

Feasibility of Heat Acclimatization in Wildland Firefighters

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PURPOSE: To determine the feasibility of implementing pre-season heat acclimatization (HA) for wildland firefighters (WFF) to reduce risk of heat illness and associated health and monetary costs. The study will assess 1) physiological and psycho-physiological adaptations and 2) self-efficacy of WFF who undergo HA. **METHODS:** A mixed-methods, non-randomized controlled trial strategy will be used. Recruitment has begun in conjunction with U.S. Forest Service following IRB approval. Up to 20 personnel will be recruited (50% intervention, 50% control). Planned measurements include rectal and skin temperature, heart rate, sweat rate, sweat electrolyte content, thermal comfort, perceived exertion, blood plasma volume, heat shock protein (HSP72), hypoxia inducible factor (HIF1), hemoglobin and hematocrit. All variables will be measured before and after two Heat Tolerance Tests (HTT) separated by 10 days. The intervention group will undergo an 8-day HA between HTTs, while the control group will complete only normal job training between HTTs. Psychological data will be collected through three semi-structured interviews (before HA, following HA, and following the fire season). WFF's responses will be used to assess changes in the magnitude and sources of self-efficacy throughout the study. The results will also determine whether efficacy generalized to their experiences during the fire season. **RESULTS:** Currently the heat chamber is constructed and being tested. A qualitative pilot study has determined that heat illness is a major safety concern of WFF. In addition, while overall knowledge of HA is low, there is interest among WFF to use HA to lower risk of heat illness. Pilot data also demonstrated WFF logistical concerns about planning of HA. Data collection is planned for April-October 2019. Researchers expect physiological adaptations will take place during the HA. Researchers also anticipate the opinion of HA will be favorable and increase self-efficacy. **CONCLUSION:** WFF are in support of using HA to reduce work-related risk of heat illness. Pilot study results indicate a need for the current study.

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Bilateral deficit revisited: no bilateral deficit for older adults or women.

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Purpose: The bilateral deficit in muscle strength has been advanced as an indicator of maximal nervous system drive. The aim was to determine age and sex-based differences in maximal force during bilateral (BIL) and unilateral (UNI) strength tests.

Methods: Healthy, moderately active, older (65-79 yrs) and young (19-27 yrs) adults were tested. They performed BIL and UNI maximal voluntary contractions (MVC) of the knee extensors in an apparatus capable of measuring left and right forces during BIL or UNI tasks. Three to five trials of BIL and UNI attempts were performed with 1-min rest between trials. The maximal force value from the maximal trial was taken as the MVC outcome. The Bilateral index (BI, %) was calculated to quantify the ratio of BIL to UNIL maximal forces $[(\text{sum of BIL MVC}/\text{sum of UNI MVC}) \times 100] - 100$. Positive BI values are bilateral facilitation and negative values are bilateral deficit.

Results: The MVC force was 38% lower for older vs. young adults ($P < 0.0001$), and 36% lower for women vs. men ($P < 0.0001$). Differences in MVC force between men and women were significant for young and older adults, and differences between young and older were significant for men and women. For the whole sample, the BI value was significantly greater than zero (bilateral facilitation, $3.47 \pm 8.33\%$, $P < 0.05$). A bilateral deficit was present in 11/40 cases. Neither older nor young adults showed a BI value different from zero. Compared with zero, the young adults exhibited significant bilateral facilitation ($4.75 \pm 7.75\%$, $P < 0.05$), while the BI values for older adults was not significant ($2.19 \pm 8.89\%$, $P > 0.05$). Women exhibited significant bilateral facilitation ($3.74 \pm 7.18\%$, $P < 0.05$), but men did not ($3.27 \pm 9.25\%$, $P > 0.05$). Between subject groups, there were no differences in BI for men vs women or young vs old ($P > 0.05$).

Conclusion: Overall, this larger sample of older and young men and women showed no consistent evidence of a reduced ability to simultaneously drive both quadriceps muscles. Young adults and women exhibited a small, but significant bilateral facilitation, however there were no age or sex differences for the bilateral index values. The findings contrast with previous studies that showed a bilateral deficit for older adults and suggested that reduced neural drive may contribute to the phenomenon.

Title: Relationship between measures of muscular strength, endurance, and power to an occupational task among SWAT operators

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PURPOSE: Special Weapons and Tactics (SWAT) officers that express high levels of strength and endurance are more likely to perform better in specific occupational tasks, such as a body drag where they must physically transport a civilian or fellow officer from a hazardous environment. The aim of the present study was to examine the relationship between measures of strength, endurance, and power to sled pull time (a simulated body drag) among SWAT officers.

METHODS: Archival data for twelve (n=12; age 34.33 ± 5.85 yrs.; ht: 183.13 ± 7.72 cm. wt: 93.45 ± 10.91 kgs.) SWAT officers. This data was collected as part of the agency's normal fitness assessment and included measures of upper-body muscular strength (pull-ups) and endurance (push-ups), trunk muscular endurance (sit-ups), anaerobic power (vertical jump; 300 m run), and aerobic capacity (20 meter multi-stage fitness test). The body drag (BD) assessment was simulated using a 90.90 kg. sled which was pulled 20 yards, backward, using a rope strap. Time to complete the BD was recorded using a stopwatch to the nearest 0.01 seconds. A Pearson's Correlation was used to determine if significant relationships existed between the measured variables.

RESULTS: The results indicated significant relationships between sled pull time and body weight ($r=-.822$, $p=.001$), BMI ($r=-.632$, $p = .028$), and number of pushups performed ($r=-.661$, $p = .02$).

CONCLUSIONS: As body weight and BMI of the SWAT officers increased, their sled pull time significantly decreased, suggesting larger officers may have an advantage when performing strength-based occupational tasks. It is important to note that simply gaining more weight will not lead to faster times, but rather increasing overall muscle mass by increasing strength would most likely yield better results. Sled pull times also decreased as officers could perform more push-ups, suggesting that overall upper-body muscular endurance may be beneficial when performing such tasks over distance of ~18 meters.

Ability of bioimpedance spectroscopy to monitor changes in total body water during exercise in humans

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During exercise, changes in body weight of $\geq 2\%$ from dehydration can have significant physiological and clinical consequences. Bioimpedance spectroscopy is a low-cost, portable method to assess hydration status by quantifying total body water (TBW). Multiple studies have identified that ambient air and/or skin temperature can influence the accuracy of bioimpedance measurements at rest, however, the influence of exercise has yet to be determined. **PURPOSE:** To determine the ability of an external bioimpedance device to track changes in TBW during exercise in varied ambient conditions. **METHODS:** In 8 young healthy individuals (5M/3F, 22 ± 3 y) we used a multi-frequency bioimpedance analysis device to derive measurements of TBW in the supine position both before and after exercise. Prior to and following exercise, individuals were weighed in dry clothing to assess dehydration due to fluid loss. Additionally, we used thermocouple temperature sensors placed at seven sites to obtain a whole body average of skin temperature. On three separate occasions, subjects exercised at 60% of their VO₂ max on a cycle ergometer for 60 minutes in an environmental chamber set at either 20° (thermoneutral [TN]), 40° (hot [H]), or 4° (cold [C]) at 20% relative humidity. **RESULTS:** At the end of exercise in TN (n=7), body weight decreased ($\Delta = -0.79 \pm 0.18$ kg; $P < 0.01$) and skin temperature increased ($\Delta = 1.01 \pm 0.31$ °C; $P < 0.05$) as expected. In contrast, bioimpedance-derived TBW increased ($\Delta = 0.24 \pm 0.38$ L). In H (n=4), body weight decreased ($\Delta = -1.23 \pm 0.16$ kg) and skin temperature increased ($\Delta = 3.46 \pm 0.56$ °C; $P < 0.01$) to a greater extent than TN, yet estimated TBW increased ($\Delta = 2.07 \pm 0.09$ L; $P < 0.05$). In C (n=7), body weight decreased to a lesser extent than TN and H ($\Delta = -0.44 \pm 0.12$ kg; $P < 0.01$), whereas skin temperature decreased ($\Delta = -0.73 \pm 0.59$ °C). Interestingly, estimated TBW decreased under this condition ($\Delta = -1.80 \pm 0.37$ L; $P < 0.01$). Pooled across all experimental conditions, the change in body weight and TBW were negatively correlated ($R = -0.5$; $P < 0.05$), whereas the change in skin temperature and TBW were positively correlated ($R = 0.71$; $P < 0.01$). **CONCLUSION:** Our results indicate that bioimpedance spectroscopy does not accurately monitor changes in TBW during exercise in humans, and this may be due to changes in skin temperature.

Effect of breaking-up sedentary activity on metabolic flexibility and glycemia in free-living overweight/obese adults

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ABSTRACT

PURPOSE: Sedentary behavior (**SB**) triggers an inability to adjust substrate use to substrate availability (metabolic flexibility, **MF**), which may precede glucose intolerance in the pathogenesis of insulin resistance. We and others have shown that frequent interruptions in SB leads to improved glycemic control, however the underlying role of MF in this process is unknown. This study examined the effects of breaking up SB on MF and glucose metabolism in free-living overweight and obese adults. To distinguish effects of breaking up SB from being physically active, we also studied a group where participants performed a single energy matched continuous bout of exercise.

METHODS: Physically inactive, adults (12F/7M, mean±SD; 33±8 yrs, BMI = 29.5±3.3kg/m²) were randomly assigned to a 4 week intervention consisting of brisk walking for 5 min each hour for 10h, 5 d/wk (**MICRO**, n=10), or 4 weeks of an intervention consisting of one continuous 45 min bout of exercise per day, 5d/wk (**ONE**, n=9). Outcomes assessed at baseline and after each intervention included: MF (waking respiratory quotient, **RQ**, minus sleeping RQ as measured in a whole room calorimeter), insulin sensitivity (**SI**, IVGTT), 24h glycaemia (continuous glucose monitor), 24h glucose oxidation (U¹³C glucose tracer), SB, time spent stepping, and performing moderate to vigorous activity (**MVPA**; ActivPAL and ActiGraph). Groups were similar on all outcome variables at baseline. Linear mixed models evaluated intervention and intervention-by-group effects.

RESULTS: MICRO and ONE decreased time sitting (-43.5±93.4 min), increased time stepping (+26.3±44.0 min) and time spent in MVPA (+9.8±17.6 min) (p<0.05 for all). No significant changes were observed in SI, but both interventions decreased fasting insulin and HOMA IR (p<0.05 for both). Compared to ONE, MICRO improved the acute insulin response to glucose (**AIRg**), lowered 24h glycemic variability, maintained exogenous glucose oxidation, and improved MF (interaction: p<0.05 for all). Improvements in MF were positively associated with changes in SI (r=0.59, p=0.02).

CONCLUSION: Independent of time sitting and stepping, breaking up SB improves glucose homeostasis and MF. The effects of such an intervention in persons with type 2 diabetes warrants further study.

Influence of Lower Limb Circulatory Occlusion on Arm Crank Ergometer Exercise Performance

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Purpose: Previously we have demonstrated an ergogenic effect of upper limb circulatory occlusion during cycle ergometer time trial performance. In the current study we investigated the reciprocal hypothesis: lower limb circulatory occlusion augments arm crank ergometer exercise performance. **Methods:** Following screening and habituation, 8 athletic young adults (5 males, 3 females, age: 23 ± 4 years, body mass index: 24.1 ± 2.5 kg/m²; mean \pm SD) completed two randomly ordered bouts of arm crank ergometer exercise. The goal was to achieve the highest possible energy expenditure during 14-minutes of arm cranking against a resistance equivalent to 2% body mass. Prior to the bouts, blood pressure cuffs were inflated around the upper thighs to either 25 mmHg (sham) or 225 mmHg (occlusion). Circulatory occlusion was confirmed by the inability to palpate a posterior tibial pulse. **Results:** Arm crank ergometer exercise performance was unaffected by lower limb occlusion (Sham: 20.2 ± 7.2 vs. Occlusion: 18.9 ± 5.1 kcal; $P=0.26$). Similarly, exercise heart rate was unaffected (Sham: 159 ± 9 vs. Occlusion: 162 ± 12 beats/min; $P=0.29$) but perceived exertion was greater with lower limb occlusion (Sham: 15.2 ± 1.0 vs. Occlusion: 15.8 ± 1.1 ; $P=0.01$). Noteworthy, the magnitude of improvement in arm crank exercise performance with occlusion was inversely related to sham performance ($r = -0.78$, $P=0.02$), implying that lower limb occlusion had the greatest benefit for participants who expended the lowest energy during the sham condition. **Conclusion:** In contrast to the influence of upper limb circulatory occlusion during cycle ergometer exercise, lower limb circulatory occlusion does not influence arm crank exercise performance.

Title: Proteinuria Following a Bout of High Intensity Functional Resistance Training

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INTRODUCTION: Extreme high intensity functional resistance training (HIFRT) may result in severe skeletal muscle breakdown leading to acute kidney injury (AKI). Urinalysis via reagent strips has the potential to quickly indicate AKI. **PURPOSE:** Examine kidney function following an extreme HIFRT workout. **METHODS:** 13 adult HIFRT athletes (9 males, 4 females, age: 25.8 ± 6.5 y, height: 174.7 ± 8.2 cm, weight: 78.4 ± 13.4 kg, training experience: 3.2 ± 1.0 y) completed a standardized HIFRT workout (1 mile run, 100 pull-ups, 200 push-ups, 300 squats, and a final 1 mile run) as fast as possible. Urinalysis via reagent strips were performed on spot urine samples at 5 time points surrounding the exercise bout including 24-hours pre (T1), immediately pre (T2), immediately post (T3), 24-hours post (T4), and 48-hours post (T5). RM-ANOVAs determined main effects of time on each reagent variable (blood, glucose, ketones, leukocytes, nitrogen, protein, and pH). Simple planned contrasts compared variable quantities at T1 (i.e., baseline) to all other time points. Frequency analysis examined incidence of specific quantities of blood and protein at each time point. **RESULTS:** Average HIFRT duration and intensity were 71.4 ± 7.3 min and $83.0 \pm 4.5\%$ of APMHR rate, respectively. RM-ANOVA revealed a main effect of time for protein only ($F_{[1,31, 15.74]} = 7.20, p = 0.01$). Contrasts showed a difference in urinary protein content between T1 (5.77 ± 2.11 mg/dL) and T3 (31.77 ± 8.91 mg/dL; $p = 0.02$). No main effects of time were observed for other variables (all $p \geq 0.08$). Frequency analysis revealed 85% ($n = 11$) of participants had trace amounts of protein or greater (≥ 15 mg/dL) at T3. Protein incidence lowered in the 48 h after the workout where 62% ($n = 8$) and 46% ($n = 6$) of participants had trace amounts or greater at T4 and T5, respectively. 21% ($n = 3$) had trace amounts of blood (5-10 Ery/ μ L) at T3 and returned to negative baseline values by T4. **CONCLUSION:** Proteinuria has served as an AKI indicator. The present study shows protein and blood in the urine may occur following long duration HIFRT. This may be attributed to severe muscle breakdown after completing many repetitions at high intensities. Since reports were negative for blood at T4 and protein returned to near-baseline levels by T5, we recommend sufficient recovery time be taken after similar workouts.

Double Peak Muscle Activation Pattern in a Baseball Swing

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The double peak muscle activation pattern has shown a positive correlation with enhanced speed and force in a golf swing and in mixed martial arts striking. Similar to golf and a mixed martial arts strike, a baseball swing is a rotational swinging motion with potential to display the double peak phenomenon.

PURPOSE: To observe muscle activation patterns using surface electromyography (sEMG) in three phases of the baseball swing.

METHODS: Single subject analysis of muscle activation while hitting a ball off a tee was performed on six NCAA Division II male baseball athletes. Subjects were asked to hit a baseball off a baseball tee into a net using game-emulated swings. The six subjects had sEMG electrodes attached at the locations for left and right rectus abdominis and left and right lumbar erector spinae muscles. Using a high-speed camera synchronized to the Noraxon sEMG electrodes, muscle amplitudes were recorded and compared to the three different phases of the swing: initial movement towards the ball, early to mid-swing phase, and bat to ball contact.

RESULTS: Double peak muscle activation patterns were observed in the swings of all subjects; however, the prevalence of the double peak phenomenon varied between subjects. In the swings that produced a double peak, there was a period of initial muscle activation in phase one (initial movement towards the ball), a decrease in muscle activation in phase two (early to mid-swing phase), and another spike in muscle activation in phase three (bat to ball contact). In the swings where a distinct double peak was not observed, there was a consistent increase in muscle amplitude through phase three (bat to ball contact).

CONCLUSION: This study observed a double peak muscle activation phenomenon during the baseball swing in Division II collegiate baseball players. These results could be used to enhance training regimens for specific rotational sports that aim to increase the consistency of the double peak in key muscle groups, increasing the effective mass transferred into an object.

Keywords: Double Peak, Surface Electromyography (sEMG), Baseball Swing, Effective Mass.

Title: Treatment with the Nrf2 activator PB125 improves mobility in guinea pigs prone to osteoarthritis and sarcopenia

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Osteoarthritis (OA) and sarcopenia, the age-related loss of skeletal muscle mass and function, are two common chronic diseases prevalent in older adults that contribute to decreased mobility. Age-related mitochondrial dysfunction contributes to oxidative stress and inflammation that disrupts protein homeostasis (proteostasis), which is an essential component of maintaining tissue integrity and preventing OA and sarcopenia. The transcription factor Nrf2 is a promising target for abrogating oxidative stress and inflammation. Nrf2 activation regulates gene expression of antioxidants and anti-inflammatory mediators. To study OA and sarcopenia, we used Dunkin Hartley (DH) guinea pigs because, beginning at about 4 months of age, they begin developing primary OA and sarcopenia similar to humans. We hypothesized that treating DH guinea pigs with a daily dose of PB125, a phytochemical Nrf2 activator, would increase their mobility and muscle mass, which is a component of proteostasis. The DH guinea pigs were treated with PB125 for 10 months from 5 to 15 months of age. During this period, we measured gait as a metric of mobility. At 15 months, we extracted and measured the hind limb muscle mass. Treatment with PB125 had a positive effect on stride length over time in male guinea pigs ($p < 0.05$), and treated female guinea pigs maintained stance width over time compared to controls ($p < 0.05$). While PB125 treatment improved the mobility of DH guinea pigs, there was no statistically significant difference in muscle mass compared to the placebo-treated controls. Future studies are required to determine exactly how PB125 enhanced mobility.

SOCIAL ECOLOGIC DETERMINANTS OF PHYSICAL ACTIVITY AMONG ADULT SURIVVORS OF CHILDHOOD CANCER

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PURPOSE

Adult survivors of childhood cancer (ASCC) are at high risk for cardiovascular disease from chemo and radiation therapy-related cardiotoxicity.¹ Physical activity (PA) can reduce this risk,² but most ASCC do not engage in sufficient PA.^{3,4} The Social Ecologic Model (SEM) is a theoretical framework which suggests multiple factors facilitate or hinder PA.^{5,6} These factors exist at the individual (e.g., motivation, genetics), micro- (e.g., parents, neighborhood parks), meso- (e.g., PA at school), exo- (e.g., parent interaction with clinicians), macro- (e.g., societal values) system levels.⁷⁻¹⁰ This study will explore barriers and facilitators of PA among ASCC using the SEM framework. Herein, we describe our study protocol and expected results.

METHODS

A concept elicitation survey was distributed to ASCC (diagnosed with cancer before the age of 18, and currently 18-39 years old) and parent/legal guardians of ASCC via Qualtrics.¹¹ Participants were recruited via purposive sampling, flyers, email distribution to ASCC support organizations, and social media platforms that target ASCC (e.g. Stupid Cancer).¹² The survey consists of open-ended questions including: “Which resources would you need to participate in PA on a regular basis?”, “Over the last year or so, what factors have made it (easy/hard) for you to be physically active on a regular basis?” Content analysis will be performed by two independent coders who will identify and code the reported barriers and facilitators of PA to match each level of the SEM until data saturation is reached. Descriptive statistics for demographics will include mean (\pm SD) and frequencies. (IBM SPSS, v.25)

RESULTS

This study received approval from the CSU IRB for the protection of human subjects in December 2018 (#18-8349H). To date, we have received $n=8$ responses ($n=7$ ASCC, $n=1$ parent of ASCC). Data collection will continue through March 2019. We hypothesize that the most frequently reported barriers will be related to the exosystem and the most frequently reported facilitators will be related to the microsystem.

CONCLUSION

This will be the first study to examine barriers and facilitators of PA among ASCC using the SEM framework. Results from this study will provide comprehensive understanding of PA determinants among ASCC to enhance future quantitative survey development.

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Effect of a Physical Activity Intervention on Fitness and Quality of Life in Cancer Survivors

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Cancer survivors experience cachexia and lower energy levels as a result of cancer and its treatments. **PURPOSE:** To determine the effect of physical activity (PA) on cancer survivors' overall fitness and quality of life (QOL). **METHODS:** Thirty-one cancer survivors volunteered to participate in a 12-week PA study; however, only 18: 7 males, 11 females completed the study (16 PA group, 2 control (C) group). PA group had an average age of 66.5 ± 11.6 yr, height 65.1 ± 8.1 in, weight 174.2 ± 31.6 lbs. The C group (average age 74.9 ± 4.9 yr, height 65.3 ± 5.8 in, weight 170 ± 77.1 lbs) were instructed to continue their regular routine. PA was individualized, supervised, and progressive including a week of pre-testing, a week of post-testing, and 10 weeks of PA; exercise included 3 days a week: 1 cardio session, 1 strength circuit, and 1 group activity. Pre-and post-tests were Fitness Age (FA) and 6-Minute Walk Test (6MWT).

RESULTS: The PA group trended toward significance for overall change in body weight (-4.6 lbs, $p=.07$) and ilium skinfold ($p=.05$). Distance for PA group for the 6MWT decreased (3.4 ± 7.3 m, $p=.19$), however, their average resting heart rate was lower (5.1 ± 16.6 bpm, $p=.14$) in post-testing. For PA group, overall FA at post-test was 52.8 ± 11.3 yr. Individual components were: cardiorespiratory FA of 65.4 ± 25.5 yr; body composition FA of 56.1 ± 20.9 yr; flexibility FA of 53.1 ± 22.8 yr; muscular strength/endurance FA of 54.4 ± 14.2 yr. PA group had less fatigue post-test compared to C group (19.2 ± 21.7 vs. 31 ± 18.4 , $p=.47$). **CONCLUSION:** With a longer intervention and greater subject compliance, significant improvements in overall fatigue and QOL, body composition and FA (overall and each component) would be more likely to occur. Improvement in 6MWT recovery heart rates from pre- to post-testing indicate that PA group was able to efficiently train the heart to recover faster. FA scores indicate PA participants had lower physiological vs. chronological age.

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Physiological Profile of Recreational Ultramarathon Runners

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PURPOSE: The purpose of this study was to determine the physical characteristics of recreational ultramarathon runners. **METHODS:** Thirty runners, 10 women (mean age = 29.1 years, height = 163.2 cm, weight = 60.4kg, and body fat percentage [BF] = 21.0%) and 20 men (mean age = 31.2 years, height = 177.5cm, weight = 79.0kg, and BF = 16.8%) participated in testing. Testing was performed in a single session in the following order: Body composition analysis, Functional Movement Screening (FMS), five-bound jump test, and maximal oxygen consumption testing. All the runners were free from injury or illness, had previously completed an ultramarathon, and were currently training for ultramarathons. An ANOVA was performed to determine differences in the variables for three running groups [Short (50km), Middle (80.5km, 100km), Long (161km+)] based on the runners' preference. Independent t-tests were used to determine statistical differences between genders. Statistical significance was assumed at $p \leq 0.05$. **RESULTS:** Results for each gender and mean values for all tested subjects can be noted in the table below. There were no significant differences between the three distance groups for any variable. Significant differences were present between males and females in bone mineral density ($p= 0.00$), VO_2 Max ($p= 0.01$), five-bound jump ($p=0.00$), and BF ($p=0.02$). Participants demonstrated a group mean deficiency in the FMS hurdle step with an average score of 1.83. **CONCLUSION:** No significant differences were noted between runners of different distance groups, which may indicate other factors could predispose a runner to success or enjoyment in a specific ultramarathon event. The investigation could into distance groups could be strengthened in future research by studying runners who specialize in a single distance. Studies measuring physiological factors across an ultramarathon season or considering a more extensive number of training variables for recreational ultramarathon runners should be conducted. The data from the current study may potentially be useful as a comparison for future research investigating ultramarathon runners and other endurance sport athletes.

Investigating the Effects of a Supervised, Physical Activity Program on Cancer Survivors' Health and QOL

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Moderate-intensity physical activity (PA) is considered an effective strategy for reducing problems caused by cancer and its related treatments, including surgery, chemotherapy, radiation, and hormone therapy (Melo et al., 2015).

PURPOSE: The purpose of this study was to determine aerobic capacity (Six-Minute Walk Test), cardiorespiratory function (Three-Minute Step Test), muscle strength and endurance (MS&E) (sit-up & push-up tests), flexibility (sit-n-reach test), body composition (4 sites using Lange calipers), overall fitness age (FA), fatigue (BFI questionnaire), and Quality of Life (EORTC-QLQ-C30 questionnaire) in cancer survivors in a rural setting after a supervised, progressive eight-week PA intervention of aerobic exercise, resistance training, stretching and group sport activities.

METHODS: A total of 27 volunteers [13 in the PA Intervention Group (PAIG) (5 = male, 8 = female), 14 in the Control Group (CG) (5 = male, 9 = female)] completed the study. At baseline, all participants as a group had a mean (\pm SD) age, height, body weight and body fat percentage (BFP) of 65.2 ± 10.8 yrs, 167.1 ± 8.7 cm, 80.5 ± 14.1 kg, and $25.6 \pm 5.1\%$, respectively.

RESULTS: Aerobic capacity ($p = 0.03$; $d = 0.69$), MS&E: sit-ups ($p = 0.001$; $d = 1.29$), overall MS&E FA ($p = 0.001$; $d = 0.96$), and overall FA ($p = 0.03$; $d = 1.44$) improved significantly for the PAIG compared to the CG. The PAIG improved on the BFI ($d = 0.26$), and global health ($d = 0.22$), physical ($d = 0.55$), role ($d = 0.57$), cognitive ($d = 0.24$) and social functioning ($d = 0.05$), and decreased in pain ($d = 0.07$) as measured by the EORTC for Quality of Life (QOL) compared to the CG ($p > 0.05$). Percent change pre-to post-testing improved for: aerobic capacity (20.61%, $p = 0.03$), overall body composition FA (-11.88%; $d = 0.51$), overall body fat percentage (-7.35%; $d = 0.36$), overall MS&E FA (-18.28%; $p = 0.001$) and overall FA (-11.15%; $p = 0.04$) for the PAIG.

CONCLUSIONS: A supervised, progressive multi-modal training program can improve physical health and QOL in cancer survivors. This special population is deconditioned from cancer-related treatments and physical inactivity. Perhaps future studies could add a longer intervention time, and investigate supplementation of nutrition and hydration, to see greater improvements in the variables tested

Characterization of Perceived muscle soreness and prediction of skeletal muscle markers of damage following a bout of high intensity exercise

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Exercise-induced skeletal muscle damage often resolves in 1-5 days, however severe complications occasionally arise. Identifying predictors of severe skeletal muscle damage may reduce potential risks associated with high volume or extended duration workouts. **Purpose:** Determine if pain perception is related to markers of skeletal muscle damage following a standardized bout of high intensity functional resistance training (HIRFT). **Methods:** Participants (n=19 [13 males, 6 females, height 174.7 ± 7.9 cm, weight 77.9 ± 13.7 kg, age 25.8 ± 6.5 y, training experience 3.5 ± 1.3 y) completed a standardized HIRFT workout (1 mile run, 100 pull ups, 200 pushups, 300 air squats, 1 mile run). At 5 time points (24 h pre, immediately pre, immediately after, 24 h after and 48 h after exercise), participants completed the Short Form McGill Pain Questionnaire (MPQ) monitoring overall perceived muscle soreness using 15 pain terms and a visual analog scale (VAS). Post-exercise plasma osmolality indicated skeletal muscle damage as significant elevations may lead to higher concentrations of skeletal muscle cell components (i.e., urea). **Results:** RMANOVA revealed a main effect of time for 11 pain variables. The following terms were significantly elevated from baseline immediately after exercise: “hot/burning”, “heavy”, “sickening”, “punishing/cruel” (all $p \leq .035$). “Cramping” and “tiring/exhausting” were significantly elevated immediately and 24h after exercise (both $p \leq .004$). These variables were significantly elevated from baseline at all post-exercise time points: “throbbing”, “aching”, VAS (all $p \leq .001$). “Tender” was significantly elevated 24h and 48h after exercise ($p \leq .001$). A stepwise regression analysis revealed a significant relationship between VAS immediately after exercise and mean plasma osmolality 48h after exercise. **Conclusion:** 11 MPQ terms described perceived muscle pain following the bout of HIRFT best. The relationship between VAS immediately after exercise and plasma osmolality 48h after exercise demonstrates individuals who perceived more pain immediately following the workout showed evidence of increased skeletal muscle damage 48h after the workout. We plan to evaluate blood samples to confirm elevated urea concentration in participants reporting higher muscle pain immediately after the workout.

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Associations of muscular power and endurance to change of direction speed under two loading conditions among female police officers

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Purpose: Change of direction speed (CODS) is essential for law enforcement officers during many occupational tasks, such as when pursuing an assailant. Typically, these tasks are performed while in uniform which can create a significant occupational load. The purpose of this study was to determine the relationship between lower-body power and upper body to a CODS task both with and without occupational load.

Methods: Forty-four (n=44, age: 27.09 ± 7.25 yrs., Ht: 166.48 ± 6.88 cm; Wt.: 69.92 ± 13.69) female police officers performed a standing long jump (SLJ), modified push-ups (MPU), and time to complete the Illinois Agility Test both unloaded (IAT) and while wearing a 10 kg vest (IATL). Completion times for the IAT and IATL were recorded to the nearest .01 sec.

Results: A Pearson's Correlation coefficient revealed significant moderate relationships between SLJ and IAT ($r = -0.586$, $p < .001$), as well as between SLJ and IATL ($r = -0.567$, $p < .001$). A low, but significant, relationship was also found between MPU and IATL ($r = -0.377$, $p = .012$). No significant relationship was observed between IAT and MPU (Table 1).

Conclusions: Female officers with greater lower-body power and upper-body endurance may have an advantage when performing the IATL, however the MPU does not appear to significantly impact in the IAT. These results suggest that as occupational load increases, especially around the trunk, greater upper-body muscular strength and endurance become more important when performing essential job tasks (i.e., 3-5 sec. rush, seeking cover from adversarial gunfire).

Table I: Relationships between Lower-body power, muscular strength/endurance, and

		Age	Ht	Wt	SLJ	PU	IAT	IATL
Age	Pearson's r	—						
	p-value	—						
HT	Pearson's r	-0.509†	—					
	p-value	< .001	—					
WT	Pearson's r	0.37†	0.292	—				
	p-value	0.013	0.054	—				
SLJ	Pearson's r	-0.475†	0.649†	0.134	—			
	p-value	< .001	< .001	0.384	—			
MPU	Pearson's r	.464**	-.244	.195	-.024	—		
	p-value	.002	.110	.204	.878	—		
IAT	Pearson's r	0.452	- 0.355*	0.171	- 0.586†	-.153	—	
	p-value	0.002**	0.018	0.268	< .001	.321	—	
IATL	Pearson's r	0.26	-0.28	0.023	- 0.567†	- .377**	0.9†	—
	p-value	0.088	0.065	0.88	< .001	.012	< .001	—

$p \leq 0.05 = *$; $p \leq 0.01 = **$; $p \leq .001 = †$

Relationships between body composition and change of direction speed under two different loading conditions among female police officers

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Purpose: Change of direction speed (CODS) is essential for law enforcement officers during many occupational tasks, such as during foot pursuits or when seeking cover. Typically, these tasks are performed while in uniform and wearing police equipment which creates additional physiological burden. Body composition in the form of functional (skeletal muscle mass) and non-functional (excess body fat) can either increase or decrease this burden. Thus, it is important to understand the relationship of functional (muscle tissue) and non-functional mass (excess adipose tissue and duty gear) on occupational tasks. The purpose of this study was to determine the relationship between body composition to a CODS task performed both with and without occupational load among female police officers.

Methods: Data for forty-four ($n=44$, age: 27.09 ± 7.25 yrs., Height (Ht): 166.48 ± 6.88 cm; Weight (Wt): 69.92 ± 13.69 kg, Body mass Index (BMI): 25.25 ± 4.72) female police officers was used in this analysis. Body composition measurement procedures were conducted using multi-channel bioelectric impedance (InBody 720: Biospace Co. Ltd, Seoul, Korea). The following variables were used for this analysis: Ht, Wt, (BMI), percent body fat (PBF), and percent skeletal muscle mass (PSMM). Additionally, performance on a CODS test (Illinois Agility Test) was measured under both unloaded (IAT) and loaded (10-kg vest) conditions (IATL). A Pearson's correlation was used to determine if significant relationships existed between body composition and performance on the IAT and IATL.

Results: The data revealed significant moderate relationships between IAT and Ht ($r = -.355$, $p = 0.18$), BMI ($r = .346$, $p = 0.021$), PBF ($r = .523$, $p < .001$), and PSMM ($r = -0.528$, $p < .001$). For the IATL, low to moderate correlations were discovered between PBF ($r = .364$, $p = 0.015$), and PSMM ($r = -.374$, $p = 0.012$) only.

Conclusions: These results suggest that as occupational load increases, greater muscle mass and lower body fat percentages may contribute to faster CODS when performing essential job tasks among female officers. These findings are significant when considering the need to accelerate, decelerate and change direction rapidly during life threatening situations. These findings support the need to develop skeletal muscle mass and reduce excess body fat to enhance occupational performance among female officers.

Does Dapagliflozin Influence Dietary Counseling Mediated Changes in Body Composition and Glucose Regulation?

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Purpose:

The diabetes medication, Dapagliflozin, is a sodium-glucose co-transporter 2 (SGLT2) inhibitor. The mechanism of action is decreasing renal absorption of glucose, leading to glucosuria, and modest weight loss. We hypothesized that SGLT2 inhibition would potentiate the favorable influence of dietary counseling on body composition and glucose regulation in overweight or obese adults.

Methods:

Fifty sedentary overweight/obese men ($n = 12$) and women ($n = 38$) (Body Mass Index: 33.2 ± 5.6 kg/m²; age: 37 ± 11 years; mean \pm SD) were randomly assigned to 12 weeks of dietary counseling for weight loss, supplemented with daily ingestion of either placebo or Dapagliflozin (up to 10 mg/day); coded as Pill A and Pill B. At this time, the study remains double blind. Dietary counseling consisted of weekly, one-on-one, 30-minute meetings targeting calorie restriction. Before and after treatment, body composition (dual energy x-ray absorptiometry) and insulin sensitivity (Oral Glucose Tolerance Test) were measured.

Results:

Twelve weeks of dietary counseling decreased ($P < 0.001$) body mass (A: $\Delta 3.44 \pm 4.12$; B: $\Delta 4.33 \pm 3.09$ kg) and fat mass (A: $\Delta 2.00 \pm 2.71$; B: $\Delta 2.21 \pm 2.50$ kg); neither variable was influenced by pill assignment (interaction: $P > 0.45$). Dietary counseling also decreased lean mass (treatment main effect: A: $\Delta 0.64 \pm 2.46$; B: $\Delta 1.99 \pm 1.95$ kg; $P < 0.001$), however the decrease in lean mass was greater in Pill B than in Pill A (interaction: $P = 0.037$). Neither fasting glucose nor 2-hour glucose area under the curve (AUC) was influenced by pill assignment ($P > 0.261$). 1-hour glucose AUC decreased post counseling (A: $\Delta 328 \pm 1043$; B: $\Delta 239 \pm 804$ mg/dL*min; $P = 0.036$). There was no difference in 2nd hour AUC ($P = 0.14$).

Conclusion:

Overall, 12-weeks of dietary counseling leads to favorable modification of body mass and fat mass, regardless of pill assignment. However, Pill A appears to reduce the dietary

counseling mediated loss in lean mass. Based on 1-hour AUC improvements, and in the absence of insulin data (analysis currently in progress) we speculate that counseling leads to improvements in glucose regulation. Upon completion of all analyses and un-blinding, we will know the influence of Dapagliflozin on dietary counseling mediated changes in body composition and glucose regulation.

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Evaluating Age-related Skeletal Muscle Architectural Changes Using a Novel Model of Osteoarthritis

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Maintenance of the musculoskeletal system is critical to prevent age-related falls and loss of mobility. Sarcopenia, the age-related loss of muscle mass and function, affects 10% of those over 65 years and as much as 50% of people over 80 years of age. Aging is a major risk factor for osteoarthritis (OA) which is characterized by a concomitant loss of skeletal muscle, further contributing to decreased mobility. Dunkin Hartley (DH) guinea pigs rapidly and spontaneously develop primary knee OA beginning at about 4 months of age with a similar pathophysiology to that of humans. Thus, we speculate that DH guinea pigs may also be a valuable model of skeletal muscle aging. **PURPOSE:** To determine if DH guinea pigs can serve as a model to understand human skeletal muscle aging. **METHODS:** We compared skeletal muscle architectural properties of the gastrocnemius (GAS) and soleus (SOL) from 5, 9, and 15 month DH guinea pigs. We also compared these changes to a strain of guinea pig, strain 13 (S13), that does not develop knee OA at an early age. Formalin fixed GAS muscles were stained in India ink to measure fan angle (FA), which is defined as the spread of fiber orientation, using ImageJ. Magnetic resonance imaging was used to examine GAS and SOL muscle mass, volume, and density. Immunofluorescent histochemistry was used to assess muscle fiber cross-sectional area and myofiber size distribution in the GAS and SOL. **RESULTS:** Compared to S13 guinea pigs, DH guinea pigs demonstrated age-related changes in FA where the FA was greater from 5 to 9 months and then demonstrated a decrease from 9 to 15 months ($p < 0.05$). DH guinea pigs also had a significant decrease in GAS density between 5 and 15 months that was not present in the SOL ($p < 0.05$). Both in the GAS and SOL, DH guinea pigs also demonstrated a shift towards a smaller average myofiber size with age. **CONCLUSION:** Based on these analyses, the DH guinea pig appears to be a potentially valuable model of musculoskeletal aging. Identifying a model to study muscular aging that mimics human conditions but in a shortened time frame, will potentially allow for rapid and effective screening of interventions for musculoskeletal aging.

Effect of a Physical Activity Intervention on Fitness and Quality of Life in Cancer Survivors

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Adams State University

Cancer survivors experience cachexia and lower energy levels as a result of cancer and its treatments. **PURPOSE:** To determine the effect of physical activity (PA) on cancer survivors' overall fitness and quality of life (QOL). **METHODS:** Thirty-one cancer survivors volunteered to participate in a 12-week PA study; however, only 18: 7 males, 11 females completed the study (16 PA group, 2 control (C) group). PA group had an average age of 66.5 ± 11.6 yr, height 65.1 ± 8.1 in, weight 174.2 ± 31.6 lbs. The C group (average age 74.9 ± 4.9 yr, height 65.3 ± 5.8 in, weight 170 ± 77.1 lbs) were instructed to continue their regular routine. PA was individualized, supervised, and progressive including a week of pre-testing, a week of post-testing, and 10 weeks of PA; exercise included 3 days a week: 1 cardio session, 1 strength circuit, and 1 group activity. Pre-and post-tests were Fitness Age (FA) and 6-Minute Walk Test (6MWT).

RESULTS: The PA group trended toward significance for overall change in body weight (-4.6 lbs, $p=.07$) and ilium skinfold ($p=.05$). Distance for PA group for the 6MWT decreased (3.4 ± 7.3 m, $p=.19$), however, their average resting heart rate was lower (5.1 ± 16.6 bpm, $p=.14$) in post-testing. For PA group, overall FA at post-test was 52.8 ± 11.3 yr. Individual components were: cardiorespiratory FA of 65.4 ± 25.5 yr; body composition FA of 56.1 ± 20.9 yr; flexibility FA of 53.1 ± 22.8 yr; muscular strength/endurance FA of 54.4 ± 14.2 yr. PA group had less fatigue post-test compared to C group (19.2 ± 21.7 vs. 31 ± 18.4 , $p=.47$). **CONCLUSION:** With a longer intervention and greater subject compliance, significant improvements in overall fatigue and QOL, body composition and FA (overall and each component) would be more likely to occur. Improvement in 6MWT recovery heart rates from pre- to post-testing indicate that PA group was able to efficiently train the heart to recover faster. FA scores indicate PA participants had lower physiological vs. chronological age.

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TITLE: Relationships Between Objectively Measured Physical Activity and Total Fecal Bile Acid Concentrations

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AFFILIATIONS: ¹Colorado State University, Fort Collins, CO

PURPOSE:

High concentrations of bile acids have been implicated in colorectal cancer (CRC). Physical activity (PA) may modulate fecal bile acid concentrations, but few studies have been conducted in humans. This study explored associations between PA and fecal bile acid concentrations in individuals at high risk for CRC.

METHODS:

Baseline data from participants ($N=11$) enrolled in a pilot, clinical trial Beans/bran Enriching Nutritional Eating For Intestinal health and Cancer Including Activity for Longevity “BENEFICIAL” (CSU IRB # 17-7464H) were included. Eligibility requirements were ≥ 1 adenomatous polyp removal in the previous 3 years. To measure PA, participants wore an activPAL™ accelerometer for 7 consecutive days, provided a stool sample, and a 3-day dietary log. Minutes of moderate to vigorous physical activity (MVPA) per day and continuous MVPA ≥ 10 minutes per day was calculated. Stool samples were lyophilized for 72 hours and analyzed for 16 primary and secondary bile acids with ultra high performance liquid chromatography tandem mass spectrometry (UPLC-MS/MS). Hierarchical multiple regression examined associations between PA and total fecal bile acid concentrations (log transformed), after accounting for BMI and dietary fiber intake. All analyses were conducted with R statistical software.

RESULTS: Participants were 36% female, M age= 58 ± 6 years old, average BMI= 26.5 ± 2.8 kg/m². Average MVPA was= 77.1 ± 26.8 minutes per day, and minutes of continuous MVPA was $M=23.6 \pm 23.4$ per day. Bile acid concentrations were $M=3.42465 \times 10^5 \pm 2.89253 \times 10^5$ ppm. MVPA, dietary fiber, and BMI did not predict total fecal bile acid ($F[3,7]=.532$ $p=0.674$, $R^2=.186$) or deoxycholic acid (DCA) concentration ($F[3,7]=.803$ $p=0.541$, $R^2=.256$). Continuous minutes, dietary fiber, and BMI did not predict total fecal bile acid ($F[3,7]=.709$ $p=0.577$, $R^2=.233$) or DCA concentration ($F[3,7]=.777$ $p=0.543$, $R^2=.250$).

CONCLUSION: This study found no association between PA and fecal bile acid or fecal DCA concentration. Other factors such as plasma triglycerides may mediate this relationship. Longitudinal studies are needed to determine how changes in PA modulate host and microbial bile acid metabolism, which likely impacts risk of CRC recurrence and disease-free survival.

Variations in Wingate Load to Optimize Peak Power Output in NCAA DII Collegiate Athletes

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The Wingate anaerobic test (WAnT) is one of the most commonly used tests to assess lower body anaerobic power; however, compared to other anaerobic power tests it has been found that the use of the standard 7.5% body weight (BW) load often underestimates peak power output (PPO) especially in athletic populations. **PURPOSE:** This study's primary purpose was to ascertain if loads above the standard WAnT load of 7.5% BW would result in higher PPO when compared to the standard. The secondary purpose was then to identify at what loads above 7.5% BW a true PPO occurred, and to determine if the difference in load varied by sex or sport.

METHODS: Ten athletes from six different NCAA DII sports (N=60) participated in the study. The six sports tested included male and female cross country (XC), softball (SB), baseball (BB), female soccer (S) and football (F). Three of the sports (BB, SB and F) were considered anaerobic, the other three (male and female XC and S) were considered aerobic. All testing was completed on a Monark bike (Ergomedic 894E). This study utilized four different loads for comparison: 7.5% BW, 9.5% BW, 11% BW and 12.5% BW. Testing of each load was randomized and blinded to the subject, and each test was separated by at least 24 hours. For the purposes of testing only PPO and reducing overall fatigue, the WAnT was modified to a 10-second protocol. **RESULTS:** A factorial ANOVA was used to compare PPO at various loads across all sports. Only one group showed statistically significant improvements between the standard 7.5% BW load and any other load ($p = 0.047$). A Tukey's post-hoc test identified that this occurred between the 7.5% BW and 12.5% BW conditions for male XC runners. All other increases in PPO across loads were not statistically significant ($p > 0.05$). While not statistically significant, WAnT loads greater than 7.5% BW did result in higher absolute PPOs. Sport did have a significant effect on PPO output ($p < 0.05$), however it did not significantly affect the load at which the greatest PPOs were obtained. Sex also had a significant effect on absolute PPO ($p < 0.05$). **CONCLUSION:** Overall, males obtained their highest PPO at 11% BW while females achieved their highest PPO at 9.5% BW. From this data it appears that male DII athletes should complete WAnTs at 11% BW, while female DII athletes should complete WAnTs at 9.5% BW in order to obtain the highest PPO.

Title: Acute Blood Pressure Response following High Intensity Functional Resistance Training

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Introduction: Moderate intensity continuous exercise (MICE) and resistance training (RT) produce immediate reductions in blood pressure (BP), which persist for ~24hr; termed post-exercise hypotension (PEH). High intensity functional resistance training (HIFRT) has increased in popularity, however, the magnitude of PEH following HIFRT has yet to be quantified. **Purpose:** To assess the acute BP responses to a single bout of HIFRT. **Methods:** Participants (n=19 [13 male, 6 female, 174.7 ± 7.8 cm, 77.92 ± 13.7 kg, 25.8 ± 6.5 yr, with training experience of 3.5 ± 1.3 y) performed a standardized HIFRT workout (1-mile run, 100 pull-ups, 200 push-ups, 300 body weight squats, and a final 1-mile run) as fast as possible. Systolic BP (SBP), diastolic BP (DBP), and mean arterial pressure (MAP) were measured: immediately pre- (baseline), immediately post-, 24 hours post-, and 48 hours post-exercise. **Results:** Average HIFRT duration and intensity were 56.9 ± 11.6 min and 75.2 ± 5.5% of age predicted heart rate max, respectively. Average resting BP was considered normal to elevated (121.8 ± 2.6, 76.3 ± 1.9 mmHg). Immediately post HIFRT, BP decreased from baseline (-14.1 ± 2.9, -4.9 ± 1.1 mmHg; both $p = .001$). 24hr post HIFRT, BP decreased from baseline (-7.6 ± 1.9, -5.8 ± 1.8 mmHg; both $p < 0.004$). 48hr post, BP decreased from baseline (-6.1 ± 2.1, -4.5 ± 1.4 mmHg; both $p < 0.005$). Similar results were seen for MAP at immediately post (-8.0 ± 1.4 mmHg, $p < .001$), 24hr post (-6.4 ± 1.7 mmHg, $p = .007$), and 48hr post (-5.0 ± 1.4 mmHg, $p = .009$) **Conclusion:** The present study demonstrated clinically meaningful reductions in BP persisting for 48 hours following a single bout of HIFRT. It is recommended that the next studies incorporate a larger sample with hypertension stage 1 to 2 to confirm these novel findings and determine whether HIFRT translates to better BP control than MICE/RT alone.

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Cancer Survivor Muscular Strength Comparison to Apparently Healthy Population Normative Data

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Muscle atrophy and dysfunction are common side effects of cancer and cancer treatments that result in severely diminished muscular strength. A common measure of muscular strength is strength to weight ratio (SWR). However, cancer specific normative data for SWR do not exist. Apparently healthy population SWR values are currently used as the only comparative measure for the cancer population. With increasing use of exercise-based rehabilitation in the cancer population, it is important to establish cancer-specific SWR values to appropriately classify these individuals and assess improvements throughout exercise interventions. **Purpose:** To compare SWR values from the cancer population with SWR values for the apparently healthy population. **Methods:** Data from cancer survivors (n=389) encompassing various cancer types across different stages were used for this study. Upon referral to a 12-week exercise rehabilitation program, participants completed assessments to estimate their one repetition max (1RM) for both chest press and leg press. Upper and lower body 1RM were used to calculate SWR by dividing 1RM by body weight. SWR values were then divided into categories by sex and age. Upper body and lower body were categorized into five different age groups (<30, 40-49, 50-59, 60-60, 70+) for both sexes, for a total of 20 different age/sex groups. SWR values from cancer survivors were then compared to normative SWR values from the apparently healthy population provided by the American College of Sports Medicine. **Results:** Upper body SWR classifications for the cancer population resulted in all age groups placing in the “very poor” category for both sexes. Lower body SWR values placed 9 of 10 groups into “well below average” with one group categorized as “average”. **Conclusion:** SWR normative data in the apparently healthy population are not sensitive enough to detect categorical improvements in strength resulting from exercise training in the cancer population, which translates into consistently lower classifications. Poor classifications and lack of improvement may lead to patient discouragement and an inability to measure intervention efficacy in this population. These data provide support for the need to establish cancer-specific normative strength data.

FITNESS TESTING IN LAW ENFORCEMENT OFFICERS: A CRITICAL REVIEW

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PURPOSE: The ability to perform physically demanding tasks is an expected requirement for law enforcement officers due to the unpredictable events that can occur in the policing profession. For this reason, it is suggested, and in some instances is a requirement, for law enforcement officers to undergo fitness testing to ensure they are prepared for the physical nature of their occupation. The aim of this review was to critically appraise research studies employing various fitness testing that law enforcement recruits complete, with an aim to inform on the use of fitness testing in an occupational setting.

METHODS: A comprehensive search of literature was conducted by two authors (MZ & JW) independently using four databases (PubMed, Embase, CINAHL, SPORTDiscus) known to generate search results related to this topic of research. After duplicate articles were removed, articles that did not meet the pre-determined inclusion criteria and met the exclusion criteria were also removed. The remaining studies were critically appraised using a Downs and Black Checklist independently by two authors (MZ & JW). Cohen's Kappa coefficient was used to measure the level of agreement between appraisers and calculated by a third author (RO). The grading system proposed by Kennelly was used to grade the methodological quality of the studies with the relevant information from the studies extracted.

RESULTS: From an initial 7384 identified studies, 11 studies met the criteria for review. The mean critical appraisal score for the articles was 74.36% ($\sigma=1.48$) being considered 'good' quality. There was a 'substantial' level of agreement between the two authors with a Cohen's kappa of $k=0.75$. The most common measures of fitness assessed amongst the 11 articles were endurance and aerobic capacity. The most common measures assessed were muscle endurance (push-ups and sit-ups) and aerobic capacity (running). The least common measure was agility. Push-up and the 2.4-km (1.5-mile) run testing had the strongest correlations to law enforcement academy graduation across the studies. Grip strength may predict occupational performance (marksmanship) as well as longevity.

CONCLUSION: This review concluded that the push-up and 2.4 km (1.5-mile) run fitness tests had the strongest positive correlation to law enforcement academy graduation. While these findings may be institutional specific (i.e. if this academy completes a high volume of push-ups and running these variables may be of greater importance to success), they highlight the need for these measures to be optimal prior to starting academy training and the potential use of barrier tests of these measures prior to acceptance

The Use of Fitness Testing to Predict Occupational Performance In Tactical Personnel: A Critical Review

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Abstract:

PURPOSE: To identify, analyse and synthesise research studies that examined the correlation between fitness tests and occupational task performance in tactical personnel (police, fire, military).

METHODS: Search terms were developed based on relevant keywords. A list of preliminary studies was identified through a search of key databases (Pubmed, EMBASE, and Ebscohost [CINAHL and SportDiscus]). Duplicates were removed during the screening process, and inclusion and exclusion criteria were applied. Three authors (JS, TS, JM) evaluated study quality using a Critical Appraisal Skills Program (CASP) Cohort Study Checklist and Krippendorff's Alpha was used to determine inter-rater reliability by a fourth author (RO).

RESULTS: From an initial 1378 studies, 15 studies were included and critically appraised with their relevant study characteristics extracted and analysed. The means critical appraisal score for all studies was $8.4 \pm 1.2/12$ ranging from 6.33 to 10.0. The Krippendorff's Alpha analysis showed the level of agreement among three raters were 80% (κ alpha=0.797). The most common fitness measures used in the study were muscular strength and aerobic capacity, followed by muscular power, anaerobic capacity, flexibility, and agility. Aerobic capacity was the most correlated fitness attribute with various occupational measures in nine of the 11 studies that included the measure.

CONCLUSION: A wide range of fitness tests are required to predict occupational performance in tactical populations. Aerobic capacity was the most strongly correlated fitness attribute with occupational performance. Other appropriate fitness measures included: muscular strength, endurance, and power; agility; and anaerobic capacity. Further research of standardised fitness tests and their relationship to specific occupational performance will assist with employment standard and training protocols for tactical populations.

QUANTIFYING PERISHABILITY IN SKILLS: A CRITICAL REVIEW

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PURPOSE: Every job or workplace requires a unique skill set, with new skills developed and old skills reviewed. Depending on the tasks required for different jobs some skills are conducted daily and others infrequently. Workplaces however, require employees to maintain skills at a high level. If retraining does not occur, skills can decline reducing the capacity to execute skills at a high level. The aim of this critical review was to identify, critically appraise and synthesize key findings from the current body of literature that explores the perishability of skills within different workplaces. **METHODS:** Search terms were developed, and a systemic search was done using the key data bases (Pubmed, CINAHL, SportDiscus). Inclusion and exclusion criteria were then applied to further ensure relevant articles were included in the review. Included studies were critically appraised, using the downs and black checklist, and a level of evidence was determined. The relevant data was extracted and synthesized. **RESULTS:** Fifteen studies were included for review and ranged in percentage quality scores from 50% to 83.9% with a mean of 65.5%. Substantial interrater agreement ($k=0.747$) existed between raters. A variety of workplace skills were examined including ECG interpretation, basic and advanced life support, laparoscopic surgical skills and motor skills in pianists. However, there was a high variety in the retention intervals, measures and their protocols. Results reported that experts in laparoscopic surgery, who were defined as a person that has performed >200 procedures during the past 3 years, were able to retain their skills over a long-time interval without training, however, novices' skills deteriorated over a shorter time interval without training. **CONCLUSION:** Though skill perishability is varied from skill to skill, there is no clear research to identify the exact degree of skill decay when additional skill retention factors and skill complexity are considered. It is clear from this review that refresher training, particularly for novices, should be performed regularly to combat skill perishability.

The Use of Fitness Testing to Predict Survivability in Selection of Specialist Tactical Personnel

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Purpose: Special Weapons and Tactics (SWAT) personnel are highly-trained individuals who possess skills that exceed capabilities and training level of general law enforcement or military personnel. To be selected into a specialist unit, candidates must typically complete some form of selection testing which assesses the candidate's ability to meet a stringent physical fitness standard and as well as their suitability for specialist service. The aims of this critical review were to identify, critically appraise and to synthesise the findings of current literature on the use of fitness testing to predict specialist personnel selection and to present their findings.

Methods: A systematic review was completed from three (Pubmed CINAHL and Medline) databases known for publishing studies or relevance to this field. Strict inclusion and exclusion criteria were applied. All studies were critically appraised using the CASP cohort study checklist with the interrater agreement calculated via Krippendorff's Alpha coefficient. The final Critical Appraisal Scores (CAS) of the CASP were calculated by the averaging of the three rater scores for each paper (out of twelve).

Results: The mean CASP score of the eight selected studies was 10.8 ± 1.4 points (range 8-12 points). The Krippendorff's alpha indicated a strong agreement between the three raters ($k_{\text{alpha}} = 0.733$). It was found in four out of the eight studies that push-ups, pull-ups and/or sit-ups were statistically significant predictors of successful selection. Additionally, five studies reported that aerobic fitness measures were indicative of success (bleep test, 2-mile run and loaded pack march).

Conclusion: The literature review concluded there were conflicting results as to what fitness measures could predict selection into the specialist team. This may be due to the specifics of the selection process where different requirements may influence the fitness measures of importance (e.g. pack march a greater indicator if the selection processes includes a high volume of loaded walking). However, upper body and trunk strength and endurance were identified as successful predictors of successful selection as was aerobic capacity. Additional research is required to develop a battery of fitness assessments, specific to each unit, to improve the selection process for specialist tactical personnel.

QUANTIFYING PERISHABILITY IN SKILLS: A CRITICAL REVIEW

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PURPOSE: Every job or workplace requires a unique skill set, with new skills developed and old skills reviewed. Depending on the tasks required for different jobs some skills are conducted daily and others infrequently. Workplaces however, require employees to maintain skills at a high level. If retraining does not occur, skills can decline reducing the capacity to execute skills at a high level. The aim of this critical review was to identify, critically appraise and synthesize key findings from the current body of literature that explores the perishability of skills within different workplaces. **METHODS:** Search terms were developed, and a systemic search was done using the key data bases (Pubmed, CINAHL, SportDiscus). Inclusion and exclusion criteria were then applied to further ensure relevant articles were included in the review. Included studies were critically appraised, using the downs and black checklist, and a level of evidence was determined. The relevant data was extracted and synthesized. **RESULTS:** Fifteen studies were included for review and ranged in percentage quality scores from 50% to 83.9% with a mean of 65.5%. Substantial interrater agreement ($k=0.747$) existed between raters. A variety of workplace skills were examined including ECG interpretation, basic and advanced life support, laparoscopic surgical skills and motor skills in pianists. However, there was a high variety in the retention intervals, measures and their protocols. Results reported that experts in laparoscopic surgery, who were defined as a person that has performed >200 procedures during the past 3 years, were able to retain their skills over a long-time interval without training, however, novices' skills deteriorated over a shorter time interval without training. **CONCLUSION:** Though skill perishability is varied from skill to skill, there is no clear research to identify the exact degree of skill decay when additional skill retention factors and skill complexity are considered. It is clear from this review that refresher training, particularly for novices, should be performed regularly to combat skill perishability.

Title: The Impact of Fitness Levels on Marksmanship: A critical narrative review

Authors: Hannah Muirhead¹, Sasha Birge¹, Robin Orr^{1,2}, Ben Schram^{1,2} & Jay Dawes³

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PURPOSE: The occupational demands of a police officer can vary between two divergent roles; one being more sedentary and the other including physically challenging field based manual tasks. With the high risk nature of this occupation, police officers are also expected to accurately aim and fire a weapon if needed. The aim of this critical review was to identify, critically appraise and synthesize the key findings of studies that investigated relationships between levels of fitness against marksmanship ability. **METHOD:** Using key words, academic databases were searched with identified studies subjected to dedicated inclusion and exclusion criteria. Included studies were critically appraised using a modified Downs and Black checklist, and a level of evidence was determined. Relevant data were extracted, tabulated and synthesized. **RESULTS:** From an initial 1450, eight studies were included for review. With a mean appraisal score of $68.5 \pm 9.3\%$ (range: 53.6% - 80.4%), there was a substantial interrater agreement ($k = 0.642$) between raters. A variety of fitness measures were used prior to marksmanship tasks, with the most common measure ($n = 7$) being grip strength. In four studies, grip strength was found to be significantly correlated with marksmanship. **CONCLUSION:** Although there currently exists a variety of fitness measures and fitness levels among police agencies and police officers, it is important to monitor and maintain grip strength ability in officers for the safety of the officer, their colleagues and the general public.

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Capability of Fitness Testing to Predict Injury Risk During Initial Tactical Training: A Systematic Review and Meta-Analysis

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PURPOSE: Individuals in tactical professions (military, law enforcement, firefighting) are often required to complete physically demanding tasks on a regular basis and as such, should maintain sufficient fitness to complete these tasks safely and effectively. Physical training, which is necessary for personnel to meet the above demands, is often a challenge for tactical institutions due to its potential association with injury, especially in less fit trainees (who are most in need of conditioning to meet requirements). Identifying trainees most susceptible to injury and proactively intervening could prevent lost time due to injury, consequent attrition, and associated fiscal costs. Therefore, the aim of this review was to identify studies that have investigated relationships between fitness measures and injury incidence, appraise the methodological quality of selected studies, draw cross-study conclusion, and describe the findings to inform tactical training facilities.

METHODS: Of the 1199 studies identified in the initial search, 28 studies met the *a priori* criteria for review. The Critical Appraisal Skills Programme (CASP) toolkit was used to assess quality. Meta-analysis was performed on studies reporting on a fixed-distance, timed run event with categorical risk or hazard ratio data.

RESULTS: The mean CASP scores were 10.6/12(9-12) for cohort studies and 9.5/10(9-10) for case-control studies. The final combined risk ratio for run performance was 2.27 (95% CI=1.96-2.63), indicating a substantial increase in injury risk for individuals performing in the bottom half or lower in comparison with trainees in the upper half or higher. Muscle strength tests were consistently effective predictors of injury, but only three studies included a true strength test in their design. Other tests were predominantly muscle endurance (push-ups, sit-ups/crunches, and pull-ups/chin-ups), and were less conclusive in their ability to effectively predict injury.

CONCLUSION: Individuals who perform poorly on a timed run, in particular, are at greater risk of injury than fitter peers when undergoing tactical training. Fitness test results could be used as a reliable means of identifying trainees at greater risk of injury for proactive intervention but further research specific to the training environment is needed.

**ANTHROPO-MORPHOLOGICAL AND PERFORMANCE RELETED DIFFERENCES
BETWEEN POLICE COLLEGE CADETS AND POLICE EMPLOYEES**

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ABSTRACT

PURPOSE: Anthro-morphological and performance characteristics are crucial components for successful performance of police duties. These characteristics have been found to decrease after the police academy or college. Thus, this research aimed to evaluate differences between police cadets (PC) and regular police employees (PE) of similar age.

METHODS: The sample consisted of 79 PC (age=22.24±0.91 yr., mean body mass [BM]=69.23±8.32 kg and mean body height [BH]=173.81±5.66 cm) and 71 PE (age=22.72±0.51 yr., BM=74.96±11.36 kg and BH=173.03±5.69 cm). Anthro-morphological and performance differences were analyzed using independent sample t-test (p<0.05). Eight variables were evaluated: BM, BH, body mass index (BMI), waist circumferences (WC), waist-to-height-ratio (WHtR), 1-minute push-up (PU), 1-minute sit-up (SU) and 2.4 km running (RUN).

RESULTS: The differences between PC and PE are presented in **Table 1**.

Variable (unit)	t	df	Sig.	Mean Diff.	SE	CI 95%	
						Lower	Upper
BM (kg)	3.485	127.17	0.001*	5.72	1.64	2.47	8.97
BH (cm)	-.843	148	0.401	-0.78	0.93	-2.62	1.05
BMI (kg/m²)	4.045	120.96	0.001*	2.13	0.53	1.09	3.17
WC (cm)	5.318	113.91	0.001*	7.24	1.36	4.54	9.94

WHtR (cm/cm)	5.496	114.37	0.001*	0.04	0.01	0.03	0.06
PU (repetition)	-6.641	119.95	0.001*	-12.92	1.94	-16.77	-9.06
SU (repetition)	-7.538	148	0.001*	-10.02	1.33	-12.64	-7.39
RUN (sec)	9.772	93.41	0.001*	139.28	14.25	110.98	167.58

* significant difference (p<0.05)

CONCLUSIONS: The study shown that physically active PC significantly differ from the PE in both, anthro-morphological and performance characteristics, suggesting that regular physical training and annual or bi-annual body composition assessments and performance testing should be a standard in law enforcement agencies. Means of controlling BM, WC and WHtR and maintaining, if not increasing, fitness for PE following police academy training should also be investigated

ACKNOWLEDGEMENT

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ASSOCIATION OF FREQUENCY AND VOLUME OF PHYSICAL ACTIVITY WITH BODY FATNESS OF POLICE OFFICERS

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ABSTRACT

PURPOSE: Body fatness is associated with physical performance and health of police officers (PO). However, the frequency (FPA) and volume of physical activity (VPA) have not been extensively investigated in PO. Thus, the aim of this study was to examine the potential effects of FPA and VPA on body fat measures of PO.

METHODS: The sample consisted of 346 PO, among which 81 from Abu Dhabi police and 265 from Serbian police force. A physical activity scale questionnaire was used to collect the data regarding the weekly FPA and VPA. Participants were divided into four groups: inactive (IA), active (FA), moderately active (MA) and very active (VA). Percent of body fat (PBF), body mass index (BMI) and index of hypokinesia (IH) were assessed and multivariate analysis of variance (MANOVA, $p < 0.05$) was used to analyze the differences between physically more and less active PO.

RESULTS: Body fatness was associated with FPA and VPA (**Table 1**).

Table 1. The MANOVA's Bonferroni post-hoc results for the absolute mean differences (AMD) in body fatness related to physical activity level.

Variable	Factor	IA vs	IA vs	IA vs	FA vs	FA vs
		FA	MA	VA	MA	VA
		(AMD)	(AMD)	(AMD)	(AMD)	(AMD)
BMI (kg/m ²)	FPA	2.96***	3.37***	3.53***		
	VPA	2.7***	3.14***	4.11***		

PBF (%)	FPA	5.03***	9.28***	8.25***	4.25***	3.22*
	VPA	5.04***	8.09***	9.91***	3.05*	4.81***
IH (index unit)	FPA	0.09*	0.24***	0.19***	0.15***	0.10*
	VPA	0.10*	0.21***	0.24***	0.11***	0.13**

Significance set to $p < 0.05$. AMD – absolute mean difference, *significant on $p < 0.05$, **significant at $p < 0.005$, ***significant at $p < 0.001$

CONCLUSIONS: Both, FPA and VPA strongly affected BMI, PBF and IH, suggesting that FPA and VPA play a fundamental role in maintaining a healthy level of body fatness of PO.

ACKNOWLEDGEMENT

The paper is a part of the project III47015, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia – Scientific Projects 2011 – 2019.

Effects of Ischemic Preconditioning on Performance, Lactate, Lipids, and Oxygen Saturation in Trail Marathon Runners.

Authors: Cody Rapley, Mackenzie Kehmeier, Aspen Heale, and Doug Eby

Faculty Advisors: Christina Buchanan and Michelle Conway

Ischemic preconditioning (IPC) is the process of blood occlusion and reperfusion to the limbs using an inflated cuff. **Purpose:** The purpose of this study was to examine the effect of IPC on the performance of trail marathon runners in the Moab Marathon. **Methods:** Seven participants, six trained trail marathon runners and one trained runner completed the study. The participants underwent baseline testing that included lipid profile, blood lactate concentration, and VO_2max testing. The VO_2max testing included an incremental maximal effort treadmill test until volitional fatigue. The VO_2max scores, measured as ml/kg/min, were used to match the participants then they were randomly assigned to receive either IPC or placebo treatment approximately 40 hours prior to the start of the Moab Marathon. Measurements of oxygen saturation, heart rate, rate of perceived exertion (RPE), and lactate levels were taken pre-, mid- (9.6 miles), and post-race. Finish times were recorded upon completion of the race. **Results:** No significant differences were found for oxygen saturation, heart rate, RPE, or lactate levels between the IPC and placebo treatment. **Conclusion:** IPC had no impact on the performance of trail marathon runners at the Moab Marathon.

Cardiovascular, Cellular, and Neural Adaptations to 4-weeks of Hot Yoga Compared to Normal Temperature Yoga.

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Heat stress requires a marked hemodynamic response that is necessary for adequate temperature regulation. Chronic heat exposure results in cardiovascular and cellular adaptations that improve an organisms' ability to handle subsequent heat stressors. Heat exposure may also promote neural adaptations including neurogenesis. Hot temperature yoga has grown in popularity and combines mind-body exercise with heat exposure. While normal temperature yoga has been shown to promote neural adaptations, the added heat component in hot temperature yoga may induce cardiovascular and cellular changes, along with the neural benefits. **PURPOSE.**

Therefore, the purpose of the present study is to compare the cardiovascular, cellular (e.g., HSP70), and neural adaptations of hot temperature yoga and normal temperature yoga.

METHODS. Eighteen subjects (males = 10, females = 8, 27 ± 6.02 years) completed 4-weeks of normal (n= 8) or hot (n=10, 41°C, 40% humidity) temperature yoga. The yoga sessions were performed 3 times/wk following a modified Bikram protocol. Pre- and post-testing included: 1. Hemodynamic measures during heat tolerance and maximal aerobic fitness testing; 2. Neural adaptations using serum levels of brain derived neurotrophic factor (BDNF) and adrenocorticotrophic hormone (ACTH), along with a mental stress questionnaire.

PRELIMINARY RESULTS. Maximal aerobic fitness increased in the hot yoga group only (3.25 ± 0.80 vs. 3.51 ± 0.82 ml.kg.min⁻¹). No evidence of heat acclimation (heart rate, core temperature changes) was observed. Preliminary serum BDNF results (n = 15) showed a trend towards a significant increase (p = .06) in both yoga groups combined. Analysis of HSP70 in peripheral blood mononuclear cells (PBMC) (n = 15) suggested higher expression of HSP70 in the hot yoga group only. **CONCLUSION.** Twelve sessions of hot temperature yoga promoted both cardiovascular fitness and cellular thermotolerance adaptations in healthy humans. Serum BDNF, a marker of neural plasticity, increased in response to yoga (normal + hot temperature yoga), and appeared to not be temperature dependent.

Validation of Heart Rate Measurement and Energy Expenditure Calculation of Wrist-Worn and Arm-Worn Apple Watches

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PURPOSE: The purpose of this study was to examine the validity of heart rate (HR) and energy expenditure (EE) measured with the Apple Watch Series 1 worn both on the wrist, as well as the upper arm. **METHODS:** Thirty healthy, young adults (15 females, 15 males) wore the two Apple Watches, one on the wrist and one on the upper arm, while participating in the Bruce treadmill maximal exercise test. Criterion measures were obtained from the Parvo Medics TrueOne 2400 Metabolic Cart for EE, and an electrocardiograph (ECG) for HR. Exercise intensity was calculated using the heart rate reserve calculation. Data were analyzed using repeated measures ANOVA, Cohen's d, and relative error rates (RER) to determine differences between the arm-worn (AW) Apple Watch, the wrist-worn (WW) Apple Watch, and the criterion measures. Scatterplots and Lin's Concordance Coefficients were used to determine the strength of correlation between the watch and criterion values. **RESULTS:** The HR measurements of the AW had the highest agreement with the ECG, with RER less than 1% for the overall sample, for males, and for females, at all exercise intensities. There were no statistical differences between the ECG measurements and the AW for HR and Cohen's d effect sizes were medium (0.54) or lower. The HR measurements of the WW had RERs ranging from 0.61% (overall sample at very light intensity) to 7.12% (males at very vigorous intensity). For this device, Cohen's d effect sizes ranged from small (0.08 for the overall sample at very light intensity) to large (0.72 for females at very vigorous intensity). For estimating total exercise bout EE, the RER was lowest for the AW at very low intensity (2.00%) and highest for males at very high intensity (43.49%). The WW had RERs of 8.34%, 20.27%, and 16.81% for the overall sample, females, and males, respectively. **CONCLUSIONS:** Wearing the Apple Watch Series 1 on the upper arm improves the RER for HR measurements, but does not improve the EE calculations of this device when compared to a criterion measure. Individuals requiring very

precise exercising HR measurements may benefit from using the Apple Watch device on the upper arm; however, users should be aware of the error that is inherent in the EE calculations, regardless of the watch placement.

How Can We Sustain Community-Based Exercise Programs for Cancer Survivors?

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Purpose: Community-based exercise programs for cancer survivors demonstrate positive impacts on physical function and quality of life. However, long-term sustainability of these programs is a challenge, and a gap in the literature. This study used a qualitative approach to summarize literature describing barriers and facilitators to sustaining community-based exercise programs for cancer survivors.

Methods: A systematic literature search was used to identify community-based exercise programs for cancer survivors, published in peer-reviewed journals between 1980-March 2018. Program characteristics were reported as Means (SD) or frequencies using SPSS. Barriers and facilitators were extracted from each publication by two coders. Themes were identified deductively, then coded and analyzed using word frequency query in Nvivo. Themes were reported as either a barrier or a facilitator (e.g., having funding vs. not having funding).

Results: Studies that met inclusion criteria ($N=31$) were held mainly at a community-based fitness facility ($n=11$, 35.5%) or wellness center ($n=12$, 38.7%). Most programs ($n=17$, 54.8%) held supervised exercise sessions twice weekly for $M=12.6\pm 5.6$ (3-30) weeks. Themes included: infrastructure (facility, funding, stakeholder support), program design (eligibility criteria, exercise/education format, data collection), and dissemination. The most frequently reported barriers included: data collection issues, strict exclusion criteria, and lack of funding or stakeholder support). Common facilitators included: centrally located and dedicated facilities; grant funding; stakeholder support; broad eligibility criteria; program duration ≥ 8 weeks; low participant cost; trained personnel; appropriate safety precautions, and combined exercise and education in a group format.

Conclusion: This review found that infrastructure, program design and dissemination are critical factors that can hinder or support sustainability of community-based exercise programs for cancer survivors. To enhance long-term sustainability, future programs should utilize convenient and appropriate facilities, broad inclusion criteria, and low participant costs; additionally, efforts should be focused on obtaining funding and support from stakeholders.

Title: Indoor vs. Outdoor VO₂max: Understanding the Impact of Environment on Maximal Exercise

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Abstract:

Green and outdoor exercise are linked to advantageous physiological markers when compared to indoor exercise. Previously published research examining green exercise has utilized low and moderate intensity exercise (50% heart rate reserve). However, lesser known, is the effect of green exercise on maximal oxygen uptake (VO₂max). **PURPOSE:** The purpose of this study was to compare indoor and outdoor VO₂max values in athletic college-aged individuals. **METHODS:** Using a randomized, counterbalanced design, 11 healthy individuals (10 males, 1 female, 23.0 ± 3.6 years, 180.5 ± 3.2 cm, 68.4 ± 15.1 kg) completed an indoor or outdoor VO₂max test on a treadmill, followed by the opposite condition three to seven days later. The tests began with a self-selected speed and increased by 1.0% incline each minute until the participant reached 10%. Thereafter, the speed was increased by 0.5 mph per minute until volitional fatigue. Following the tests, participants were instructed to walk at 2.0 mph and 0% incline for five minutes to measure recovery. **RESULTS:** Mean VO₂max outdoors (58.3 ± 8.5 mL/kg/min) was found to be significantly lower than indoors (60.9 ± 7.3 mL/kg/min) (p=0.01). Recovery heart rate was significantly lower outdoors (112.3 ± 11.2 bpm) compared to indoors (117.4 ± 11.1 bpm) (p=0.025). VO₂ recovery was significantly lower outdoors (17.1 ± 2.8 mL/kg/min) than indoors (20.4 ± 2.9 mL/kg/min) (p=0.022). Maximal respiratory exchange ratio was significantly higher outdoors (1.34 ± 0.20) than indoors (1.23 ± 0.10) (p=0.04). Ventilatory threshold one was significantly lower outdoors (41.7 ± 5.3 mL/kg/min) than indoors (45.11 ± 5.44 mL/kg/min) (p=0.005). **CONCLUSION:** This study indicates that VO₂max values are lower outdoors compared to indoor values and overall recovery may be improved outdoors compared to indoors.

Impact of insufficient sleep on insulin sensitivity in sedentary versus active volunteers

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Purpose: Insufficient sleep impairs insulin sensitivity and metabolic dysfunction; however, no countermeasures exist to these impairments. Exercise is a modifiable behavior that improves insulin sensitivity. We therefore sought to examine the potential of exercise to mitigate impaired insulin sensitivity during insufficient sleep in active versus sedentary volunteers.

Methods: Eleven sedentary (SED: 6F, 24.9±4.2y, 22.3±1.7kg/m²; mean±SD) and 11 physically active (PA: 6F, 23.5±3.3y, 22.0±2.3kg/m²) participants completed a 6-day inpatient protocol. Subjects maintained a 9-hour sleep schedule at their habitual time for one week prior to the inpatient laboratory stay. An oral glucose tolerance test (OGTT) was conducted at baseline and after 3 nights of 5h sleep opportunity/night achieved by delaying bedtime by 4h to maintain habitual wake time. Sleep was recorded each night by polysomnography and scored using standard methods. PA participants continued to exercise during insufficient sleep by conducting 60 minutes of moderate exercise (treadmill running) at 65-75% of maximum heart rate, as assessed by VO₂ max testing during screening and confirmed by heart rate monitors during exercise. Exercise was conducted 8.5h after wake time in each participant. To control for light exposure, SED participants were brought to the same treadmill room for 60 minutes at the same time relative to wake where they could read or watch television.

Results: Insulin sensitivity was reduced following 3 nights of insufficient sleep in both active (-9.2±7.8%; p<0.05) and sedentary participants (-24.2±9.4%; p<0.05), as determined by the Matsuda Insulin Sensitivity Index. Though not statistically significant, active participants had a trend for a smaller reduction in insulin sensitivity during insufficient sleep (p=0.09).

Conclusions: Daily, moderate exercise is not sufficient to fully protect against the metabolic impairments associated with insufficient sleep.

Resistance exercise and doxorubicin treatment: effects on antioxidant enzyme expression in type II muscle

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Doxorubicin (DOX) is a chemotherapy drug used to effectively treat a variety of cancers. Its clinical use, however, is limited by its toxicities commonly attributed to increased oxidative stress in cardiac and skeletal muscle. The DOX-induced rise in oxidative stress can quickly overwhelm endogenous antioxidants yet exercise (both endurance and resistance) has shown promise in attenuating this decline. Little information, however, is available on how DOX and resistance exercise affect antioxidant enzymes in type II skeletal muscle. **PURPOSE:** To determine the effects of resistance training before and during DOX treatment on superoxide dismutase (SOD) 1 and SOD2 expression in the primarily type II EDL muscle. **METHODS:** Thirty-six male Sprague-Dawley rats were randomly assigned to one of four groups: sedentary+saline (SSS), sedentary+DOX (SSD), resistance training+saline (RRS), or resistance training+DOX (RRD). The resistance training protocol incorporated a raised cage model where food and water were elevated progressively which provided hind limb loading 10 weeks prior to DOX injection and 4 weeks during DOX treatment. Groups treated with DOX received 3 mg/kg DOX weekly for 4 weeks (12 mg/kg cumulative), and saline-treated groups received 0.9% NaCl as a placebo. Five days following the final DOX or saline injection, EDL muscles were excised, and Western blotting was performed to quantify SOD1 and SOD2 expression. **RESULTS:** Although no significant drug effects, activity effects, or drug x activity interactions were observed with SOD1 and SOD2 expression ($P > 0.05$), a trend toward SSD expressing less SOD1 and SOD2 than SSS was observed (-25% and -37%, respectively). This same trend in SOD1 and SOD2 expression, however, was not observed in RRD (+3% and -3%, respectively vs SSS). **CONCLUSION:** The DOX dosing regimen used in the current study had no effect on SOD1 and SOD2 expression in the EDL muscle, and the resistance training protocol also did not affect SOD1 and SOD2 expression. These results suggest that resistance exercise may play a limited role in modulating oxidative stress of DOX in type II skeletal muscle.

Longitudinal Associations of Physical Activity with Motivation and Physical Activity Planning among Emerging Adults

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PURPOSE: Physical activity (PA) is negatively associated with the risk for obesity-related diseases. Only 25% of adolescents engage in the recommended amount of PA, indicating the need for a better understanding of potential behavioral determinants, such as motivation and planning. **METHODS:** This study used data from the NEXT Generation Healthy Study (NEXT), a nationally representative study of adolescents, to examine longitudinal relations of PA participation among emerging adults with intrinsic motivation, extrinsic motivation, and PA planning. The NEXT study administered yearly surveys, beginning in 10th grade. This study used data from Waves 2 (11th grade) through 7 (4 years post-high school). Growth models examined the longitudinal effects of time-invariant (sex, race, affluence, and BMI) and time-varying (intrinsic and extrinsic motivation and PA planning) covariates on PA participation using a piece-wise approach to account for the U-shaped trajectory of PA participation. Model fit was tested using log likelihood difference tests, RMSEA, and BIC, and accounting for complex survey features. **RESULTS:** The two-piece final model indicated: 1) PA declined from W2 – W4 ($b=-0.37, p<.05$) and increased from W4 – W5 ($b=-0.04, p=.19$); 2) at W2, females ($b=-0.83, p<.05$) and Blacks ($b=-0.48, p<.05$) demonstrated significantly lower PA compared to males and Whites, respectively; and 3) in W4 – W7, participants with low ($b=-0.19, p<.05$) or high ($b=-0.22, p<.05$) affluence demonstrated significantly smaller declines in PA compared to those with moderate affluence. Increased intrinsic motivation significantly predicted increased PA across all waves ($b: 0.09-0.36, p<.05$). Increased extrinsic motivation significantly predicted increased PA at W6 ($b=0.13, p<.05$) and W7 ($b=0.22, p<.05$) only. PA planning significantly varied between individuals ($b=0.40, p<.05$). **CONCLUSION:** Our findings indicate the transition from adolescence to early adulthood marks a low point in PA participation and may be an important timeframe for addressing PA participation. Intrinsic motivation and PA planning had a greater association with longitudinal PA participation than extrinsic motivation, suggesting that these may be useful to prioritize as intervention targets during this adolescence-into-adulthood transition.

A Comparison of Physical Activity Behaviors and Sleep in Female NCAA Division-I Athletes versus Controls

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Physical activity behaviors and sleep patterns influence health in the general population but have not been evaluated in collegiate student athletes. For these individuals the demands of academics and athletics alter these parameters but have not been fully characterized or compared to students who are not collegiate athletes.

Purpose: This study compared physical activity (PA) behaviors and sleep patterns of female NCAA D I student-athletes (Athletes) to recreationally active female students (Controls).

Methods: Across three consecutive semesters, subjects were recruited for one to three weeks of monitoring. Sleep was monitored with Actiwatches. PA was monitored using ActivPals. Forty-five females were recruited from the University of Colorado, Boulder. Athletes were recruited from the Golf (n=6) and Tennis teams (n=8). Controls were recruited from the general student body (n=31). Subjects were instructed to wear devices at all times except during competitions. Travel days and days with less than 90% waking wear time were removed from analysis. Time spent in Sedentary (SED), Low Intensity (LIT) and Moderate-Vigorous Physical Activity (MVPA) are presented as percent of waking day.

Results: Mean days recorded per individual was: Controls 15.1; golf 10.2; and tennis 15. Compared to Controls, Athletes had higher daily step counts ($12,040 \pm 6498$ vs $8,992 \pm 5240$, $p < .01$), less SED (63.5 ± 15.0 vs 71.4 ± 13.3 , $p < .05$), higher LIT (26.4 ± 12.9 vs 21 ± 10.8 , $p < .05$) and higher MVPA (26.4 ± 12.9 vs 21 ± 10.8 , $p < .01$). For both groups, weekends had higher LIT (+3.0%, $p < .01$), decreased MVPA (-.75%, $p < .05$), and a trend toward decreased SED (-2.3%, $p = .0563$) compared to weekdays. There were no differences in PA between Golf and Tennis. Sleep was not significantly different in Athletes versus Controls, including duration of sleep ($6\text{h}22\text{min} \pm 2\text{h}23\text{min}$ vs $6\text{h}42\text{min} \pm 2\text{h}39\text{min}$, $p = .4$) and sleep midpoint. Yet, midpoint was significantly later on weekends vs. weekdays in both groups ($4:34 \pm 1:18$ vs $4:03 \pm 1:26$, $p < .01$).

Conclusion: Female Athletes had higher physical activity demands than Controls. Yet both groups, on average, slept less than the American Academy of Sleep Medicine recommended 7-hours. This may negatively impact overall health. Research is needed on how these sleep and activity behaviors influence academic and athletic outcomes.

Relationship between hepcidin, Interleukin-6, and Ferritin in Division-I Cross-Country runners over a competitive season

Jesse A. Goodrich, Sewan Kim, Dillon J. Frisco, Kimberly Detwiler, Miguel Rueda, Sourav Poddar, William C Byrnes

Iron deficiency, which can be assessed by the iron storage protein ferritin (fer) can negatively affect athletic performance. We have previously observed that Division 1 cross country (XC) runners have fer levels that are at the low end of normal ranges despite being iron supplemented. The hormone hepcidin and the cytokine/myokine interleukin-6 (IL6) can both influence iron regulation but have not been evaluated in this population.

Purpose: The purpose of this study was to determine how hepcidin and IL6 change over a season in DI XC runners and determine whether changes in these parameters were related to changes in fer, hemoglobin concentration (Hb) or hematocrit (Hct).

Methods: 45 athletes (25 female, 20 male) were recruited from the University of Colorado DI XC team in the fall of 2017. Fasted blood samples were collected in October (before NCAA XC championships), January, and March (during the outdoor track season). Blood samples were analyzed for Hb, Hct, fer, IL6 and hepcidin. All runners were provided with oral iron supplements from a certified nutritionist during this period.

Results: All biomarkers remained stable across the season except Hb, which was significantly higher in March. In males vs. females, there were no differences in hepcidin (24 ± 11 vs. 21 ± 11 ng/mL; $p > 0.05$) or IL6 (16 ± 21 vs. 12 ± 24 pg/mL; $p > 0.05$). When compared to females, males had higher fer (64 ± 33 vs 47 ± 24 ng/mL; $p < 0.05$), Hct (48 ± 2 vs 44 ± 3 %; $p < 0.001$), and Hb (16.3 ± 0.7 vs 14.8 ± 0.8 g/dl; $p < 0.01$). After controlling for sex, there was a positive relationship between hepcidin and fer ($r = 0.47$, $p < 0.01$); 20% of the variability in fer was explained by hepcidin and 51% was explained by individual variability. There were no relationships between IL6 and hepcidin or IL6 and fer.

Conclusion: Despite a consistent iron supplementation regime, hepcidin, IL6 and fer do not seem to systematically change across a season in collegiate runners. As expected, hepcidin and fer were positively related, but there were no relationships between IL6 and other measured parameters. Although fer was at the low end of normal for both men and women, all other parameters were normal at all time points, suggesting that the normal range of fer for endurance athletes may be lower than the general population.

Comparing total hemoglobin mass between selected NCAA Division I athletes and recreationally active students

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Total hemoglobin mass (tHb) is linearly related to total body mass, however, whether this relationship is altered by lean tissue mass, training or sex remains controversial.

Purpose: To investigate if lean mass is a more appropriate determinant of tHb compared to body mass across NCAA DI athletes and controls. We will also determine if this relationship is altered by sex and/or training status.

Methods: Nordic (6F & 6M) and alpine (5M) skiers, football players (7M) and recreationally active student controls (9F & 10M) from the University of Colorado Boulder participated. The optimized carbon monoxide rebreathing procedure was used to determine tHb. Body composition was determined via DXA. Since female athletes were not present in all groups, statistical analyses were performed for males across all groups and a separate comparison was made between female nordic skiers and control groups.

Results: The overall correlations of tHb with body mass or lean tissue mass were significant ($R^2 = 0.73$ & $R^2 = 0.88$), but the positive relationship was stronger when using lean mass ($p < 0.001$).

For males, body mass and lean tissue mass were greater in football with no significant differences between any other group. Football had a greater tHb compared to control and alpine (1168.7 ± 126.9 vs. 925.9 ± 123.0 & 936.8 ± 151.9 g), but was not different than nordic (1052.5 ± 166.7 g). Nordic tHb was greater than control, but not different from alpine. When tHb was normalized using body mass and lean mass, nordic (14.5 ± 1.5 & 16.5 ± 1.2 g/kg) was greater than football (10.4 ± 0.9 & 14.4 ± 1.5 g/kg), alpine (11.6 ± 1.1 & 14.2 ± 0.6 g/kg) and control (11.8 ± 0.6 & 14.6 ± 0.8 g/kg) groups while no differences between any other groups were found.

For females, body mass, lean tissue mass and tHB (656.4 ± 72.9 vs. 566.1 ± 66.0 g) were not different between nordic and control. When tHb was normalized using body mass, nordic (11.3 ± 0.7 g/kg) was greater than control (9.5 ± 1.0 g/kg), but when tHB was normalized using lean mass there was no difference (14.5 ± 1.1 vs. 13.8 ± 1.4 g/kg).

Conclusion: Lean tissue mass explains a greater amount of variability in tHB compared to total body mass. In males, to examine the effect of endurance training on tHb, it is more appropriate to normalize by lean mass. Additional research is needed when comparing the effects of endurance training between female groups.

Impaired Force Control Contributes to Car Steering Dysfunction in Chronic Stroke

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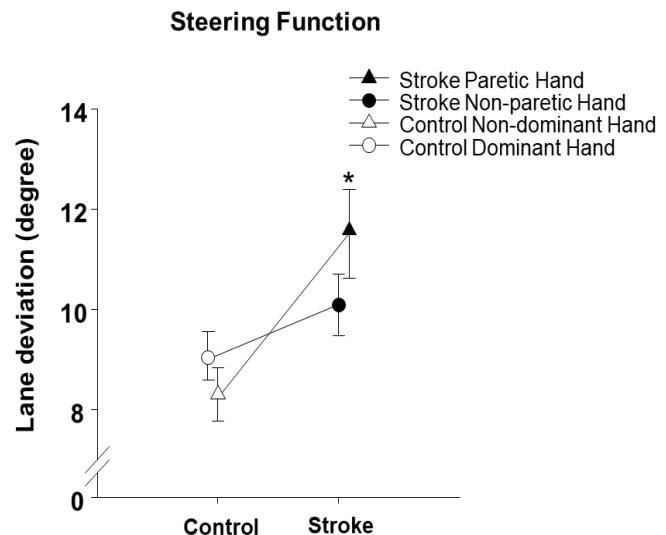
PURPOSE: The purpose of this study was to determine the impact of stroke on car steering and identify the contribution of strength and force control to steer a car following stroke.

METHODS: Twelve chronic stroke (67.04 ± 12.73 years; time since stroke = 6.41 ± 4.25 years) and age-matched controls (70.56 ± 8.12 years) performed three tasks: (1) maximum voluntary contractions (MVC), (2) visuomotor force tracking involving ramp-up and hold phase with isometric submaximal grip force, and (3) a steering task in a simulated driving environment that required maintaining the car in the center of the driving lane. Each task was performed unimanually with both hands. We quantified strength as the maximum force produced during isometric grip task and force control as variability of force output in the ramp-up phase. Steering function was quantified with lane deviation as the extent of deviation from the center of the lane. For statistical analysis, a two-way 2 (groups) \times 2 (hands) mixed model ANOVA was used to compare strength, force control, steering function. In the stroke group, we performed multiple linear regression to determine the contribution of grip strength and force variability of paretic hand to the lane deviation.

RESULT: The stroke group showed significantly reduced paretic grip strength as compared with non-dominant hand in the control group ($p < 0.05$). The force variability of the paretic hand in the stroke group tended to be higher than non-dominant hand in the control group ($p = 0.053$). Further, the stroke group showed increased lane deviation in the paretic hand compared with the non-dominant hand in control group ($p < 0.01$). The multiple linear regression model revealed the force variability of paretic hand significantly predicted lane deviation ($R^2 = 0.64$, $p < 0.05$). Paretic hand grip strength did not predict lane deviation ($p > 0.05$).

LEGEND:

Car steering function was quantified as the extent of deviation from the center of the driving lane. **Figure 1** shows lane deviation result of steering task. Increased lane deviation suggests poor steering function. The paretic hand lane deviation was significantly increased compared with non-dominant hand in the control group revealing paretic hand's poor steering function. Significant differences are indicated by * $p < 0.05$.



CONCLUSION: The steering function of paretic hand is impaired. Furthermore, increased grip force variability contributes to steering dysfunction not the reduced grip strength in chronic stroke. Upper limb motor impairments following stroke negatively impact steering ability by affecting precise control of the steering wheel. These novel findings suggest that rehabilitation interventions should focus on improving force control ability to ameliorate driving deficits and improve functional independence following stroke.

Physical activity is associated with cognitive, social, and emotional function in colorectal cancer patients: the ColoCare Cohort

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ABSTRACT

Purpose: Physical activity can help maintain or improve quality of life in cancer patients. However, which subdomains of quality of life experience improvement remains unclear. The purpose of this study was to assess associations between physical activity prior to undergoing surgery (=baseline) and emotional, cognitive, and social function in colorectal cancer patients through the first year of survivorship.

Methods: Data were obtained from n=344 colorectal cancer patients (stages I-IV) in the ColoCare Heidelberg cohort. Self-reported physical activity levels were assessed at baseline by using the VITAL questionnaire and calculated into metabolic equivalent (MET) hours/week (h/wk). Emotional, cognitive, and social functional scales were determined using the EORTC QLQ-C30 questionnaire at baseline and at 6 and 12 months post-surgery. Spearman correlation and linear regression analyses were performed to quantify associations between physical activity and functional scales at baseline and at 6 and 12 months. Linear mixed models were computed to analyze the association between baseline physical activity levels and changes of functional scales over time. Analyses were adjusted for age, sex, cancer stage, and body mass index.

Results: In average, emotional and social function improved at 12 months compared to baseline and 6 months post-surgery (68.4 ± 24.4 , $p < 0.001$; 74.4 ± 29.9 , $p = 0.003$; respectively). Baseline physical activity levels were moderately correlated with emotional and cognitive function at baseline ($r = 0.16$, $p = 0.005$; $r = 0.16$, $p = 0.004$; respectively) and social function at 12 months post-surgery ($r = 0.14$, $p = 0.046$). Comparable results were observed using linear regression models. Increased physical activity levels were statistically significantly associated with improvement of emotional and social function over time (both: $p < 0.001$).

Conclusions: Our results suggest beneficial effects of physical activity on subdomains of health-related quality of life, particularly emotional and cognitive function, in colorectal cancer patients. They emphasize the importance of promoting physical activity guidelines among colorectal cancer survivors in order to improve health-related quality of life.

INVESTIGATING THE EFFECTS OF A SUPERVISED, PHYSICAL ACTIVITY PROGRAM ON CANCER SURVIVORS' HEALTH AND QOL

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Moderate-intensity physical activity (PA) is considered an effective strategy for reducing problems caused by cancer and its related treatments, including surgery, chemotherapy, radiation, and hormone therapy (Melo et al., 2015). **PURPOSE:** The purpose of this study was to determine aerobic capacity (Six-Minute Walk Test), cardiorespiratory function (Three-Minute Step Test), muscle strength and endurance (MS&E) (sit-up & push-up tests), flexibility (sit-n-reach test), body composition (4 sites using Lange calipers), overall fitness age (FA), fatigue (BFI questionnaire), and Quality of Life (EORTC-QLQ-C30 questionnaire) in cancer survivors in a rural setting after a supervised, progressive eight-week PA intervention of aerobic exercise, resistance training, stretching and group sport activities. **METHODS:** A total of 27 volunteers [13 in the PA Intervention Group (PAIG) (5 = male, 8 = female), 14 in the Control Group (CG) (5 = male, 9 = female)] completed the study. At baseline, all participants as a group had a mean (\pm SD) age, height, body weight and body fat percentage (BFP) of 65.2 ± 10.8 yrs, 167.1 ± 8.7 cm, 80.5 ± 14.1 kg, and $25.6 \pm 5.1\%$, respectively. **RESULTS:** Aerobic capacity ($p = 0.03$; $d = 0.69$), MS&E: sit-ups ($p = 0.001$; $d = 1.29$), overall MS&E FA ($p = 0.001$; $d = 0.96$), and overall FA ($p = 0.03$; $d = 1.44$) improved significantly for the PAIG compared to the CG. The PAIG improved on the BFI ($d = 0.26$), and global health ($d = 0.22$), physical ($d = 0.55$), role ($d = 0.57$), cognitive ($d = 0.24$) and social functioning ($d = 0.05$), and decreased in pain ($d = 0.07$) as measured by the EORTC for Quality of Life (QOL) compared to the CG ($p > 0.05$). Percent change pre- to post-testing improved for: aerobic capacity (20.61%, $p = 0.03$), overall body composition FA (-11.88%; $d = 0.51$), overall body fat percentage (-7.35%; $d = 0.36$), overall MS&E FA (-18.28%; $p = 0.001$) and overall FA (-11.15%; $p = 0.04$) for the PAIG. **CONCLUSIONS:** A supervised, progressive multi-modal training program can improve physical health and QOL in cancer survivors. This special population is deconditioned from cancer-related treatments and physical inactivity. Perhaps future studies could add a longer intervention time, and investigate supplementation of nutrition and hydration, to see greater improvements in the variables tested.

Changes in Sleep among Cancer Survivors Following a 12-week Exercise Program

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Purpose: As a side effect of cancer treatments (e.g., chemo, radiation, and hormone therapy), many cancer survivors report sleep disturbance. This includes impairments in sleep duration as well as sleep quality, both of which are independently associated with increased mortality risk in the general population. Exercise is suggested to improve sleep quality; however, whether exercise improves sleep among cancer survivors is not well understood. This study examined changes in sleep in cancer survivors enrolled in a 12-week exercise program.

Methods: Participants were enrolled in the BfitBwell Exercise Program between 03/2016-04/2018, diagnosed with any type of cancer, and currently receiving, or within six months of completing chemo and/or radiation therapy at the University of Colorado Cancer Center. BfitBwell consists of supervised aerobic and resistance exercise sessions, held twice per week at the University of Colorado Anschutz Health and Wellness Center. Sleep duration and markers of sleep quality were measured using a pre/post-program questionnaire. Non-parametric statistical tests (McNemar) examined changes from pre- to post-program in the number of participants who (i) rated their sleep quality as poor or very poor, (ii) reported awakening feeling rested, and (iii) awakening \geq once per night.

Results: Of $N=102$ enrolled, $n=23$ (22.5%) completed the sleep questionnaire, and were included in analyses ($MAge = 51.2 \pm 13.0$ years, $MBMI = 26.0 \pm 5.5$ kg/m²). These participants were mostly female (65.2%), diagnosed with breast cancer (34.8%), 43.5% were receiving chemo, and 26.1% receiving radiation therapy. Following the exercise program, there was no change in the percentage of participants who rated their sleep quality as poor or very poor (pre= 26.1 %, post = 26.1%, $p=1.00$), reported awakening feeling rested (pre= 43.5%, post=43.5%, $p=1.00$), or awakening \geq once per night (pre= 43.5%, post= 56.5%, $p=0.508$).

Conclusion: We did not observe changes in sleep following an exercise program in middle-aged cancer survivors. Limitations were small sample size, and subjective reporting of sleep. Future studies should utilize objective measurements of sleep for better clarification on the effect of exercise on sleep duration and quality among cancer survivors.

Cardiovascular, Cellular, and Neural Adaptations to 4-weeks of Hot Yoga Compared to Normal Temperature Yoga.

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Heat stress requires a marked hemodynamic response that is necessary for adequate temperature regulation. Chronic heat exposure results in cardiovascular and cellular adaptations that improve an organisms' ability to handle subsequent heat stressors. Heat exposure may also promote neural adaptations including neurogenesis. Hot temperature yoga has grown in popularity and combines mind-body exercise with heat exposure. While normal temperature yoga has been shown to promote neural adaptations, the added heat component in hot temperature yoga may induce cardiovascular and cellular changes, along with the neural benefits. **PURPOSE.**

Therefore, the purpose of the present study is to compare the cardiovascular, cellular (e.g., HSP70), and neural adaptations of hot temperature yoga and normal temperature yoga.

METHODS. Eighteen subjects (males = 10, females = 8, 27 ± 6.02 years) completed 4-weeks of normal (n= 8) or hot (n=10, 41°C, 40% humidity) temperature yoga. The yoga sessions were performed 3 times/wk following a modified Bikram protocol. Pre- and post-testing included: 1. Hemodynamic measures during heat tolerance and maximal aerobic fitness testing; 2. Neural adaptations using serum levels of brain derived neurotrophic factor (BDNF) and adrenocorticotrophic hormone (ACTH), along with a mental stress questionnaire.

PRELIMINARY RESULTS. Maximal aerobic fitness increased in the hot yoga group only (3.25 ± 0.80 vs. 3.51 ± 0.82 ml.kg.min⁻¹). No evidence of heat acclimation (heart rate, core temperature changes) was observed. Preliminary serum BDNF results (n = 15) showed a trend towards a significant increase (p = .06) in both yoga groups combined. Analysis of HSP70 in peripheral blood mononuclear cells (PBMC) (n = 15) suggested higher expression of HSP70 in the hot yoga group only. **CONCLUSION.** Twelve sessions of hot temperature yoga promoted both cardiovascular fitness and cellular thermotolerance adaptations in healthy humans. Serum BDNF, a marker of neural plasticity, increased in response to yoga (normal + hot temperature yoga), and appeared to not be temperature dependent.

ARE THERE DIFFERENCES IN OXYGEN CONSUMPTION BETWEEN A BREATHING RESTRICTIVE MASK AND HYPOBARIC HYPOXIA?

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PURPOSE: To determine the acute effects of a breathing restrictive mask (M) set to 2743 m (M only) during steady-state cycling compared with 1) wearing the mask set to 914 m at 1829 m of hypobaric hypoxia (H) (combined = 2743 m) (M+H) and 2) 2743 m of hypobaric hypoxia (H only) in subjects living at moderate altitude. **METHODS:** Nine subjects (5 males, 4 females) completed four, 1-hour sessions. Subjects completed a maximal oxygen consumption ($\text{VO}_{2\text{max}}$) cycling test to determine a 60% $\text{VO}_{2\text{max}}$ workload at Albuquerque's altitude (~1570m). The following three sessions were randomized by condition: 1) M only, 2) M+H, and 3) H only. After a warm-up, subjects cycled at 60% of their $\text{VO}_{2\text{max}}$ workload for 20 min. Oxygen consumption was recorded every five minutes. Repeated measures ANOVA with Bonferroni's pairwise comparisons ($p < 0.05$) determined significant differences between the three conditions and if the three conditions' VO_2 differed from 60% of the baseline $\text{VO}_{2\text{max}}$. **RESULTS:** The average (Δ) VO_2 measured for the set workload (60% $\text{VO}_{2\text{max}}$) for each condition were 29.6 ± 4.1 , 34.3 ± 4.9 , 31.4 ± 5.1 , and 28.8 ± 4.5 $\text{ml} \cdot \text{kg}^{-1} \cdot \text{min}^{-1}$ for baseline, H only, M+H, and M only, respectively. Comparisons of the three conditions to the baseline 60% $\text{VO}_{2\text{max}}$ workload yielded a significant F value, $F_{(3,21)} = 6.20$, $p = 0.003$. The VO_2 was significantly higher than baseline for H only ($p = 0.022$), but was similar to M+H and M only ($p > 0.05$). Comparisons between the three experimental conditions yielded a significant F value for VO_2 , $F_{(2,14)} = 8.714$, $p = 0.003$. There was a significant difference between H only and M only ($p = 0.028$), but not between H only and M+H nor between M+H and M only ($p > 0.05$). **CONCLUSION:** Oxygen consumption during M+H was similar to H only, whereas M only elicited lower ΔVO_2 compared to H only. Individuals living at moderate altitude should use the 914 m mask setting rather than the 2743 m setting since the higher setting elicits lower VO_2 at the same workload, and the training stimulus would be reduced. However, it is still best to use hypobaric hypoxia as VO_2 for H only increased during exercise only compared to baseline. Neither mask condition showed a different average submaximal VO_2 compared to the same workload at 1570m. This could explain why previous studies have not found post-training differences in $\text{VO}_{2\text{max}}$ between control and mask groups.