος (σε συγκεκριμένες τιμές) κατά τη διάρκεια του αγώνα.

3. Εισαγωγή και ανασκόπηση της βιβλιογραφίας

Η διαδικασία της προθέρμανσης είναι ένα πολύ σημαντικό κομμάτι για τη σωστή ενεργοποίηση του αθλητή-τριας καλαθοσφαίρισης πριν από τον αγώνα[1]. Ένα άθλημα σαν αυτό της Καλαθοσφαίρισης, όπου οι αλλαγές είναι πολλές και σημαντικές για την έκβαση ενός αγώνα[2], παρουσιάζονται μεγάλα χρονικά διαστήματα κατά τα οποία ο καλαθοσφαιριστής-στρια ερχόμενος-η από το πάγκο καλείται να δώσει το 100% των δυνατοτήτων του στον αγωνιστικό χώρο. Οι προπονητές φαίνονται ανεκτικοί στα πρώτα λεπτά του αγώνα καθώς πρόσφατη έρευνα που πραγματοποιήθηκε[3] έδειξε ότι οι ίδιοι επιλέγουν να κάνουν τη πρώτη αλλαγή, κοντά στο 5΄ «καθαρού» αγώνα κάτι που σύμφωνα με άλλη έρευνα αντιστοιχεί σε ≅ 7΄ συνολικού πέρας αγώνα[4]. Τέλος, έχουν παρουσιαστεί και περιπτώσεις όπου αθλητές παρέμειναν ανενεργοί στο πάγκο, μέχρι να γίνουν αλλαγή περισσότερο από 30΄[5].

Η θερμοκρασία πυρήνα και δέρματος αυξάνονται κατά τη διάρκεια της προθέρμανσης και μπορούν να μειωθούν στο ημίχρονο κατά 0.5ºC[5]. Ή συνολική θερμοκρασία του δέρματος

μετά από 11’ αδράνειας σε καλαθοσφαιριστή (προηγήθηκε προθέρμανση) μειώθηκε έως και 2 ^{o}C[5]. Αυτή η μείωση της θερμοκρασίας του ανθρώπινου σώματος δεν επηρεάζει μόνο την απόδοση του παίκτη-τριας αλλά μπορεί να τον οδηγήσει και σε τραυματισμούς[5, 6].

4. Μεθοδολογία

Εισαγωγή: Για την εκπόνηση της έρευνας θα χρησιμοποιηθεί ειδικός εξοπλισμός για τη μέτρηση του περιβάλλοντα χώρου και του ανθρώπινου σώματος, ειδικός αθλητικός ρουχισμός και θερμαινόμενες κουβέρτες

Δείγμα: 25 αθλητές ή αθλήτριες Καλαθοσφαίρισης θα αποτελέσουν το δείγμα της έρευνας μας. Το δείγμα μας θα χωριστεί σε 3 υπο-ομάδες: control group, η ομάδα «ειδικού» ρουχισμού και η ομάδα που θα χρησιμοποιήσει τις θερμαινόμενες κουβέρτες.

Κύριος μέρος:

Πίνακας 1. Οργανόγραμμα έρευνας. Οι δοκιμαζόμενοι θα απασχοληθούν σε τρεις επισκέψεις.

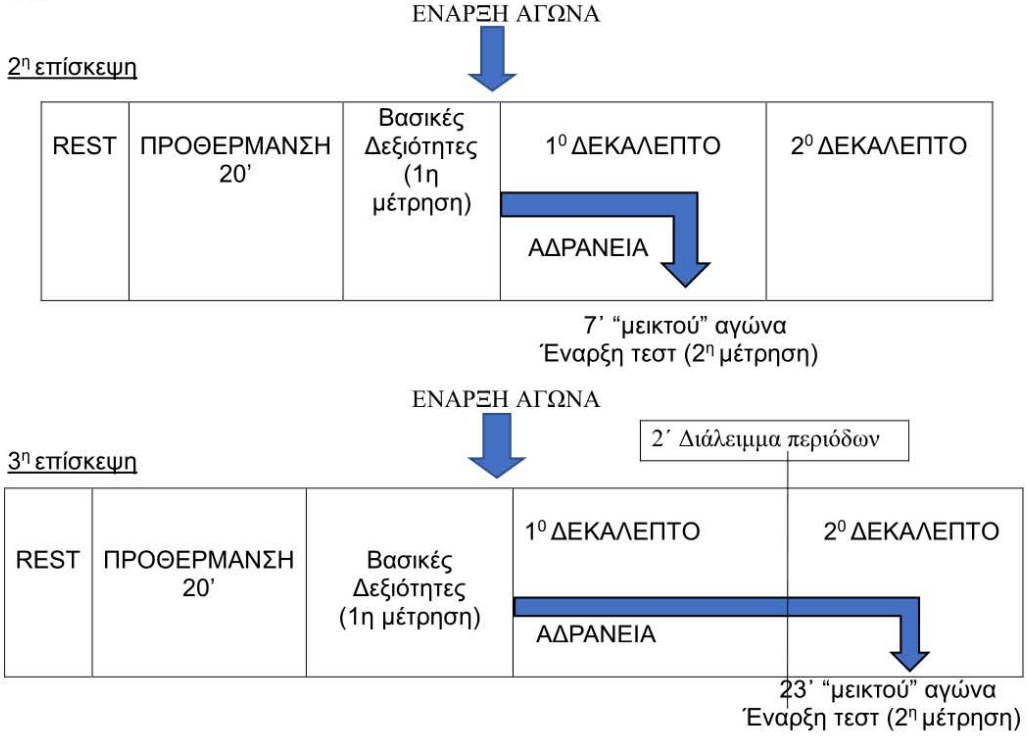
	1η επίσκεψη	**2η επίσκεψη (7’ “μεικτού” αγώνα)**	**3η επίσκεψη (21’ “μεικτού” αγώνα)**
ΕΝΗΜΕΡΩΣΗ	✓		
ΑΝΘΡΩΠΟΜΕΤΡΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ	✓		
Επαναλαμβανόμενα άλματα 30’’		✓	✓
ΚΑΤΑΚΟΡΥΦΟ ΕΠΙΤΟΠΙΟ ΑΛΜΑ Χ2		✓	✓
ΔΟΚΙΜΑΣΙΑ ΕΥΣΤΟΧΙΑΣ Χ2		✓	✓
ΔΟΚΙΜΑΣΙΑ ΑΜΥΝΑΣ Χ2		✓	✓
Καταγραφή θερμοκρασίας Περιβάλλοντος		✓	✓
Καταγραφή θερμοκρασίας δέρματος		✓	✓
Καταγραφή θερμοκρασίας μυός		✓	✓

- **ΕΝΗΜΕΡΩΣΗ:** Οι εθελοντές θα ενημερωθούν για τις λεπτομέρειες σχετικά με την συμμετοχή τους στη έρευνα και θα απαντηθούν από τους ερευνητές του προγράμματος πιθανόν απορίες σχετικά με τη διαδικασία της έρευνας.
- **Ανθρωπομετρικά χαρακτηριστικά**: Θα μετρήσουμε το ύψος (αναστημόμετρο) , το βάρος (Tanita) καθώς και το ποσοστό λίπους Tanita των εθελοντών. Συγκεκριμένα, το ποσοστό σωματικού λίπους θα εκτιμηθεί με τη χρήση της βιοηλεκτρικής

αγωγιμότητας (Tanita Corporation of America, Inc, Arlington Heights, IL, ή Body Composition Monitor, Fresenius Medical Care AG & Co., KGaA D-61346 Bad Homburg, Germany). Θα υπολογισθεί ο ΔΜΣ.

Βασικές Δεξιότητες Καλαθοσφαίρισης

- **Επαναλαμβανόμενα άλματα 30'':** Συνεχόμενα επιτόπια άλματα από τους εθελοντές (με γωνία αγκώνα 90^0) θα εκτελεστούν για 30'' σε φορητό δυναμοδάπεδο (Optojump).
- **Δοκιμασία ευστοχίας:** Θα πραγματοποιήσουν σουτ από πέντε διαφορετικά σημεία,τα οποία είναι ορισμένα, για ένα λεπτό συνεχόμενα. Κάθε επιτυχημένο καλάθι θα μετρηθεί για δυο πόντους και κάθε άστοχο καλάθι για ένα πόντο[7].
- **Δοκιμασία άμυνας:** Οι εθελοντές θα πραγματοποιήσουν αμυντικά γλιστρήματα με μέγιστη ταχύτητα στη περιοχή της ρακέτας από έξι συγκεκριμένα σημεία του γηπέδου[7].



Μετρήσεις Θερμοκρασίας

- **Θερμοκρασία δέρματος:** Συγκεκριμένα, θα μετρηθεί η θερμοκρασία δέρματος με τη χρήση αισθητήρων iBUTTON (type DS1921H, Maxim/Dallas Semiconductor Corp., USA)[8] οι οποίοι έχουν χρησιμοποιηθεί σε ζώα και σε ανθρώπους. Ο αισθητήρας iBUTTON είναι ένα μικρό (16 x 6 mm2) σύστημα σε σχήμα δίσκου το οποίο εφαρμόζεται προσωρινά στο δέρμα με χρήση κολλητικής ταινίας μιας όψεως

(tape) και μετρά και καταγράφει την θερμοκρασία σε ένα προστατευμένο τμήμα μνήμης. Στην συνέχεια, τα δεδομένα για το χρόνο και τη θερμοκρασία μεταφέρονται σε υπολογιστή για την ανάλυση των δεδομένων.

- **Μέτρηση θερμοκρασίας δέρματος με αισθητήρες δέρματος:** Η θερμοκρασία δέρματος θα αξιολογείται συνεχώς μέσω της χρήσης ειδικών αισθητήρων δέρματος (Mon-a-Therm, probe 400 TM) οι οποίοι εφαρμόζονται προσωρινά στο δέρμα με χρήση κολλητικής ταινίας μιας όψεως (tape). Οι θερμοκρασίες θα καταγράφονται σε μια φορητή μονάδα και θα αποθηκεύονται σε ένα υπολογιστή (Smart Reader 8 Plus, ACR Systems, Surrey, BC, Canada). Η μέση θερμοκρασία δέρματος υπολογίζεται ως εξής: δικέφαλος βραχιόνιος * 0.3 + μείζων θωρακικός * 0.3 + τετρακέφαλος * 0.2 +γαστροκνήμιος * 0.2.[9]

- **Άνεση και αίσθηση θερμοκρασίας περιβάλλοντος:** Συγκεκριμένα, η άνεση και η αίσθηση της θερμοκρασίας περιβάλλοντος θα αξιολογηθεί με τη χρήση τυποποιημένων ερωτηματολογίων[10].
- **Μέτρηση θερμοκρασία μυός:** η μέτρηση της θερμοκρασίας του μυός ποδιού θα πραγματοποιηθεί μέσω της τεχνικής του iDISK σύμφωνα με τυποποιημένες διαδικασίες. Η θερμοκρασία του μυός θα αξιολογείται συνεχώς μέσω της χρήσης ειδικού αισθητήρα δέρματος (Mon-a-Therm, probe 400 TM) ο οποίος εφαρμόζεται προσωρινά στο δέρμα με χρήση κολλητικής ταινίας μιας όψεως (tape). Πάνω από τον αισθητήρα εφαρμόζεται δίσκος neoprene με διάμετρο 5 cm και πάχος 4.8 mm. Ο δίσκος εφαρμόζεται προσωρινά στο δέρμα με χρήση κολλητικής ταινίας μιας όψεως (tape). Οι θερμοκρασίες θα καταγράφονται σε μια φορητή μονάδα και θα αποθηκεύονται σε ένα υπολογιστή (Smart Reader 8 Plus, ACR Systems, Surrey, BC, Canada)[10].

5. Απαιτούμενη έγκριση από φορείς

Έγκριση από την Εσωτερική Επιτροπή δεοντολογίας του ΣΕΦΑΑ ΠΘ.

6. Κριτήρια Συμμετοχής στη Μελέτη

Οι συμμετέχοντες θα πρέπει να είναι υγιείς αθλητές-τριες καλαθοσφαίρισης από 18 έως 40 ετών και θα συμμετάσχουν εθελοντικά.

7. Κριτήρια Αποκλεισμού Συμμετοχής

Αφού γίνει έλεγχος του ιστορικού υγείας (μέσω της συμπλήρωσης του ερωτηματολογίου υγείας) των υποψήφιων συμμετεχόντων, θα αποκλειστούν από την έρευνα όσοι έχουν χειρουργηθεί τους τελευταίους 12 μήνες.. Επίσης απαραίτητη προϋπόθεση για τη συμμετοχή στην έρευνα είναι ότι οι αθλήτριες πρέπει να συμμετέχουν σε πρωτάθλημα οποιασδήποτε κατηγορίας ορισμένο από την ΕΟΚ τα τελευταία πέντε χρόνια.

8. Εγκαταστάσεις

Κλειστά Γυμναστήρια στα οποία πραγματοποιούνται προπονήσεις και αγώνες Καλαθοσφαίρισης.

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