The Correlation of VO_2 Peak and Repeated Sprint Ability in College Hockey Athletes

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Abstract

Abstract

Introduction: The purpose of the present research is to examine the relationship between VO2 peak, O2 kinetics, and their advocacy for a new general preparation model. Team-sport often requires a blend of metabolic training to maximize performance. Contrary to the belief of sports-specific training, most coaches in anaerobic sports do not believe aerobic training will have any benefit to game performance as it's not what players experience during competition. Previous research has shown VO2 peak to have a beneficial correlation with the ability to decrease fatigue. Therefore, there appears to be a platform for anaerobic athletes to increase oxygen capacity.

Methods: Twenty-two collegiate hockey players, men (age 21±3), who currently play Varsity Ice Hockey participated in this study. Subjects were familiarized for each testing protocol prior to data collection. Subjects completed the Peterson On-Ice Repeated Shift Test to assess fatigue index, Skating Multistage Aerobic Test (SMAT) to estimate oxygen capacity (VO2 peak), and a cycle ergometer Wingate Peak Power test. Subjects were also assessed for body composition. Fatigue Index was calculated by the Peterson on-ice repeated shift test formula (%decrease = (100 x (Total sprint time ÷ Ideal sprint time)) – 100).

Results: A significant correlation was determined between VO2 peak and percent fatigue decrease (3.37 +/- 1.230) (r = -0.643, p = 0.001). Additionally, a significant correlation was determined between body composition (10.60 +/- 2.610 and VO2 peak (62.46 +/- 5.66) (r = -0.665, p = 0.001).

Conclusion: The primary factor that leads to fatigue at the muscular level is the accumulation of metabolic bi products. Athletes with higher oxygen uptake (VO2 peak) may have the potential to delay the onset of fatigue. The delay of fatigue is induced by oxygen uptake kinetics; including an increase in blood flow to muscles, increased resynthesis of phosophocreatine, and an enhanced clearance of hydrogen and inorganic phosphate ions. The results of the present study display there may be a potential for an increased oxygen capacity to expedite O2 kinetics and delay fatigue in hockey players.

Methods

Design
A correlational design was used to assess the relationship between peak aerobic capacity and body composition as it relates to RSA and fatigue. Subjects performed one maximal test during three different sessions. Three testing sessions were performed on different days to prevent any fatigue that may confound the results. Body composition and the Wingate cycle ergometer test were performed in the laboratory on day 1. The repeated shift test (RST) and skating multistage aerobic test (SMAT) were performed at the Schwann Super Rink in Blaine, Minnesota on days 2 and 3. Allowing the subjects to rest would allow for creatine phosphate (CP) resynthesis and the removal of accumulated lactate (4). The submaximal and maximal velocity skate to exhaustion was used to calculate the accumulated oxygen deficit (AOD).

Subjects
A group of twenty-two collegiate hockey athletes ages 18-25 volunteered to participate in the present study. All testing procedures and data collection was obtained prior to the competitive start to the NCAA season. Subjects were all active members from the NCAA men's hockey team and each had previously adhered to their team's specific training and running programs given by their coaches. All participants were screened for previous injuries and were deemed healthy. Informed consent was obtained from each participant and approval was obtained from the Bethel University Health Department prior to the commencement of the study.

Anthropometry
Each participant's height (in meters) and weight (in kilograms) was measured using a certified scale and standard stadiometer. Height measurements were recorded to the nearest millimeter. Weight was measured to the nearest 0.1 kg. Anthropometric measures were collected at the familiarization/pre-test screening on each participant. Subjects were also advised to avoid intense physical activity for a 24-hour period.

Peterson On-Ice Repeated Shift Test
Eight maximal sprints (approximately 23 seconds); 90 seconds rest between each sprint (Peterson, 2013).
Test procedure:
Start- End zone face off dot, skate to near blue line, back to top of crease, skate length of ice to end zone face-off circle, complete full circle. Transition to bottom half of the adjacent circle, skate all the way through red line to **Finish.**
Laser Placement:
(1) At start face off dot. (2) Near blue line after stopping at crease. (3) Finish line at red line.
Fatigue percent calculation:
% dec = (100 x (Total sprint time ÷ Ideal Sprint Time)) - 100
*Total Sprint Time = Sum of sprint times from all trials
**Ideal Sprint Time = Fastest sprint time multiplied by number of trials.

Skating Multistage Aerobic Test (SMAT)
The SMAT is a skating test to assess oxygen uptake. Oxygen is assessed at submaximal and maximal velocities during an on-ice intermittent maximal multistage shuttle skate test with a 1-min/0.5-min work/rest ratio. This procedure consists of skating back and forth on a distance of 45m (stop and go) while following a pace fixed by an audible signal: initial velocity of 3.5m• s–1 with increments of 0.2m• s–1 every stage. The skating multistage aerobic test (SMAT) enables the prediction of the V˙ O2max (ml•kg–1 •min–1) from the maximal velocity (m• s–1) by means of the following regression equation: V˙ O2max=18.07× (maximal velocity) – 35.596 (r = 0.97, SEE = 3.01) (7).

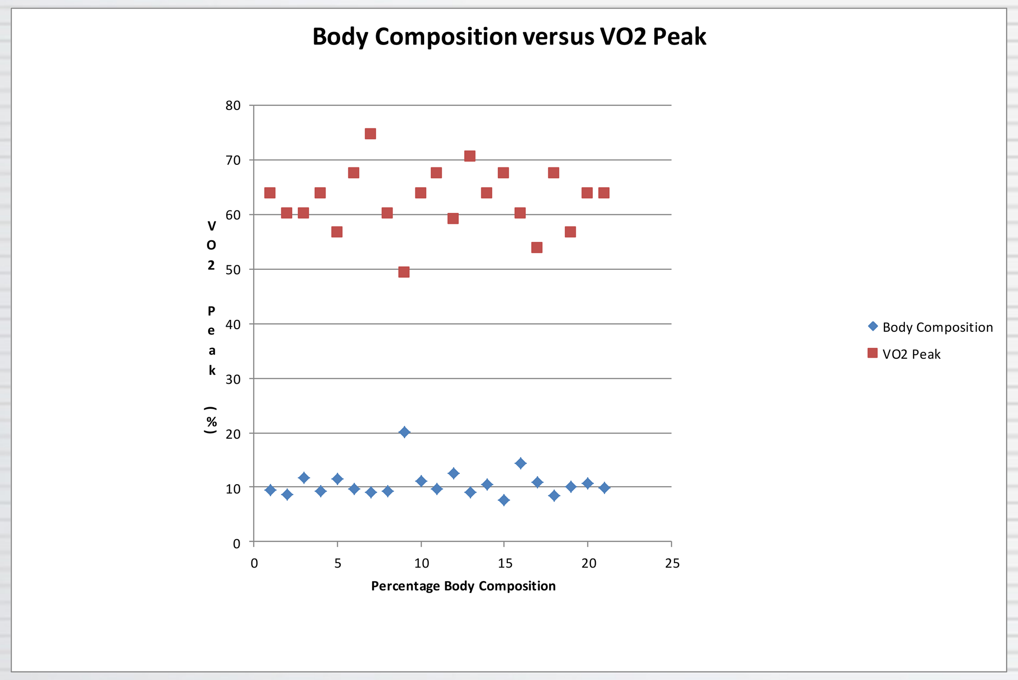
Skinfold Technique
The skin fold technique is a non-invasive method used to determine body composition. Subcutaneous fat folds are measured using a caliper. The ASCM male seven-site skin fold procedure and equation was used to determine body fat percentage. (chest, mid-axillary, triceps, subscapular, abdomen, supra-iliac, thigh)

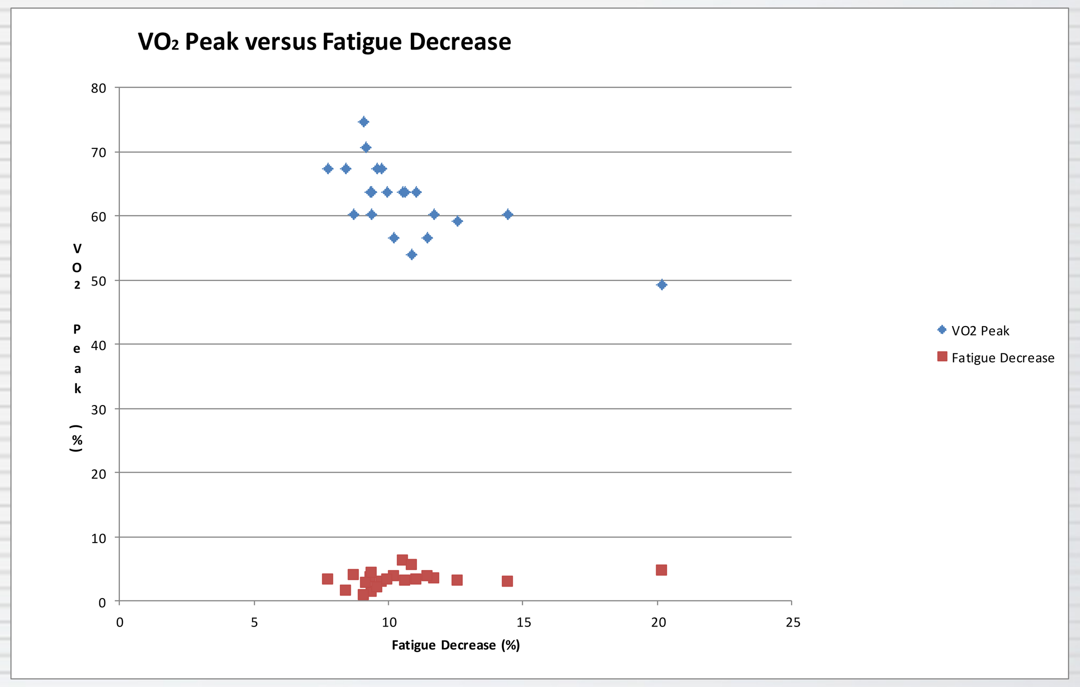
Wingate
Wingate is a 30 second anaerobic test performed on a cycle ergometer to determine the rate of leg muscle fatigue and peak power. It can be used for training purposes or to detect overtraining. This test requires the athlete cycle as fast as possible for 30 seconds. The assistant weighs the athlete (kg), the athlete warms up for 10 minutes, the assistant calculates and records the flywheel resistance required as follows: Athlete's weight x 0.08, the assistant gives the command "GO" and starts the stopwatch and the athlete pedals as fast as possible with no flywheel resistance, after 3 seconds the assistant applies the calculated flywheel resistance and the athlete continues to pedal as fast as possible until 30 seconds has elapsed, after 30 seconds the athlete stops pedaling. For this research, the Wingate information that was obtained was the subject's peak power.

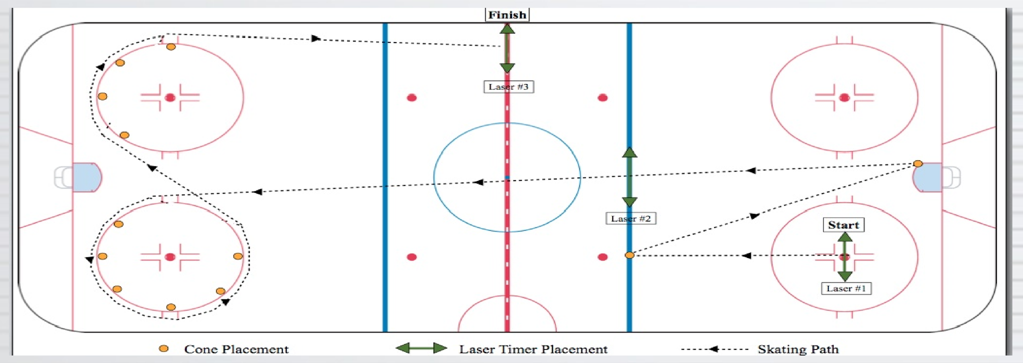
Introduction

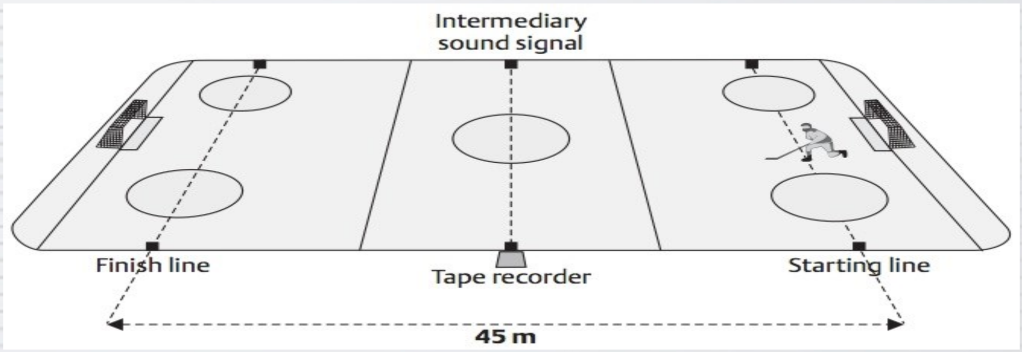
Many team-based sports require a blend of metabolic processes to maximize performance (7). Often sport practitioners of anaerobic base sports such as ice hockey, football, lacrosse, soccer, ect., have negated aerobic training as a training modality as it is not what players experience during competition. Additionally, the trend is due to a growing theory that aerobic training has the potential to inhibit strength, power, and/or overall anaerobic performance. However, aerobic conditioning benefits to the anaerobic athlete have been overlooked. Improving an athlete's aerobic conditioning level or fitness level, predominantly assessed by the VO_{2max}, can lead to a greater ability to replenish phosphocreatine stores which is linked to increasing the ability to perform repeated high-intensity bouts (3, 11). Aerobically trained athletes possess a greater ability to reduce anaerobic glycolysis and limit lactate production while performing intense anaerobic bouts by the improved ability to utilize oxygen during the high-intensity working bout (5). Additionally, athletes with an increased aerobic capacity are able to clear lactate more efficiently while recovering, thereby increasing power during subsequent working bouts (9). Inorganic intercellular phosphate, a contributing factor in muscle fatigue, is linked to faster removal rates in aerobically conditioned athletes as well (16). Finally, injury rate reductions have been linked to higher levels of aerobic capacity (12) as expressed in military studies.

Repeated sprint ability (RSA) is the ability to produce the best possible average sprint performance over a series of sprints (≤10 seconds), separated by short (≤60 seconds) recovery periods. RSA is therefore an important fitness requirement of team-sport athletes (1, 2). Coaches over utilize training modalities that mimic in game situations or as today is known to call it "sports specific training". The goal in mind with sports specific training is to increase the athlete's lactic threshold in order to delay the onset of fatigue. Peterson et al. (2013) evaluated that during maximal repeated sprint bouts, of ice hockey athletes, aerobic energy contributed to increasing total blood flow to heart and lungs, increase fast phase of phosphocreatine resynthesis, and enhanced the clearance rate of hydrogen and inorganic phosphate ions. Therefore, the purpose of the present research is to examine the correlation between aerobic capacity and the ability to repeat high intensity on ice skating bouts in collegiate hockey players and their advocacy for a new general preparation model**.** This study utilizes testing protocols with the highest validity and reliability in measuring VO_2 peak and anaerobic capacity of ice hockey athletes. The testing protocols used were the Peterson On-Ice Repeated Shift Test, The Skating Multistage Aerobic Test (SMAT), Wingate cycle ergometer anaerobic fatigue test, and body fat composition using the skin fold technique.









Results

Twenty-two collegiate hockey players (age 21±3) were examined. A significant correlation was determined between VO_2 peak and percent fatigue decrease (3.37 +/- 1.230) (r = -0.643, p = 0.001). Results indicate that the athletes with higher VO_2 peak on the SMAT test had lower fatigue values on the Petersons repeat sprint test. Additionally, a significant correlation was determined between body composition (10.60 +/- 2.610 and VO_2 peak (62.46 +/- 5.66) (r = -0.665, p = 0.001). Indicating that athletes with more fat free mass performed better on the SMAT test. Further research should be conducted to assess the potential relationship between fat free mass and O_2 kinetics..

Conclusion

The major finding from the present research indicate that an athlete with a higher VO_2 peak has the ability to repeat sprints with a lower fatigue index than an athlete with a lower VO_2 peak. Increasing an athletes VO_2 peak increases that athletes ability to perform maximal repeated sprints; which is what the athlete will experience in competition.

The primary factor that leads to fatigue at the muscular level is the accumulation of metabolic bi products (1). Athletes with higher oxygen uptake (VO_2 peak) may have the potential to delay the onset of fatigue. The delay of fatigue is induced by oxygen uptake kinetics; including an increase in blood flow to muscles, increased resynthesis of phosphocreatine, and an enhanced clearance of hydrogen and inorganic phosphate ions (10). The results of the present study display there may be a potential for an increased oxygen capacity to expedite O_2 kinetics and delay fatigue in hockey players

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