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Original Research Article

The Effects of Wearing Cold Garments on Energy Expenditure

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Abstract

Introduction: Stimulation of brown adipose tissue (BAT) by cold exposure purportedly upregulates energy expenditure (EE) and has been suggested as a method to reduce adiposity. BAT in humans is located primarily in the upper torso. Manufacturers have developed garments that contain ice packs and are designed to be worn over these areas. Two such products are the Cool Fat Burner and the Cool Gut Buster. The Cool Fat Burner places ice packs against the shoulders and neck, while the Cool Gut Buster is worn around the abdomen. **Purpose:** This study was designed to evaluate changes in EE when wearing the Cool Fat Burner and the Cool Gut Buster. **Methods:** Twenty subjects (12 males; 8 females) sat quietly for a total of 90 minutes while heart rate (HR) and VO_2 were recorded. Data collection was separated into three 30-minute phases: rest, low-intensity, and high-intensity. Subjects sat quietly during the rest phase, wore both the Cool Fat Burner and the Cool Gut Buster during the low-intensity phase, and wore both garments and drank cold water during the high-intensity phase. **Results:** Average VO_2 increased significantly across all three phases (rest: 295.6 ± 69.1 ml/min; low-intensity: 333.0 ± 83.2 ml/min; high-intensity: 372.8 ± 87.5 ml/min). When VO_2 was converted to EE, it was found that 6 additional kcals were burned in the 30-min low-intensity phase compared to rest (50.1 ± 12.6 vs. 44.1 ± 10.5 kcal) and 11.7 additional kcals were burned during the 30-min high-intensity phase compared to rest (55.8 ± 13.2 vs. 44.1 ± 10.5 kcal). **Conclusion:** Wearing cold garments resulted in a significant increase in EE. However, the magnitude of the increase may not be practically useful as a weight loss tool.

Key Words: Brown Fat, Weight Loss, Non-shivering Thermogenesis

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INTRODUCTION

Globally, the number of obese and overweight people has reached alarming levels. In the U.S alone, 70.1% of adults are classified as being either overweight or obese[1]. Additionally, the prevalence of chronic diseases that are associated with obesity has increased, with 12.6% of U.S. adults having diabetes and 33.5% having hypertension[1]. In order to combat this epidemic, researchers have begun to look beyond conventional weight loss practices, such as diet and exercise, to other methods of increasing energy expenditure (EE). Within the last decade, researchers have highlighted the potential of brown adipose tissue (BAT) as a tool to manipulate energy balance.

Unlike white adipose tissue, which stores energy, BAT has the ability to use/burn energy (e.g., fatty acids, glucose) in order to generate heat. Brown adipose tissue microscopically appears different than white adipose tissue due to the large mitochondrial density within the cell. Further differentiating BAT from white adipose tissue is the presence of uncoupling protein 1 (UPC1). This unique protein uncouples the electron transport chain and results in heat generation rather than ATP production[2]. Because of this, BAT is especially important to infants, who are unable to generate heat through shivering thermogenesis (ST), due to lack of skeletal muscle. For years, it was thought that humans lost BAT stores as they developed and aged. However, within the last decade, BAT has been extensively researched and it is now apparent that BAT not only exists in adults, but it remains functional[3,4]. The location of BAT deposits in adults vary, but are generally greatest in the upper torso.

Because UPC1 allows for the thermogenic oxidation of fatty acids and glucose, BAT could prove to be invaluable as an energy balance tool for those with obesity and chronic diseases[5]. Even though BAT is present in adults, it is not always active. Brown adipose tissue is activated when the body is exposed to cold temperatures, a phenomenon called non-shivering thermogenesis (NST). van Marken Lichtenbelt et al[3] found that during cold exposure (16° C for 2 hours), BAT was activated in 96% of adult male subjects. Additionally, they found that BMI was negatively correlated with BAT activity and that resting metabolic rate (RMR) was positively correlated with BAT activity. This suggests the potential for overweight or obese individuals to benefit from therapies targeted at increasing BAT activity. Additional studies have found that increased BAT activity can positively alter insulin sensitivity[6,7], suggesting that prediabetic individuals and diabetic patients could benefit from increased BAT activity as a result of cold exposure.

Studies have also demonstrated a significant increase in EE by simply exposing subjects to cold room temperatures (16-19°

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C)[3,8]. In the study by van Marken Lichtenbelt et al[3], exposing people to cold temperatures (16° C) for 2 hours increased resting EE between 5-30%. However, turning down the thermostat in a house or workplace setting may not always be ideal. Therefore, several products have been introduced to the market that are designed to enhance BAT activation and increase EE from NST.

Cool Fat Burner, LLC[9] has two products available: 1) the Cool Fat Burner, which is attached over the shoulders, and 2) the Cool Gut Buster, which is worn over the abdomen. Both products have pouches in which frozen cold packs are inserted. In an attempt to burn more calories, users can intensify their experience while wearing the garments by drinking cold water or sitting in a cold room. Because BAT activation can most readily be seen during positron-emission tomographic and computed tomographic (PET-CT) imaging, it is almost impossible to measure routinely. However, because BAT activation leads to increased EE through heat production, indirect calorimetry is a surrogate way to measure BAT activity. The purpose of this study was to determine if EE while wearing the Cool Fat Burner and the Cool Gut Buster is greater than resting EE.

METHODS

Participants

The subjects for this study were 20 apparently healthy volunteers (12 males; 8 females), between 19 and 25 years of age, from the La Crosse area. Subjects were required to have a body mass index (BMI) greater than 25 kg/m^2, classifying them as either overweight or obese. The PAR-Q was completed by each subject to screen for known cardiovascular and orthopedic contraindications to exercise and eligible subjects provided written informed consent. The study protocol was approved by the Institutional Review Board for the Protection of Human Subjects at the University of Wisconsin-La Crosse. Descriptive characteristics of the subjects who participated in the study are presented in Table 1.

Table 1. Descriptive characteristics of the subjects (N=20).

Variable	Males (n=12)	Females (n=8)
Age (yr)	20.9 ± 1.78	22.4 ± 2.00
Height (cm)	179.2 ± 6.32	165.1 ± 6.24
Weight (kg)	89.0 ± 15.99	75.2 ± 9.45
BMI (kg/m^2)	27.6 ± 3.86	27.5 ± 2.45

Procedures

Data collection took approximately 2 hours for each subject. Subjects arrived at the testing facility after an 8-12 hour fast. Subjects were also instructed to abstain from tobacco and caffeine for at least 8-12 hours prior to testing and to not exercise or consume alcohol for at least 24 hours prior to testing. Height was measured to the nearest .5 cm using a stadiometer and weight was measured to the nearest .1 kg using a mechanical scale (Pellstar Health O Meter, McCook, IL).

Subjects completed three sequential 30-minute testing phases: 1) rest, 2) low-intensity, and 3) high-intensity. The testing sequence was designed to replicate as closely as possible what was demonstrated on the manufacturer's website[9]. Subjects had a heart rate (HR) monitor attached (Polar Elector Inc., Woodbury, NY, USA) and were connected to a metabolic cart (AEI Technologies, Pittsburgh, PA, USA). They then sat quietly for 5 minutes, which served as a metabolic stabilization period. Resting data was then collected for 30 minutes. The subject was disconnected from the metabolic cart, fitted with the Cool Fat Burner vest and the Cool Gut Buster, and reconnected to the metabolic cart. After a 5-minute stabilization period, data was again collected for 30 minutes. This was termed the low-intensity phase. At the conclusion of the low-intensity phase, subjects were disconnected from the metabolic cart, drank 16 ounces of ice cold water, and were reconnected to the metabolic cart. After a 5-minute metabolic stabilization period, data collection restarted. They continued to wear the Cool Fat Burner and Cool Gut Buster. Data was collected for 15 minutes, the subject quickly removed the facemask, drank another 16 ounces of ice cold water, and was reconnected to the metabolic cart for an additional 15 minutes. This 30-minute sequence was termed the high-intensity phase.

All testing took place in a quiet, temperature controlled laboratory set at 22° C. A cotton t-shirt was worn under the cold garments to protect the skin from coming into contact with the cold packs. Subjects wore fleece gloves and socks in an attempt to keep their extremities warm. For all testing phases, HR (bpm) and VO_2 (ml/min) were recorded every minute. Energy expenditure was calculated from the VO_2 data by the metabolic cart, based upon the caloric equivalent for the requisite respiratory exchange ratio. Energy expenditure was represented as kcal/min and total kcal for each 30-minute period.

Statistical analyses

Standard descriptive statistics were used to characterize the subject population and to summarize the physiologic responses to each phase. Differences between phases and gender were compared using two-way ANOVA with repeated measures. Because there were no differences in the responses of males and females, data were collapsed across gender. When there was a

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significant F ratio, pairwise comparisons were made using Tukey's post-hoc tests. Alpha was set at 0.05 to achieve statistical significance for all analyses. All data were analyzed using the Statistical Package for the Social Services (SPSS Inc., Chicago, IL) version 25.

RESULTS

Results of the testing are presented in Figures 1-3. Average VO_2 increased significantly across phases and averaged 295.6 ± 69.1, 333.0 ± 83.2, and 372.8 ± 87.5 ml/min for the rest, low-intensity, and high-intensity phases, respectively (Figure 1). Energy expenditure increased significantly across all phases and averaged 1.47 ± .35, 1.67 ± .42, and 1.86 ± .44 kcals/min during the rest, low-intensity, and high-intensity phases, respectively (Figure 2). Total EE during each 30-minutes segment was 44.1 ± 10.5 kcal for the rest, 50.1 ± 12.6 kcal for the low-intensity phase, and 55.8 ± 13.2 kcal for the high-intensity phase, respectively. Average HR decreased significantly across all phases and was 67 ± 8.2, 65 ± 7.1, and 59 ± 6.8 bpm for the rest, low-intensity, and high-intensity phases, respectively (Figure 3).

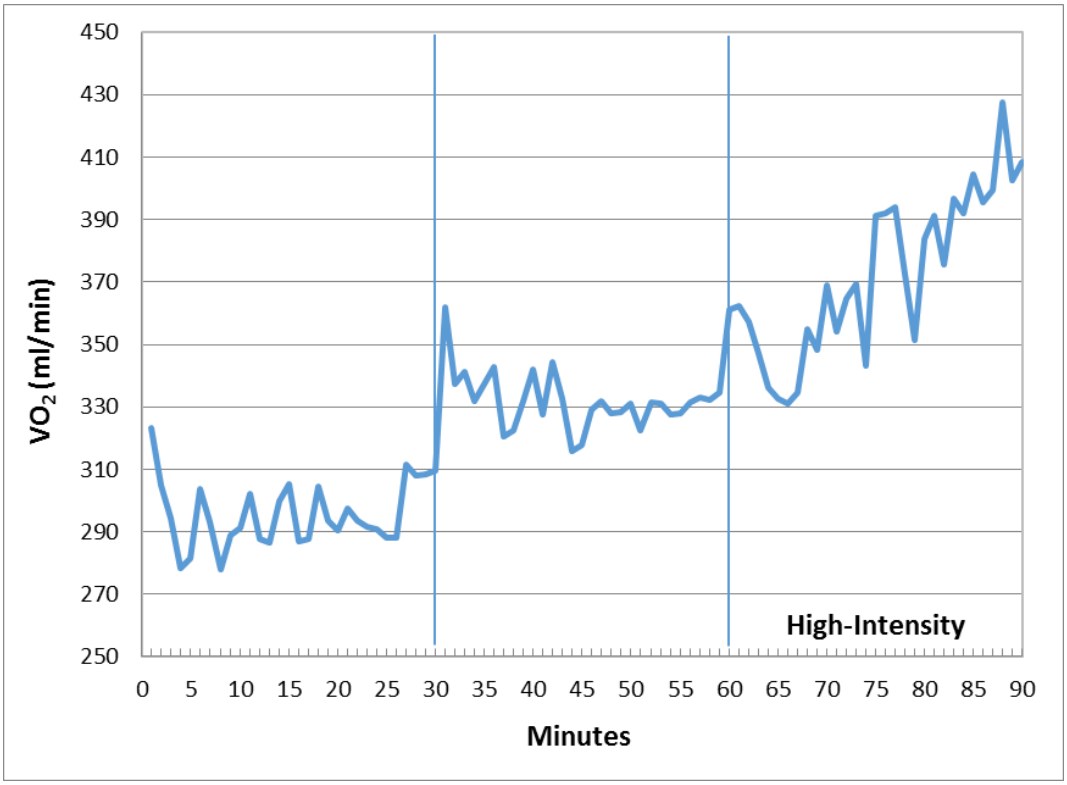

Figure 1. Oxygen consumption during the rest, low, and high intensity phases.

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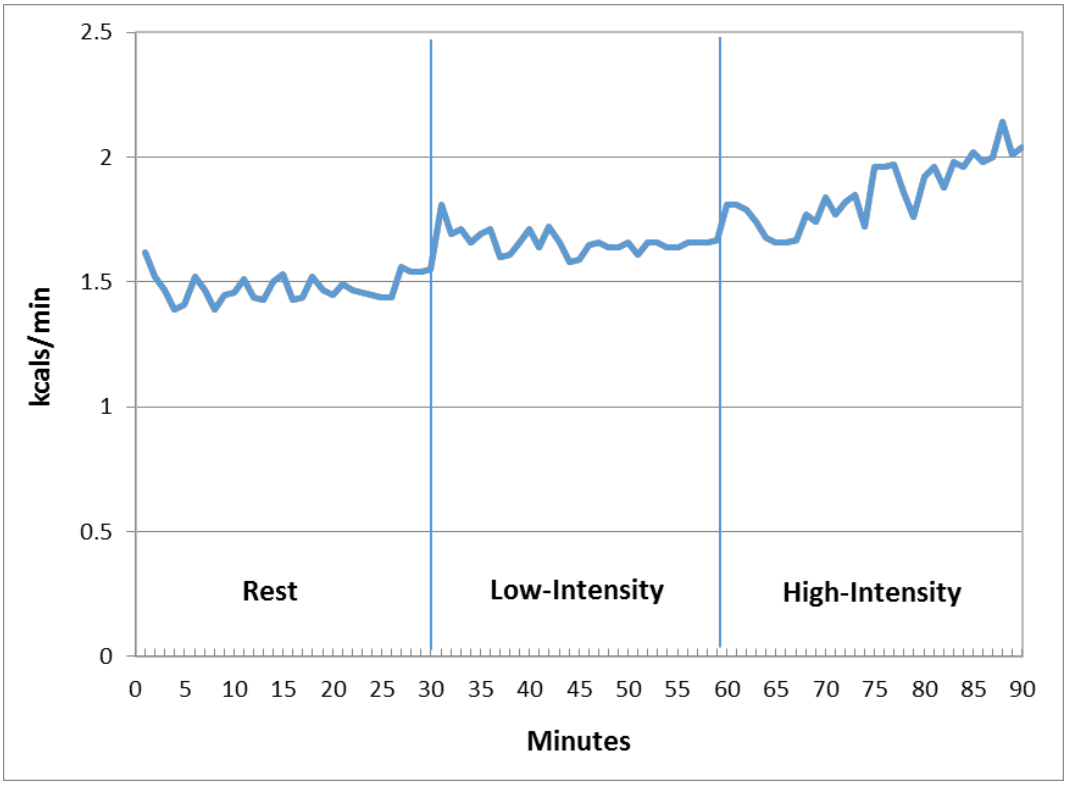

Figure 2. Caloric expenditure during the rest, low, and high intensity phases.

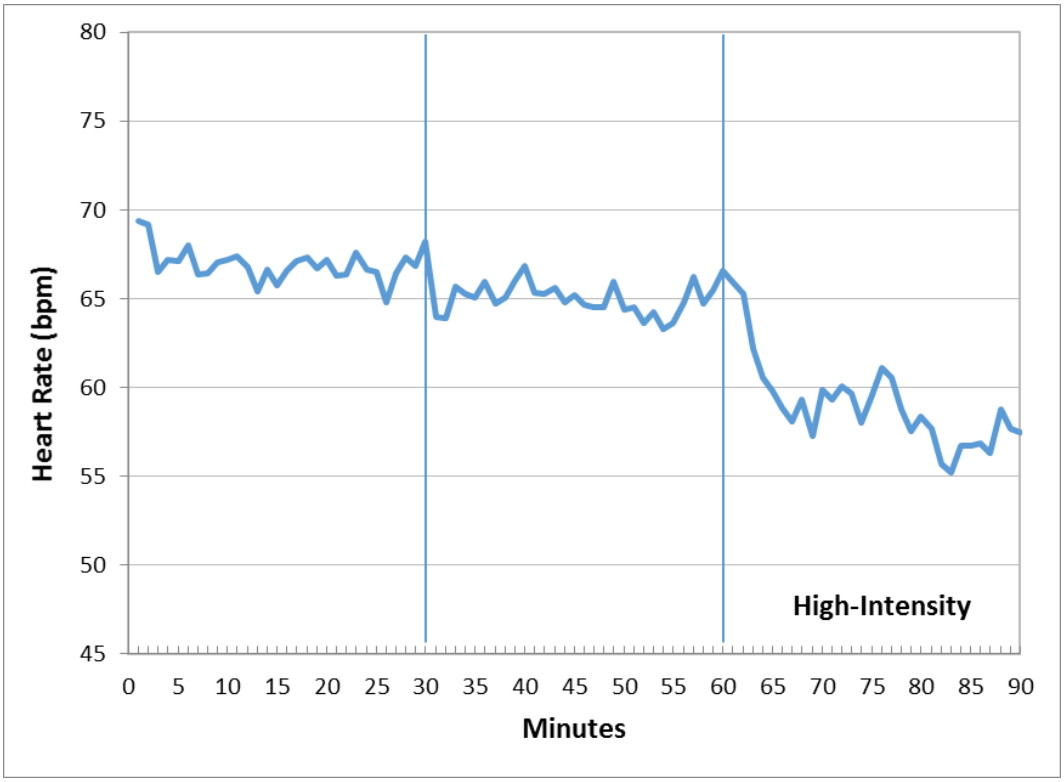

Figure 3. Heart rate during the rest, low, and high intensity phases.

DISCUSSION

The main purpose of this study was to determine if wearing the Cool Fat Burner and Cool Gut Buster could significantly increase EE compared to resting values. For both the low and high-intensity phases of testing, EE was significantly greater than the rest condition. During the low and high-intensity phases, EE was 14% and 27% greater than rest, respectively. However, this only amounted to 6 and 11.7 kcal increases over resting values in each 30-minute testing period. Claims made by the manufacturer suggest that individuals can increase their metabolic rate up to 300% and burn an additional 500 kilocalories per day from 2 hours of wearing the vest[7]. The Cold Shoulder, another cold vest, also claims the vest results in an increase in EE of 500 kcals per day[8]. When the data from our study are extrapolated to 2 hours, 24 additional calories would have been expended during the low-intensity phase and 46.8 additional calories would have been expended during the high-intensity phase, which is less than 10% of what is suggested by manufacturers of these products.

Very little research has been done on the effects of wearing a cold vest on EE. Although this study found an increase in the number of calories burned, the increase was less than advertised. When looking at possible reasons why our results were different than manufacture's claims, there are several possibilities. It is possible that subjects in the current study had low levels of BAT. Cypess et al[6] found wide variability in BAT levels in both men (.5-42.0 g) and women (1.1-170 g). Since cold vests purportedly work by activating BAT, if subjects had low levels of BAT, the increase in EE would be less than expected. Yoneshiro et al[11] also showed that being cold-acclimated results in greater activation of BAT and therefore, greater levels of EE. Along those lines, Romu et al[12] found that after 6 weeks of cold-acclimation, there was significant increase in supraclavicular BAT deposits. In the current study, subjects were likely not cold-acclimated, meaning they probably had very little BAT.

Heart rate was shown to decrease in response to wearing the cold garments. When comparing HR at rest to HR during the final phase of testing, there was an 8 bpm decrease. These results are similar to what was seen in baseball players who wore a cold vest[13] and also similar to those of Cypess et al[14] who demonstrated a significant decrease in HR when subjects wore a cooling vest set at 14°C for 2 hours. During ST, HR tends to increase from the increase in skeletal muscle activation. Because our subjects had an overall decrease in HR, this indicates that subjects were most likely staying warm due to NST and BAT activation.

A potential limitation of the current study was that energy expenditure was not recorded after the cold garments were

taken off. The manufacturer reported an increase of 232% in metabolic rate during the first 15 minutes after the vest was removed[9]. Our data cannot address this claim.

These questions open the door for potential future research. A follow-up study in which subjects wear the cold garments for 1-2 hours a day for several weeks, in order to become cold-acclimated, could be conducted. Additionally, since we did not measure EE after the cold garments were removed, another study could assess how long it takes for metabolic rate to return to baseline once the garments are taken off.

CONCLUSIONS

Wearing cold garments resulted in a significant increase in EE. However, the increase amounted to only 17.7 additional calories over the 1 hour testing period. Additionally, there were varying levels of comfort while wearing the cold garments. Anecdotally subjects did not enjoy being "chilled" for that long a period of time. Given the fact that it is recommended the garments be worn for 2 hours each day, compliance could be an issue regarding the practicality of using cold garments as a weight loss tool.

Disclosures

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