BRIEF REPORT

Cardiovascular Demands of Deer Retrieval Methods

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Objective.—The purpose of this study was to compare the cardiovascular (CV) demands of 2 deer retrieval methods.

Methods.—Twelve male participants (weight 86 ± 24 kg, age 21 ± 1 years) performed a maximum treadmill test on day 1 to determine baseline fitness levels. On day 2, all participants first towed, then dragged a 45-kg simulated deer carcass for 457 m at a self-selected pace. The tow condition utilized a shoulder harness system with a 2-m strap connecting the harness to the carcass, allowing the participant to walk upright as he towed the load. The dragging condition required the participants to flex their trunk, grasp the legs of the deer with both hands, and drag the carcass the length of the course. Heart rate and oxygen consumption (Vo_2) from each trial were measured by indirect calorimetry.

Results.—The CV responses of towing were significantly less compared with those of dragging for Vo_2 peak ($P = .001$), peak heart rate ($P = .003$), average heart rate ($P = .028$), and rating of perceived exertion ($P < .001$). No significant differences were observed for average Vo_2 ($P = .91$) or time to completion ($P = .27$).

Conclusions.—The results of this study suggest towing a deer with a shoulder harness results in significant reductions in CV demand and lower perceived exertion compared with traditional deer dragging techniques. Deer hunters who are deconditioned or have CV risk factors are strongly encouraged to consider deer retrieval methods utilizing a shoulder harness and tow rope to mitigate the increased demands commonly found with traditional retrieval methods.

Key words: deer, heart rate, heart physiology, oxygen consumption, physical exertion

Introduction

According to the US Fish and Wildlife Service, approximately 10.8 million Americans participate in deer hunting annually.¹ For many deer hunters, the retrieval of game can be a major struggle due to the emotional, environmental, and physical stresses associated with hunting.² Owing to the rugged terrain frequented by hunters, motorized vehicles are seldom able to assist in the retrieval of game. Therefore, when hunters find themselves miles away from base camp or roads, dragging the deer by the antlers or limbs are two of the most common retrieval strategies utilized.

According to the Minnesota Department of Natural Resources, the average white-tailed deer weighs 68 to 90

kg, and in some cases, may weigh more than 180 kg.³ After removing the internal organs to preserve the meat by field dressing, a mature deer may still weigh 45 kg or more.⁴ Previous research has found dramatic elevations in the cardiovascular (CV) responses of hunters, particularly while dragging a deer carcass through the woods. Haapaniemi et al² demonstrated that deer hunting activities result in dramatic increases in heart rate and metabolic responses, leading to increased risk of sudden cardiac death for deconditioned hunters. Likewise, Peterson et al⁵ also found dramatic elevations in the CV and hemodynamic responses of deer hunters. To date, alternatives to deer dragging that are less metabolically taxing have not been investigated. Therefore, the purpose of this study was to compare the CV demands of dragging a simulated deer carcass versus towing a simulated deer carcass with a shoulder harness on an indoor track.

Methods

The University of Minnesota's Institutional Review Board approved this within-subjects study. Healthy male

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participants ($n = 12$, weight 85.7 ± 23.6 kg, age 21.5 ± 1.3 years) with a background in deer hunting were recruited for this study. Pilot testing in conjunction with previous deer hunting studies indicated that, with expected effect sizes of $d = 1.0$, 10 participants would yield a statistical power of 80%. All participants signed informed consent documents and completed the Physical Activity Readiness Questionnaire before participation. Those with any musculoskeletal injuries or other health problems that would inhibit their ability to perform deer retrieval tasks were excluded from the study. Participants were instructed to perform three tasks: 1) a treadmill test to determine CV fitness; 2) a towing condition in which the participant was fitted with a shoulder harness and towed a simulated deer carcass; and 3) a dragging condition in which the participant dragged a simulated deer carcass. All 12 participants successfully completed each of the three conditions and reported no injuries throughout the course of the study.

Because of hygienic and decomposition concerns, a simulated 45-kg deer carcass was used. It was constructed from sand encased in plastic bags, wrapped in a blanket, and held together with a strap. Two wooden dowels covered with felt were affixed to the strap to replicate the legs of a deer.

On day 1, participants performed a graded exercise test according to an incremental treadmill protocol to determine baseline fitness levels. Maximum heart rate ($HR_{\max}$) and maximal aerobic capacity ($VO_{2\max}$) were measured by indirect calorimetry (Fitmate PRO, Cosmed Inc, Rome, Italy). Baseline fitness levels indicated the participants achieved an average $HR_{\max}$ of 194 ± 7 beats/min and mean $VO_{2\max}$ of 55 ± 10 mL $\cdot$ kg $^{-1}\cdot$ min $^{-1}$.

On day 2, participants towed, rested for 20 minutes, and then dragged the deer carcass for 457 m at a self-selected pace around an indoor track. The tow condition utilized a shoulder harness system (Deer Drag Harness, Heavy Hauler Outdoor Gear, Kingsley, IA, USA) with a 2-m strap connecting the shoulder harness to the carcass, allowing the subject to walk upright while towing the load (Figure 1). The dragging condition required the subjects to flex the trunk, grasp the legs of the simulated deer with both hands, and drag it the length of the course (Figure 2). Heart rate and oxygen consumption for each condition were measured by portable indirect calorimetry (Fitmate PRO). Rating of perceived exertion (RPE) using the Borg 6 to 20 RPE scale was obtained upon the completion of each condition.⁶

Statistics

All data were analyzed using IBM SPSS Statistics (Version 21, IBM Corp, Armonk, NY, USA). Paired-samples t tests

Figure 1. Towing condition.

were performed to compare the differences between the dragging and the towing conditions. The level of significance was $P < 0.05$. Cohen's d effect sizes were calculated ($d = \text{pooled mean/pooled SD}$) to assess the meaningfulness of significant differences, in which $d = 0.2$, 0.5 , and 0.8 , representing small, medium, and large effects, respectively.⁷

Results

The cardiovascular demands between the towing and dragging conditions are presented in Table 1. All data are presented as mean $\pm$ SD with 95% confidence interval. Paired-samples t tests indicated that the CV responses of towing were significantly less when compared with dragging for VO_2 peak ($P = .001$, $d = 1.25$), peak heart rate ($P = .003$, $d = 1.1$), average heart rate ($P = .028$, $d = 0.72$), and RPE ($P < .001$, $d = 2.7$). No significant differences were observed for average VO_2

Figure 2. Dragging condition.

Table 1. Cardiovascular demands compared between towing and dragging conditions

Condition	Peak $\dot{V}O_2$ ($\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)	% $\dot{V}O_{2\text{max}}$ ^a	Average $\dot{V}O_2$ ($\text{mL} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$)	% $\dot{V}O_{2\text{max}}$ ^a	Peak HR (beats/min)	%HR _{max} ^a	Average HR (beats/min)	%HR _{max} ^a	Perceived exertion rating	Time to completion (s)
Towing	36.2 ± 5.8 (32.5–39.9)	66	32.0 ± 5.5 (28.5–35.5)	58	153.8 ± 16.2 (143.5–164.0)	79	140.8 ± 14.6 (131.5–150.1)	66	11.7 ± 1.4 (10.6–12.8)	467.2 ± 54.6 (432.5–501.9)
Dragging	39.1 ± 6.0 ^b (35.3–42.9)	71	32.1 ± 5.4 (28.7–35.5)	58	167.5 ± 17.6 ^b (156.3–178.7)	86	150.7 ± 16.9 ^c (140.0–161.5)	78	15.4 ± 1.2 ^b (14.5–16.4)	488.1 ± 88.1 (432.1–544.1)

Values are mean ± SD (95% confidence interval).

$\dot{V}O_2$, oxygen consumption; HR, heart rate.

^a Reflects each condition's peak/average as compared with treadmill fitness test, $\dot{V}O_{2\text{max}}/\text{HR}_{\text{max}}$.

^b $P < .01$.

^c $P < .05$.

($P = .91$) or time to completion ($P = .27$). Individual CV responses are displayed in Figures 3 and 4.

Discussion

According to American College of Sports Medicine (ACSM) standards for cardiorespiratory fitness, the CV demands of both deer retrieval tasks used in this study reached peak heart rate levels that would reach benchmarks indicating vigorous intensity exercise (77% to 95% HR_{max}).⁶ In terms of average HR, however, the towing condition would be classified as a moderate intensity exercise (64% to 76% HR_{max}), whereas the dragging condition would remain classified as vigorous intensity.⁶ Moreover, the RPE for the towing condition (corresponding to “fairly light” exertion) was significantly less than for the dragging condition (corresponding to “hard” exertion), reflecting a clear distinction between the perceived relative intensity of each task.⁶ Therefore, the results of this study provide preliminary evidence that deer retrieval strategies utilizing towing may result in lowered CV demands and perceived effort when compared with dragging.

In terms of observed $\dot{V}O_2$ and heart rate responses to each condition, the question of statistical significance versus clinical meaningfulness bears further discussion. Calculated effect sizes indicated moderate and large effects for average heart rate ($d = 0.72$) and peak heart rate ($d = 1.1$). Thus, for the health professional prescribing exercise and physical activity, a seemingly trivial approximately 10 beats/min heart rate difference may mean the difference between a person remaining in an aerobic training heart rate zone or entering into heart rate zones reflective of anaerobic energy production in which the onset of increased breathing, heart rate, and metabolic acidosis will quickly limit the physical activity being performed.⁶

In contrast to the large differences observed in heart rate responses, average $\dot{V}O_2$ responses indicated no difference between the towing and dragging conditions. We believe the most plausible explanation for this finding is the exercise pressor reflex, in which static exercise creates large increases in mean arterial pressure, but small increases in cardiac output.⁸ The participants in the dragging condition assumed a position that necessitated a static, flexed forward trunk position, with isometric contractions in the hands and arms, to grip and drag the carcass. In contrast, the towing condition allowed the participants to remain upright and freely move their arms, allowing for dynamic muscle contractions and subsequent reduced CV responses and perceived relative exertion of the task.

Figure 3. Individual variability in peak heart rate responses for treadmill (blue line), dragging (red line), and towing (green line) conditions.

Isometric activities such as hunting, snow shoveling, and weight lifting exercises have been associated with increased risk of acute CV events,^{2,5,8} especially among unfit people. Thus, our findings provide further evidence that if the exercise pressor reflex is present in a healthy population, the ramifications of deer dragging in

deconditioned populations with additional CV risk factors may be further contraindicated.

The results of this study are similar to those of previous studies investigating the peak CV demands of traditional methods of carcass dragging by deer hunters. In a study of 16 young, healthy male hunters, Peterson

Figure 4. Individual variability in peak oxygen consumption (VO₂) responses for treadmill (blue line), dragging (red line), and towing (green line) conditions.

et al⁵ found dragging a 56.8-kg deer carcass for 0.4 km over lightly rolling terrain resulted in peak VO_2 and peak heart rate measurements of more than 90% of maximum. Similarly, in a study of 25 middle-aged men who had or did not have coronary artery disease, Haapaniemi et al² found that for subjects without coronary artery disease, deer dragging resulted in an average heart rate equivalent to 90% of HR_{max} , whereas for subjects with coronary artery disease, dragging resulted in a heart rate greater than 104% of HR_{max} . Collectively, our study, in conjunction with previous studies, demonstrates that regardless of the age of the hunter, the CV demands of dragging a deer carcass can be extreme. Therefore, our study provides a novel alternative to traditional dragging methods and encourages consideration of a towing method to lessen CV demands, particularly for hunters who may have CV risk factors.

Study Limitations

Our study is not without limitations. First, we recruited a convenience sample of young, healthy male hunters; therefore, care is needed if attempting to generalize our findings to older, deconditioned, or female hunting populations. Nonetheless, our study demonstrated a clear distinction between the CV demands of towing and dragging, thus making it plausible that the results would be similar across different hunting populations. Also, despite the high statistical power achieved ($>80\%$), our sample was small, and our results should be interpreted with caution. Moreover, we did not utilize a randomized cross-over trial of each condition, as each subject performed the towing condition, rested 20 minutes, then performed the dragging condition; and we duly note this as a potential limitation. Nevertheless, pilot testing and post-hoc analysis comparisons of baseline CV measures between each beginning condition indicated no significant differences in either heart rate or VO_2 , thus reducing the likelihood that the first test confounded the results of the second.

In an attempt to control for the environmental challenges associated with hunting, all testing was completed indoors on a level surface with the use of a simulated deer carcass. However, our dragging/towing conditions and subsequent distance covered reached CV levels similar to those previously observed in field-based studies,^{2,5} indicating that the indoor setting was not

critically dissimilar to field conditions. Also, regardless of the setting, this study demonstrated a significant and meaningful CV response difference between the two conditions, confirming that our study provides preliminary insight into alternative deer retrieval strategies, with the acknowledgement that additional research is needed in a variety of populations and environmental conditions with larger samples.

Conclusion

The results of this study suggest towing a deer carcass with a shoulder harness may result in significant reductions in CV demands and lower RPE when compared with more traditional deer dragging techniques. Deer hunters who are deconditioned or have CV risk factors are strongly encouraged to consider deer retrieval methods utilizing a shoulder harness and tow rope to counter the increased CV demands commonly found in rugged terrain and cold weather conditions.

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