Research Service Report

to

KOAR International LLC
2114 Pico Boulevard
Santa Monica, CA 90405

Project Title:

Effects of KOAR Oxide Coated Sports Apparel on Various Physiologic Measures Assessed During Aerobic and Anaerobic Exercise

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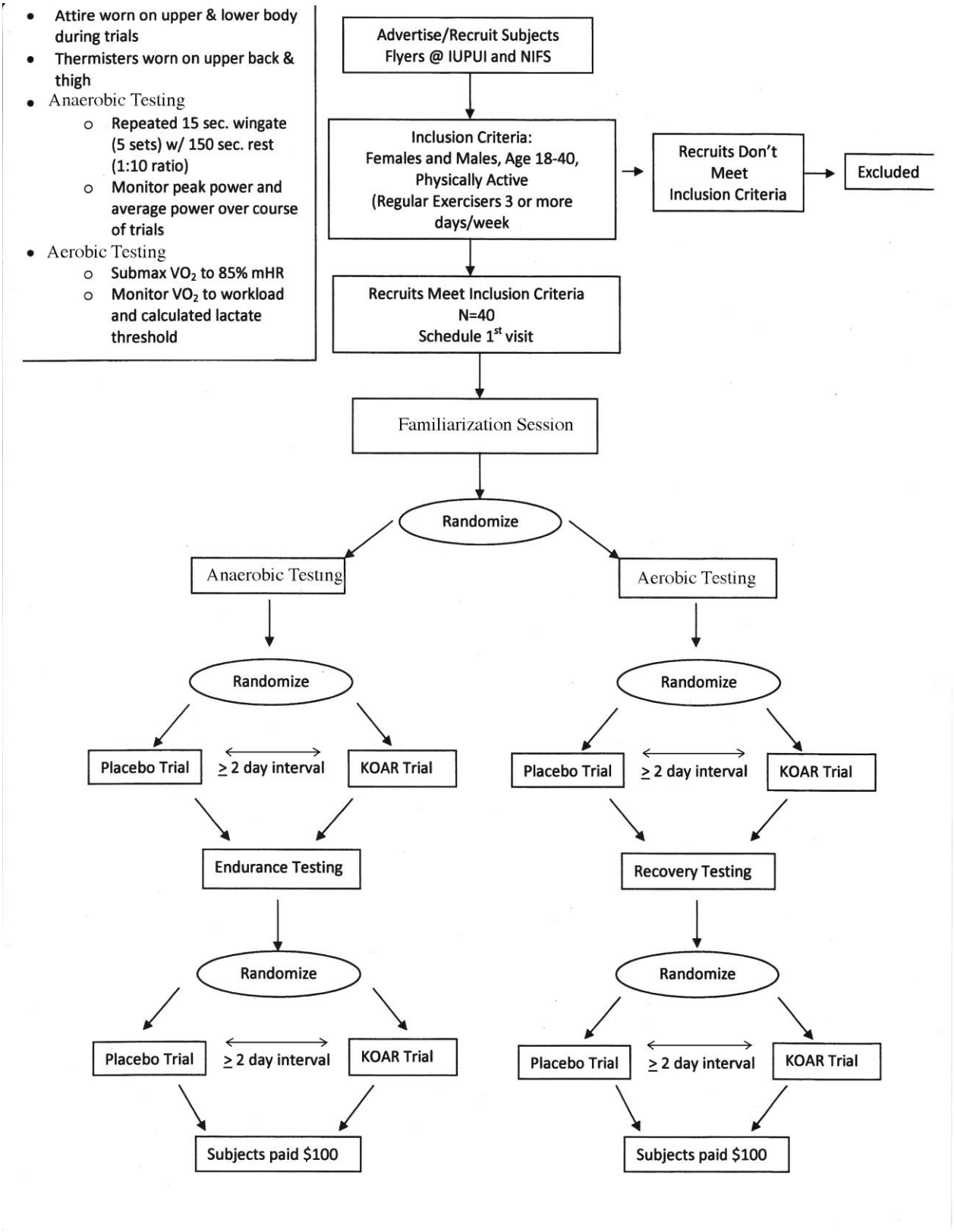
Introduction:

In early September of 2011, Kevin McCarthy of KOAR International, LLC approached Melanie Roberts at the National Institute for Fitness and Sport (NIFS) about the possibility of assessing the physiological effects of their oxide treated sport apparel during exercise. In October, a formalized agreement to test the apparel was entered into between KOAR International, LLC and NIFS. This report presents the results of the service research project that arose from those initial conversations.

Research Design:

This research project involved a repeated measures, double blind, placebo controlled design in which 40 recreationally-active subjects, 18 to 40 years of age performed both aerobic and anaerobic exercise tests. Two trials were performed for each exercise test (i.e. one wearing KOAR apparel and the other wearing placebo apparel). The order of testing (i.e. aerobic or anaerobic) and the assigning of apparel to be worn were randomized via drawing of labeled chips. The drawn chips were not placed back in the selection pool thereby assuring that half the subjects started with the aerobic exercises and half started with the anaerobic exercises. Likewise, half of the subjects performed their first exercise trial wearing the KOAR apparel and the other half wearing the placebo apparel. Figure #1 gives a visual representation of the research design.

Figure 1: Diagram of Experimental Protocol



Testing Methods:

Prior to any data collection, subjects who volunteered for the study were scheduled for a familiarization session with the staff. During the familiarization session, the subjects read and signed the required informed consent to participate, were given the opportunity to ask any questions, and then were oriented to the exercises that were to be performed during the actual test days when data was going to be collected. The reason for giving the subjects a chance to practice and get comfortable with the exercises in a familiarization session prior to data collection was to decrease the chances of a learning effect and the impact it can have on test reliability.

Aerobic Exercise Testing: The aerobic exercise session involved a progressively staged treadmill test, which continued until the subjects reached an exercise heart rate equivalent to 85% of their maximal heart rate. Maximal heart rate was estimated for each subject using the formula: HRmax = 208 – (Age x .70). Subjects were able to select the running speed (i.e. 4, 5, or 6 miles per hour) they were most comfortable with during the familiarization session. This speed was used in the subsequent testing sessions. During the aerobic exercise sessions heart rate, oxygen consumption, and blood lactate data were collected. Once subjects reached 85% of the HRmax the treadmill speed was slowed to a walking speed of 3 miles per hour for a three-minute active cooldown. Upon completion of the 3-minute cooldown the subjects were seated in a chair for an additional 17 minutes of passive recovery. Figure 2 is a photograph of the treadmill setup used during the aerobic exercise session and Table 1 shows the Experimental Variables measured during the aerobic treadmill test.

Figure 2: Aerobic Exercise Testing Equipment

Table 1: Experimental Variables Measured and Procedures

Periods	Duration (minutes)	Treadmill Speed (mph)	Treadmill Elevation (%)	Measurements Taken
Warmup 1	2	1.7	0	HR, VO_2
Warmup 2	2	3.3	0	HR, VO_2
Stage 1	3	4, 5, or 6*	0	HR, VO_2, Lactate, Leg & Back Temperatures
Stage 2	3	4, 5, or 6*	3	HR, VO_2, Lactate, Leg & Back Temperatures
Stage 3	3	4, 5, or 6*	6	HR, VO_2, Lactate, Leg & Back Temperatures
Stage 4	3	4, 5, or 6*	9	HR, VO_2, Lactate, Leg & Back Temperatures
Stage 5	3	4, 5, or 6*	12	HR, VO_2, Lactate, Leg & Back Temperatures
Stage 6	3	4, 5, or 6*	15	HR, VO_2, Lactate, Leg & Back Temperatures
Cooldown 1	5	1.7 mph-3 minutes Seated-2 minutes	0	Lactate, Leg & Back Temperatures
Cooldown 2	5	Seated	Seated	Lactate
Cooldown 3	5	Seated	Seated	Lactate
Cooldown 4	5	Seated	Seated	Lactate, Leg & Back Temperatures

*Selected by the subject based on which speed was most comfortable to them
HR = Heart rate
VO_2 = Oxygen Consumption
Lactate = Blood Lactate

Anaerobic Exercise Testing: The anaerobic exercise session consisted of a standardized 5-minute warm-up followed by 5 repeated, 15 seconds all-out bike ergometer sprints using Wingate testing procedures with 2.5 minutes of rest in between each sprint. The resistance that the subjects pedaled against during each sprint was standardized relative to the subject's body weight (i.e. 7.5% of body weight). The sprints were performed on a Monark 894e Peak Bike ergometer (Vansbro, Sweden) interfaced with a Dell Desktop computer. A bike setup was performed for each subject during the familiarization session so that the bike setup would be exactly the same for the two anaerobic exercise sessions. The Monark software calculated the peak power, average power, minimum power, and fatigue index during each 15-second sprint. Back and leg temperatures were measured before and after each sprint. Below is a photograph of the Monark Bike Ergometer used for the anaerobic exercise sessions.

Figure 3: Anaerobic Testing Equipment

Back and Leg Temperatures: During both the aerobic and anaerobic exercise sessions temperature probes were placed under the garments. Specifically, the temperature probes were placed on the right upper back just superior to the inferior angle of scapula and on the anterior midline of the right thigh halfway between the hip and knee joints. The temperature probes were connected to a Model 4600 Precision Thermometer (Measurement Specialties, Dayton, OH) with a sensitivity of $\pm 0.019^{o}C$. Below is a photograph of the Measurement Specialties Thermometer and an attached temperature probe.

Figure 4: Temperature Sensors

Lactate Measurements: Lactate measures were taken during the aerobic exercise sessions using blood samples taken from finger stick. Specifically, at various time intervals (see table in the aerobic exercise section) duplicate samples were obtained using lancet sticks of the fingers. The first drop of blood was wiped from the finger and samples were taken of the next droplet using Lactate Scout Test strips. The test strips were then placed in a Lactate Scout analyzer (Sports Resource Group, Inc., Hawthorne, NY) with a precision of ±0.2 mmol/liter for lactate determination. Below is a photograph of the Lactate Scout measurement device, the lancet used to draw blood, and a test strip used to collect a blood sample.

Figure 5: Lactate Measuring Equipment

<u>VO2 / Oxygen Consumption Measures:</u> Oxygen consumption (i.e. VO2) was measured throughout the aerobic exercise session using a ParvoMedics TrueOne 2400 metabolic system (ParvoMedics, Inc., Sandy, UT). Subjects wore a conforming face mask which allowed for collection and analysis of expired air by the ParvoMedics metabolic system. The metabolic system was calibrated before each test following standardized procedures and reference calibration gases recommended by the manufacturer. Below is a photograph of the ParvoMedics metabolic cart used in the determination of oxygen consumption.

Figure 6: VO2 and Oxygen Measurement Equipment

Laundering of Garments: Apparel was washed on site, after each exercise session, in a residential, top loaded washer in cold water. The powder detergent used was "Trader Joe's Laundry Detergent". The ingredients listed on the label are: coconut based surfactants (no DEA), carbonate salt, sodium bicarbonate, sodium percarbonate, optical brightener. No fabric softeners were used. After washing, the apparel was hung in the laboratory to dry on a clothes rack (see Figure 7).

Figure 7: Laundering and Drying Procedures

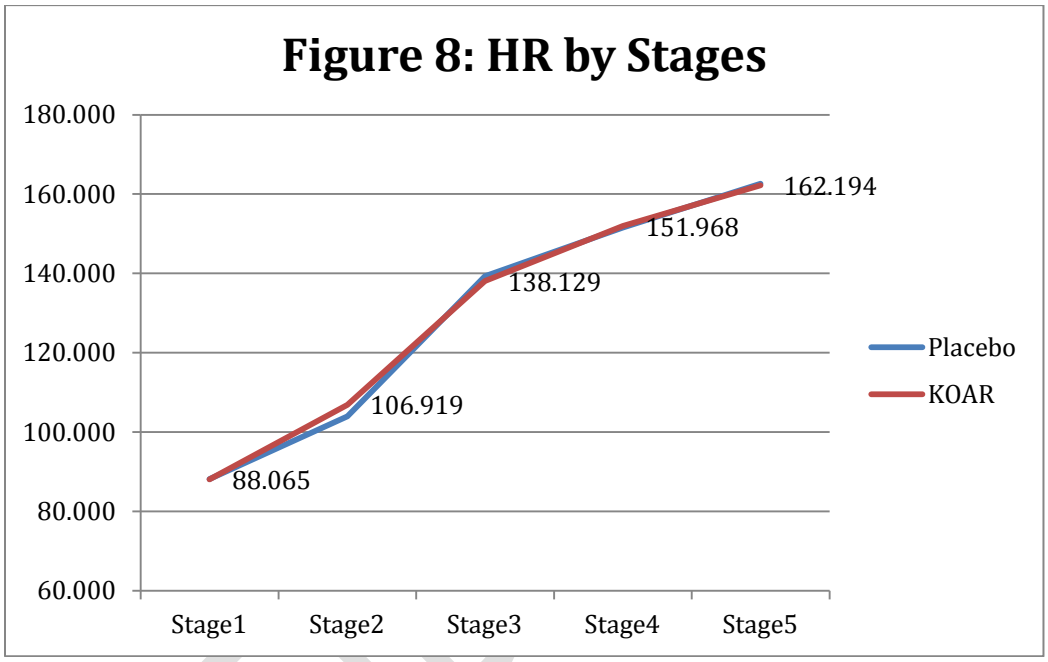
Statistical Analysis: The experimental variables (see Table 1.) were analyzed using SPSS (Statistical Package for the Social Science, IBM Statistics, SPSS 19) at the p=.05 level. Factorial repeated measures Analysis of Variance (ANOVA) techniques were used to determine significant main effects. If significant main effects were found, Bonferroni corrections for multiple comparisons were performed. Paired t-tests were also used in selected variables to determine differences between the placebo and the KOAR apparel.

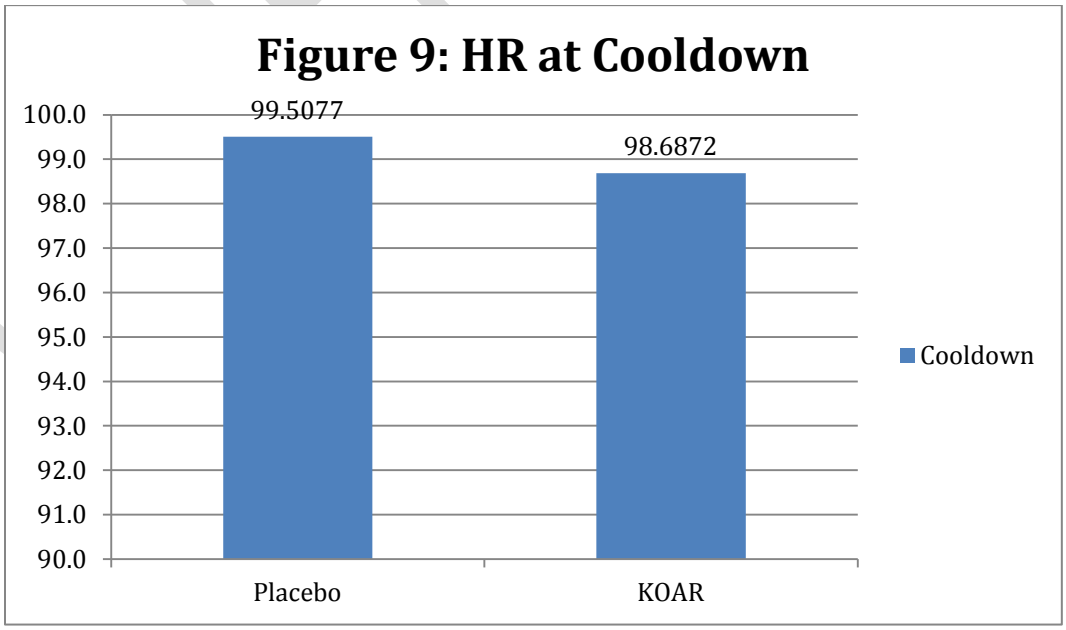
What is the P value? The statistical significance of a result is the probability that the observed relationship (e.g., between variables) or a difference (e.g., between means) in a sample occurred by pure chance ("luck of the draw"), and that in the population from which the sample was drawn, no such relationship or differences exist. Using less technical terms, we could say that the statistical significance of a result tells us something about the degree to which the result is "true" (in the sense of being "representative of the population"). Specifically, the p-value represents the probability of error that is involved in accepting our observed result as valid, that is, as "representative of the population." For example, a p-value of .05 (i.e., 1/20) indicates that there is a 5% probability that the relation or difference between the variables found in our sample is a "fluke." In other words, assuming that in the population there was no differences between those variables whatsoever, and we were repeating experiments such as ours one after another, we could expect that approximately in every 20 replications of the experiment there would be one in which the differences between the variables in question would be equal or stronger than in ours.

RESULTS

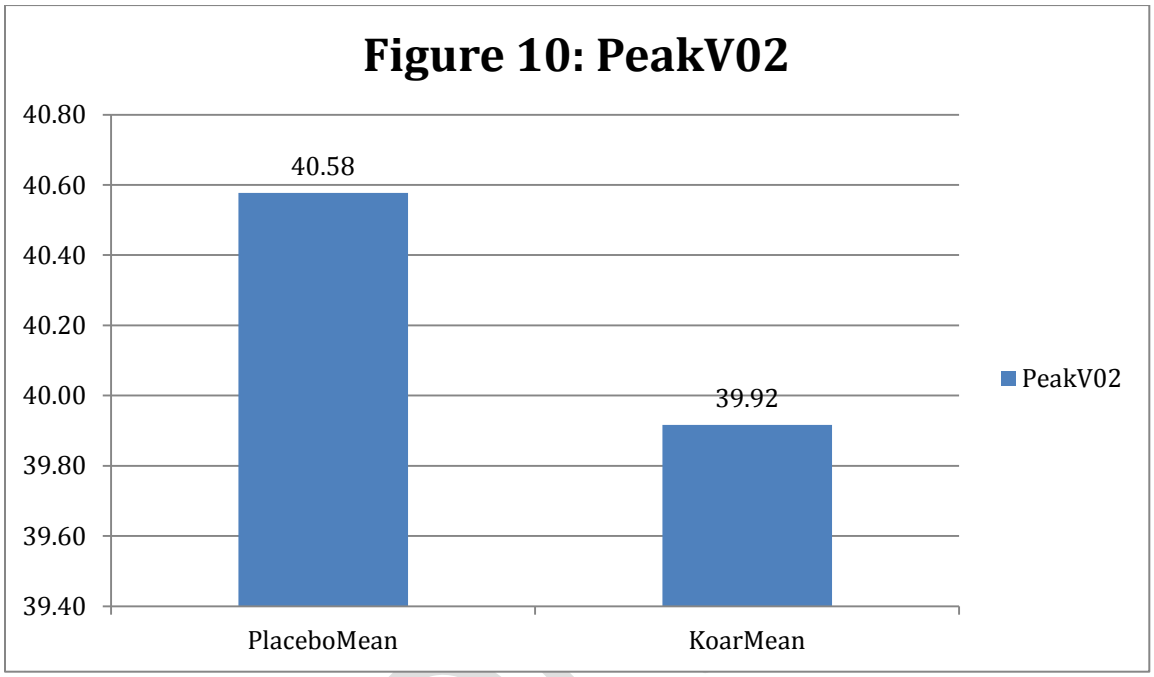
Treadmill Test Results:

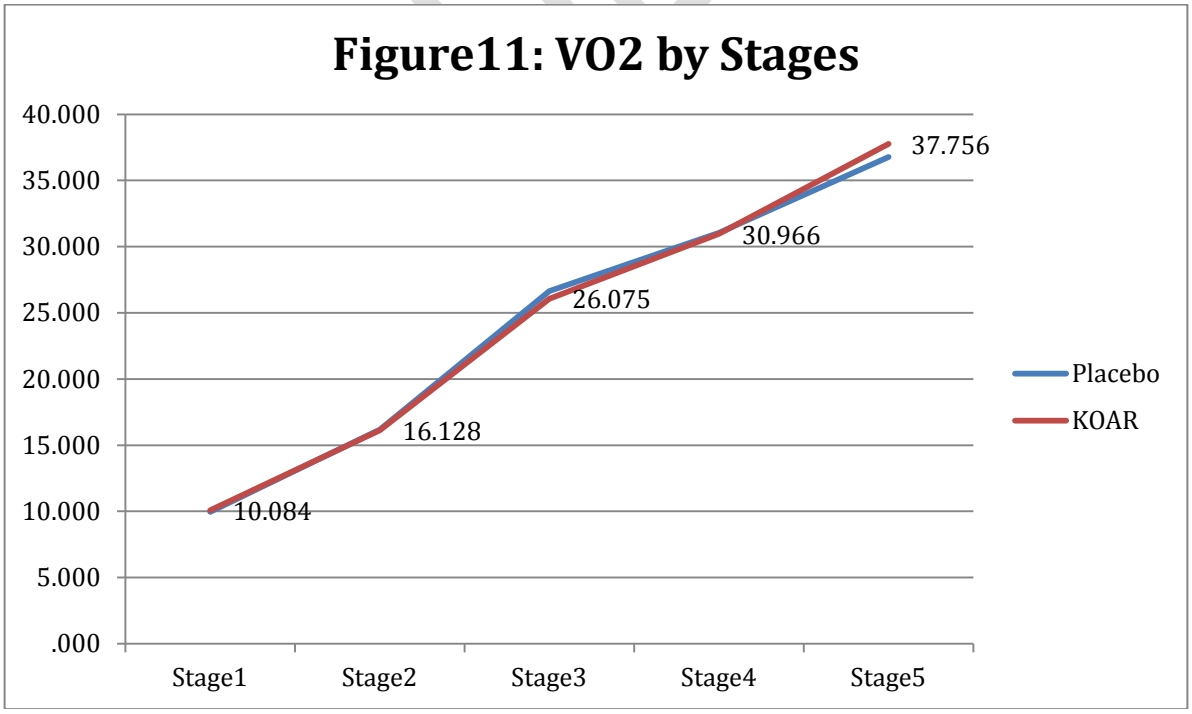
Heart Rate: Figures 8 and 9 show the HR response by stages and after cool down during the treadmill test. The HR responses were similar between the placebo and KOAR apparel during the treadmill test and after cool down.





Peak VO_2: *When the subjects wore the KOAR apparel their mean Peak VO_2 at 85% MAXHR decreased by 1.63%* (see Figure 10). Figure 11 shows the VO2 response by each stage.





Lactate: Lactate values tended to be lower during all stages of the treadmill tests when wearing *the KOAR apparel*.

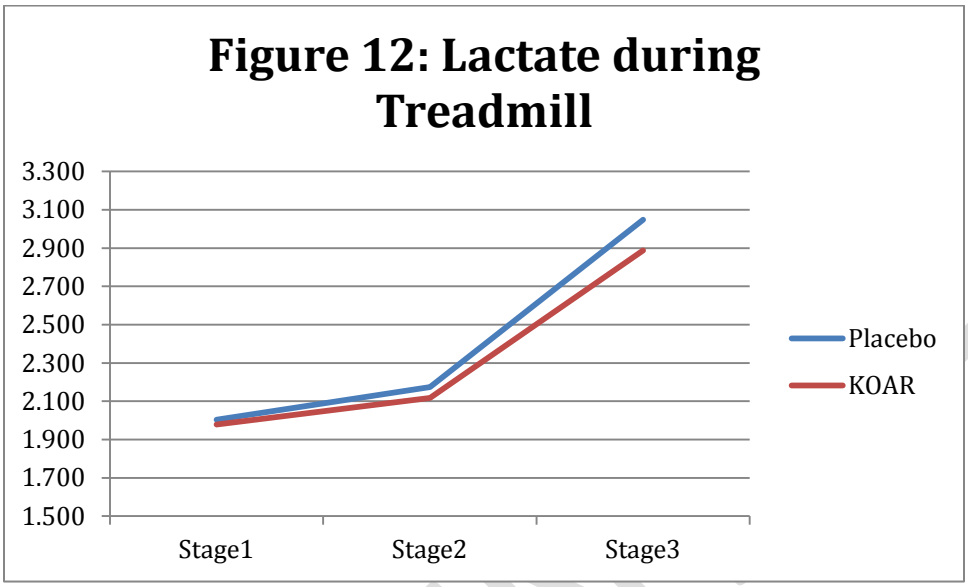
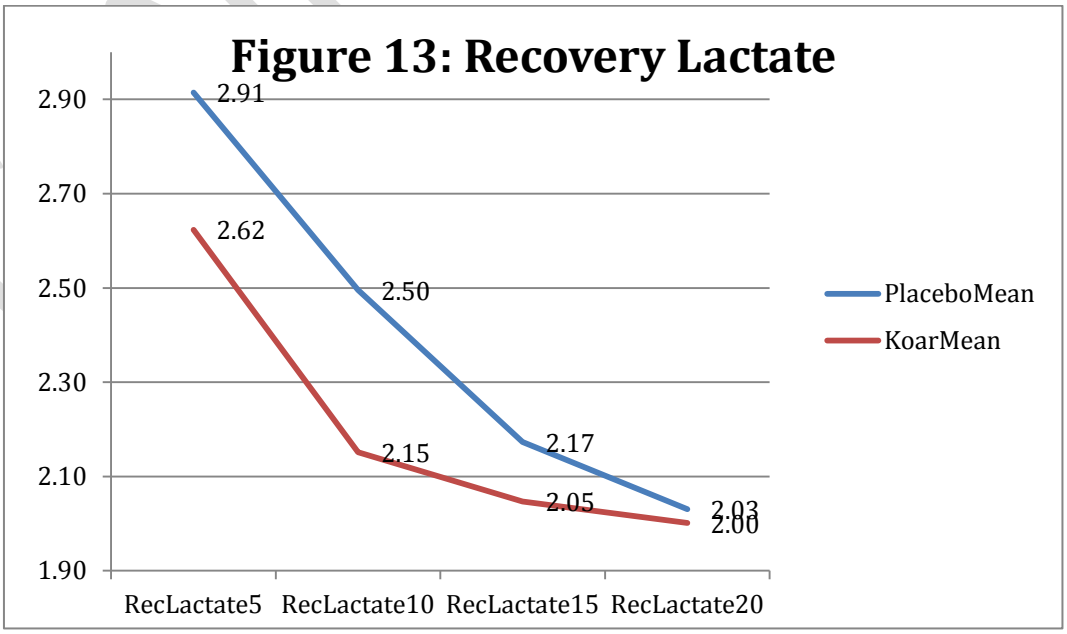


Figure 13 shows the lactate values at 5, 10, 15, and 20 minutes during recovery. *The KOAR apparel showed consistent lower lactate values during recovery*. There was a consistent trend across the recovery period: the KOAR apparel had lower lactate values than the placebo. These values translate into a 10%, 14%, 6% and 1.5% reduction in lactate levels at 5, 10, 15, 20 minutes of recovery.



Back Temperatures during Treadmill Testing: Figures 14 & 15 show the back temperatures during the five stages of the treadmill test and after 20 minutes of recovery, respectively. *There was a strong and consistent trend, with higher back temperatures recorded when the subjects wore the KOAR apparel across the five stages of exercise and after the 20 minutes of recovery*.

Leg Temperatures during Treadmill Testing: Figure 16 shows the difference on the leg temperature readings during the treadmill test were minor.

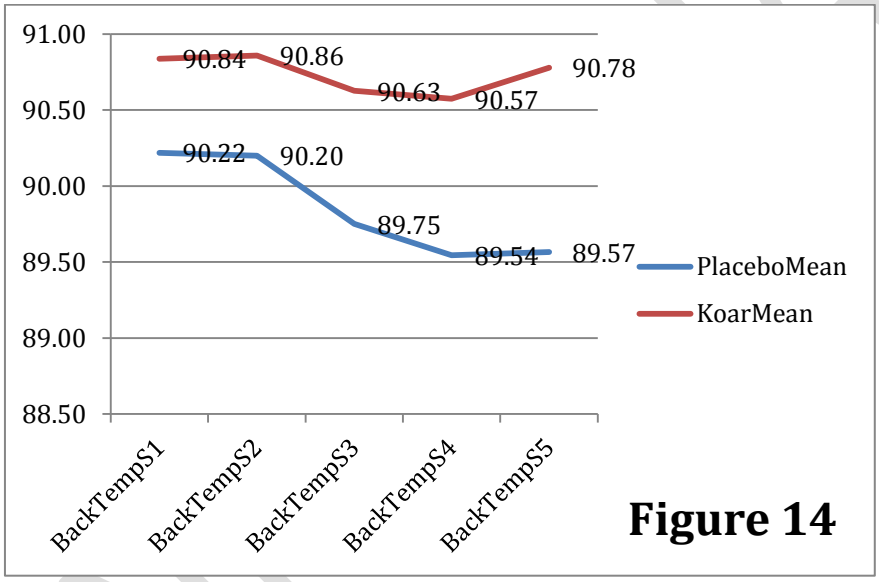
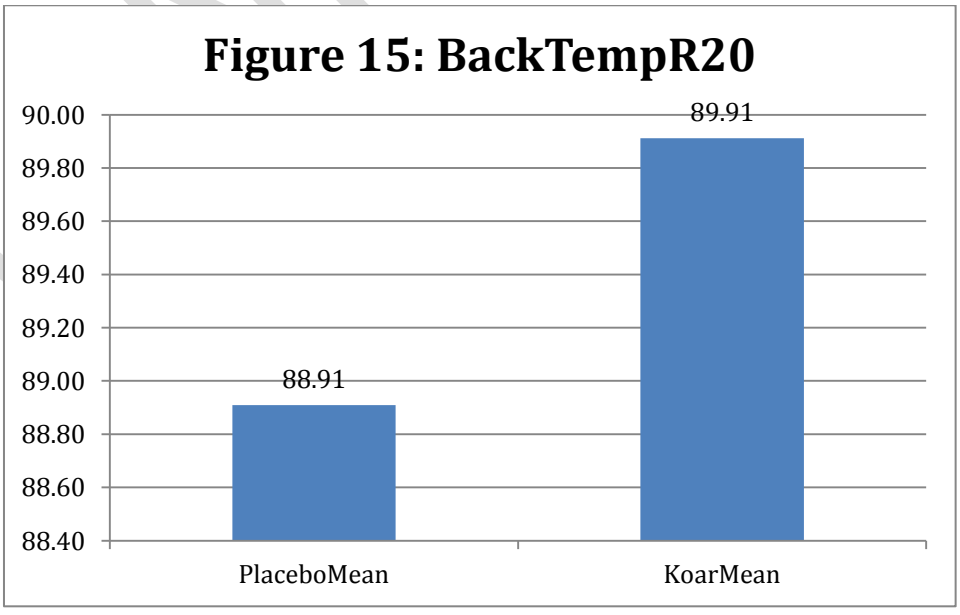
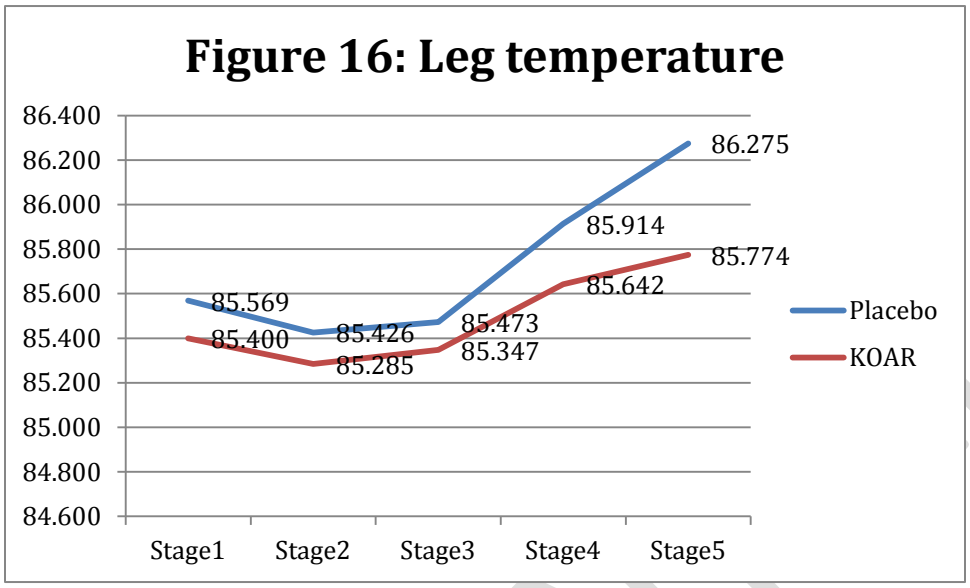


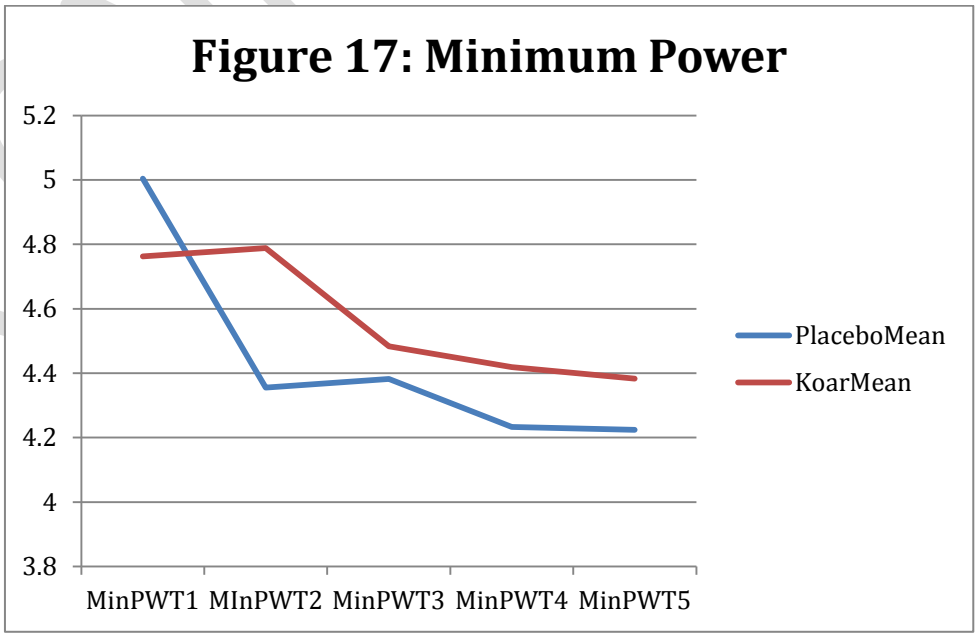
Figure 14



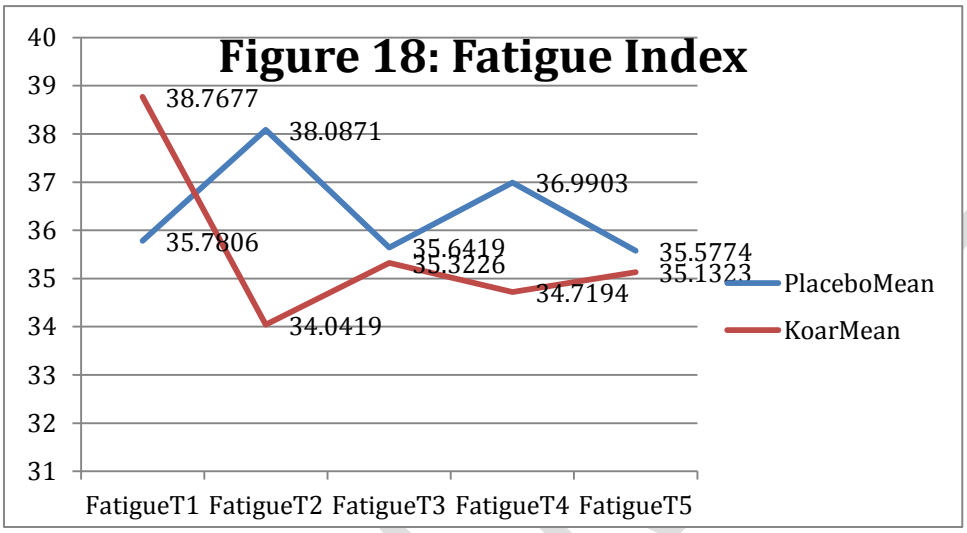


Anaerobic Test Results:

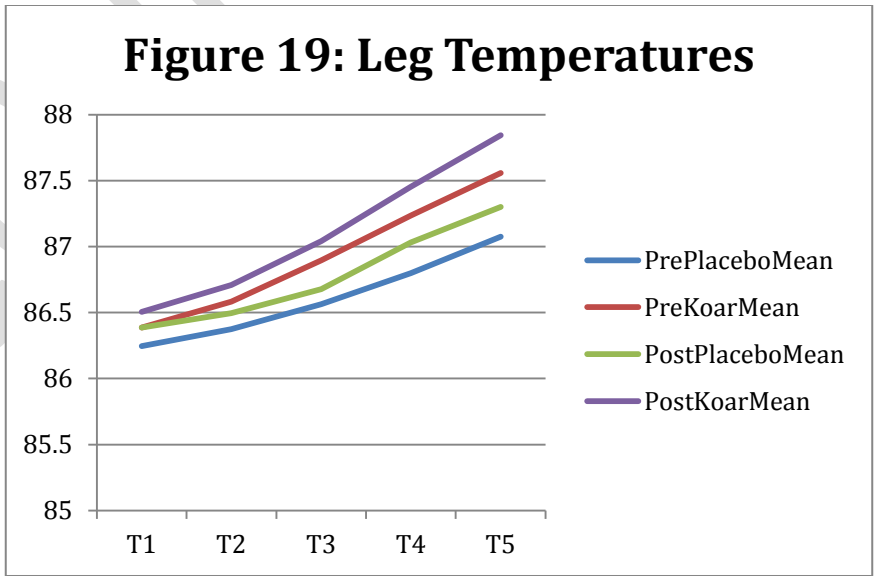
Power: The minimum power generated during each trial of the anaerobic Wingate test was higher for all trials, except for trial #1, when subjects wore the KOAR apparel (see Figure 17).

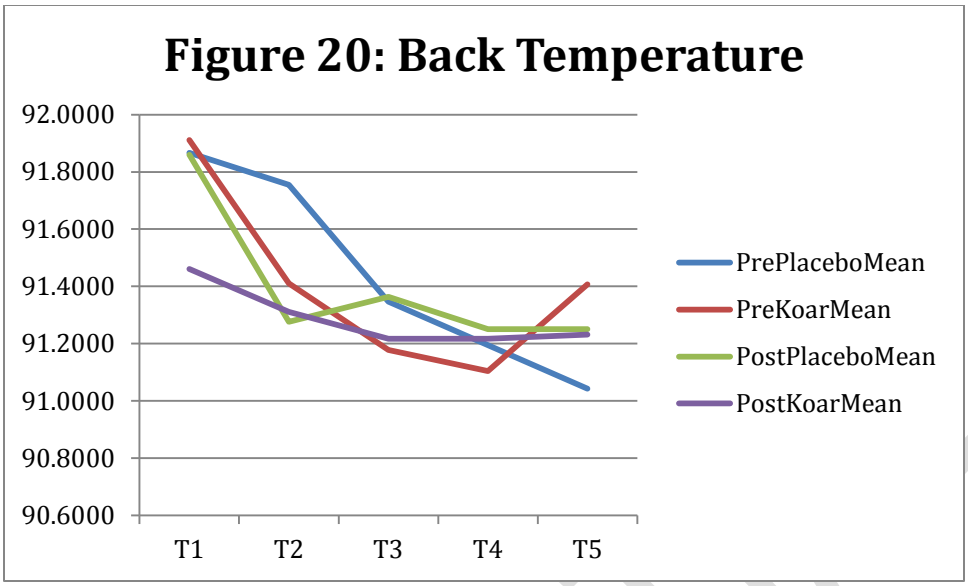


Fatigue Index: Figure 18 shows the computed Fatigue Index for each trial of the anaerobic Wingate test. Subjects wearing the KOAR apparel had lower fatigue index values than when wearing the placebo in each trial except for the trial #1.

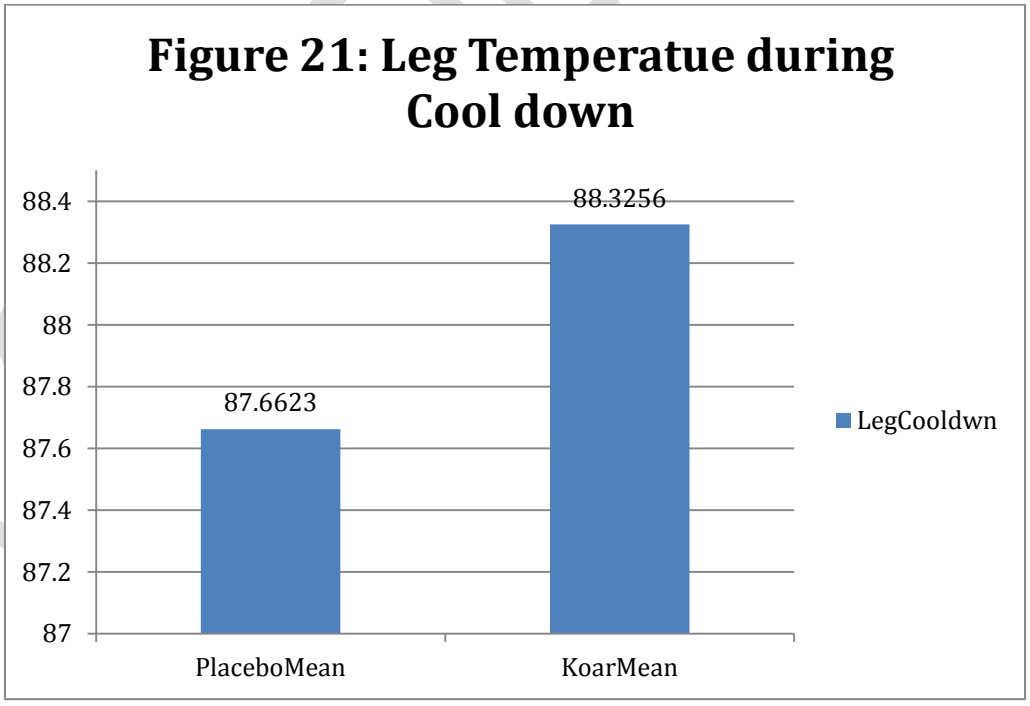


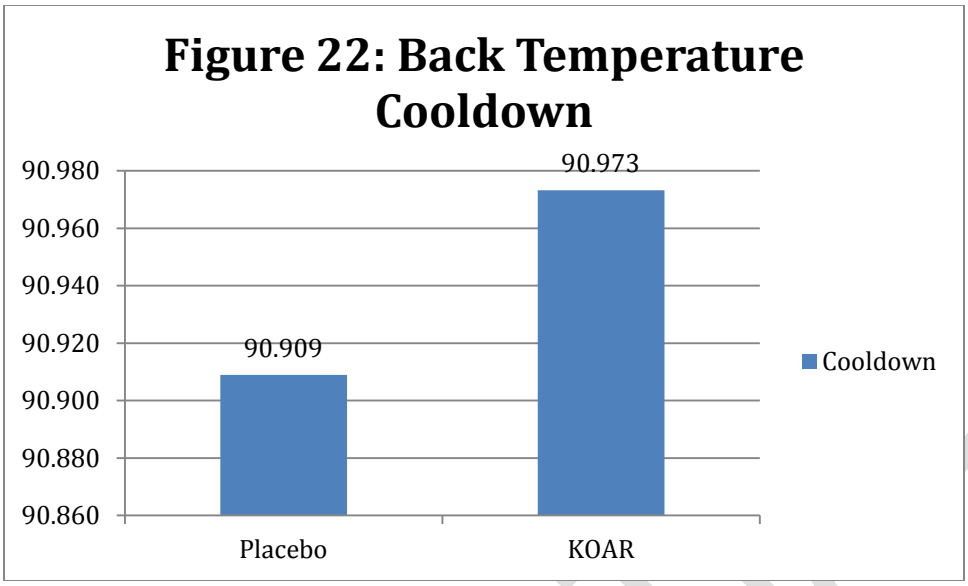
Leg and Back Temperatures during Anaerobic Bike Test: Figure 19 shows the leg temperatures pre and post the anaerobic trials. Leg temperatures were higher both before and after the anaerobic bike trials when subjects were wearing the KOAR apparel compared to the placebo apparel. Figure 20 shows the back temperatures pre-post bike trials.





Leg and Back Temperature after Cool down: Figure 21 and 22 show the leg and back temperatures after the cool down period for the anaerobic tests. There *were higher back and leg temperatures after the cooldown period* when the subjects were wearing the KOAR apparel.





Summary:

The most important findings of this study are the following:

- The KOAR apparel seems to reduce blood lactate during recovery
- The KOAR apparel seems to increase surface temperature on the back and leg while exercising and during recovery.