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BRIEF REPORT

Alaska Mountain Wilderness Ski Classic: Alterations in Caloric Expenditure and Body Composition

Michelle M. Johannsen, MS; Kenneth J. Shin, BS; Karolina Priebe, DNP; Robert H. Coker, PhD

From the Institute of Arctic Biology, University of Alaska, Fairbanks, Fairbanks, AK (Ms Johannsen, Mr Shin, and Dr Coker); and the Mountain View Medical Center, Fairbanks, AK (Dr Priebe).

Introduction—The Alaska Mountain Wilderness Ski Classic is a self-supported ultramarathon cross-country skiing event that traverses one of the mountain ranges of Alaska each winter. Unique aspects of this event challenge athletes with a significant amount of physical and mental stress while in the chronically cold conditions of the Arctic. Assessment of energy requirements or body composition has never been performed during this event. The objective of the study was to evaluate the influence of the 2016 Alaska Mountain Wilderness Ski Classic on caloric expenditure and body composition.

Methods—Caloric expenditure was estimated using GT3x+ Actigraph accelerometers and ActiLife software. Lean tissue mass, total fat mass, visceral fat mass, and bone mineral density were measured using a General Electric iDXA before and after the event. Data are presented as mean±SD. Differences were analyzed using paired *t* tests with significance at $P<0.05$.

Results—Fifteen participants (age=32.7±6.6 years, body mass index=23.7±2.3 kg·m^2) completed the study, 8 males and 7 females. Caloric expenditure was 6238±1390 kcal·day^{-1}, and 37,163±8425 kcal for the entire event. Fat mass was reduced from pre-event (Δ1.3±0.7 kg, P=0.00003). There was an increase in lean tissue mass (Δ1.7±1.3 kg, P=0.0003) and relative skeletal muscle index (Δ0.2±0.2 kg·m², P=0.001). There was no change in bone mineral density (Δ0±0 g·cm^3, P=0.4).

Conclusions—Despite the metabolic demands, fat mass was reduced and lean tissue mass was preserved. Future studies of this event should be directed toward assessment of the nutritional provisions utilized and the mechanisms responsible for the preservation of lean tissue mass.

Keywords: endurance, cold exposure, fat mass, lean tissue mass, physiological resilience, arctic

Introduction

The Alaska Mountain Wilderness Ski Classic (AMWSC) was founded in 1987 and is recognized as one of the most challenging backcountry treks available to cross-country skiers.[1] The course changes every 3 years and can be 160–289 km (100–180 mi) long, traversing one of the Alaskan mountain ranges. Because these mountain ranges exhibit seasonal changes at different times, the date of the AMWSC varies depending on the location. The event is most often held in the month of April, during the late winter–early spring season, when temperatures range from -20 to -12°C.

Unlike many ultramarathon events, the AMWSC is entirely self-supported. Participants must carry all food, equipment, and medical/first aid supplies that might be needed during the event. The participants are permitted to consume foods of their choosing ad libitum throughout the event. There are no aid stations, and it is the responsibility of the participant to establish an expected return date with friends or family and devise a plan of action if rescue becomes necessary. In previous years, courses of a similar length took participants 5 to 7 days to complete. Communications in this region are severely limited, but participants may carry a satellite phone or a global positioning system SOS messenger system. Reliance on these devices as a safety net during the event is not recommended, given that electronics do not function well at low temperatures and that mountain ranges often interfere with communication signaling. Participants are

Corresponding author: Michelle M. Johannsen, MS, Institute of Arctic Biology, University of Alaska – Fairbanks, 2090 Koyukuk Drive, Fairbanks, AK 99775-7000; e-mail: mmjohannsen@alaska.edu.

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not retrieved from the course by event personnel. Instead, if they have not arrived at the finish line or reported that they have dropped out to fellow competitors by an 8-day cutoff time, an emergency contact and the Alaska State Troopers would be called.

The 2016 AMWSC took place in the Brooks Range, the northernmost mountain range of Alaska. The course started at Galbraith Lake, above the Arctic Circle, sandwiched between the Arctic National Wildlife Refuge to the east and the Gates of the Arctic National Park and Preserve to the west. The participants traveled approximately 289 km (180 mi), moving southwest from the lake to Anaktuvuk Pass in the Gates of the Arctic National Park, then traveling southeast and ending in Wiseman, Alaska, at the southern edge of the Brooks Range. In the 2016 AMWSC, 31 individuals participated (20 males, 11 females), but only 15 individuals participated in the study described herein. All participants were required to complete a mandatory check-in at the halfway point of the event at the National Park Service Office at Anaktuvuk Pass.

The AMWSC is a physically and mentally challenging event, yet energy requirements and alterations in body composition have never been measured. The duration and intensity of exercise and harsh environmental exposure in an event like this may create special alterations in body composition.[2,3] For example, exercising in the cold may promote a significant reduction in fat mass (FM) but mitigate deleterious alterations in lean tissue mass (LM).[4,5] Similar conclusions have been drawn from studies of athletes participating in the 692-km (430-mi) Yukon Arctic Ultra, during which temperatures can frequently reach below -40°C.[6]

The purpose of the present study was to estimate caloric expenditure and measure changes in body composition elicited by prolonged exercise under chronic cold exposure in athletes participating in the AMWSC. We hypothesized that LM would be preserved in athletes participating in the AWMSC.

Methods

After consultation with the organizers of the event, research participants were recruited from athletes registered in the 2016 AMWSC event. Study participants arrived at the University of Alaska Fairbanks (UAF) Clinical Research and Imaging Facility within 48 h of the start and end the event for all measurements. This study was approved by the UAF Institutional Review Board.

Data were analyzed using Microsoft Excel, ActiLife, and iDXA software. Data are presented as mean±SD for all metrics. Paired *t* tests were used to compare differences between pre-event and post-event values and differences between male and female values. Statistics were considered significant with a P value of <0.05.

MEASUREMENT OF BODY COMPOSITION

Body composition was measured using dual energy x-ray absorptiometry scans (General Electric-Lunar iDXA, Chicago, IL). The scans measured LM, FM, relative skeletal muscle index, bone mineral density, and visceral adipose tissue using enCORE software (General Electric Healthcare, Chicago, IL). Bodyweight was also measured using a digital scale (Seca 769; Seca, Chino, CA) before and after the event during the same visits.

ESTIMATION OF CALORIC EXPENDITURE

Participants were outfitted with GT3X+ ActiGraph accelerometers (ActiGraph Corp, Pensacola, FL) worn around the wrist for the entire duration of the event. These monitors were programmed to begin recording movement at the start of the event and were turned off by the researchers after the participants had completed the event. Data were interpreted using the ActiLife software and the "Freedson 1998 algorithm" to calculate estimated caloric expenditure.[7] This algorithm does not account for the additional energy required to carry a load. Therefore, the following equation was used to account for additional caloric expenditure of carrying a pack:

$$\text{caloric expenditure/h} \times [(\text{pack weight} + \text{body weight}) / (\text{body weight})] = \text{total caloric expenditure/h}$$

We developed this equation by entering body weight into the Actigraph software and then the combined body weight and pack weight to determine the coefficient by which caloric expenditure increased when each participant was carrying a load. Coincidentally, this coefficient was approximately equal to the ratio of combined body and pack weight to body weight alone.

Participants self-reported their backpack weights and kilocalories consumed during the event. Initial pack weights averaged 16±3 kg (37±6 lbs) with an approximate but not directly measured 1 kg (2 lb) reduction in pack weight for each day of the event to account for the consumption of daily meals. The ratio of combined body and pack weight to body weight alone was recalculated for each day of the event to account for the daily 1 kg reduction in pack weight. Because participants would remove their backpacks during periods of rest and sleep, the equation used for the estimation of caloric expenditure was only implemented during times when the individual's activity was above a threshold value of an