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Effects of Various Golf Bag Loading Strategies on Perceived Exertion and Vertical Jump Performance

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EFFECTS OF VARIOUS GOLF BAG LOADING STRATEGIES ON PERCEIVED EXERTION AND VERTICAL JUMP PERFORMANCE

by

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(Under the Direction of Samuel J. Wilson)

ABSTRACT

INTRODUCTION: The sport of golf is increasing in popularity among both novice and skilled players alike. A round of golf necessitates players to cope with a range of physically demanding movement patterns. At the collegiate level, golfers must transport their clubs by loading them onto the body. Previous literature has yet to determine how different golf bag carrying positions influence periodic, unloaded jump performance and perceived exertion of the load carrying task. PURPOSE: The purpose of this study is to investigate how different golf bag load carriage methods may influence vertical jump performance and perceived exertion. METHODS: Five golf bag load transport conditions. Participants included 3 male and 7 female college-aged, novice golfers (23.6 ± 2.63 years; 79.3 ± 18.42 kg; 172.3 ± 7.94 cm). Participants completed a 4.8 kilometer (km) walk to simulate a 9-hole game of golf. The walk was completed on separate days under five conditions: double strap above sacrum, double strap below sacrum, single strap, pushcart, and no bag. At each .4 km covered, participants reported ratings of perceived exertion and performed three countermovement vertical jumps on a force plate. Data collected from five days of testing were used for analysis. RESULTS: Analyses comparing concentric peak force (F(48,432) = 1.395, p = 0.047, 2 = 0.134) and time to peak force revealed a significant interaction (F(48,432) = 1.750, p = 0.002, 2 = 0.180) during the pushcart condition. The repeated measures ANOVA for vertical jump height revealed a significant interaction (F(48, 432) = 1.699, p = 0.003, 2 = 0.159). Ratings of perceived exertion were greater at the 2.4 km mark and 4.8 km mark during the single strap condition. CONCLUSION: Employing the pushcart may be more advantageous to maintain jump performance compared to other conditions. Further research is needed to determine which load carrying strategy deteriorates golf performance.

INDEX WORDS: Golf bag, Load carriage, Countermovement vertical jump

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MASTER OF SCIENCE

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DEDICATION

I dedicate this thesis to my Mom and Grandmother. You both gave me a life full of love, support, and the tools to succeed. This accomplishment is owed entirely to you both.

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I want to thank my committee members Drs. Wilson, Munkasy, and Siekirk for providing me with the most incredible academic experience at Georgia Southern. From my time as an undergraduate and throughout graduate school, you all have continually supported me in my endeavors, challenged me in my studies, and inspired me to work harder. Without you three, I do not know where I would be today. I would also like to thank Cory, Sarah, Petra, Benjamin, Hui, Cameron, Derick, Tom, Morgan, Andrew, Savannah, Keagan, Caroline, and Jaedah for being on this academic voyage. I will cherish every moment we spent together, struggling, learning, and growing. And thank you Mom and Autumn for being my heart and soul, respectively.

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CHAPTER 1 INTRODUCTION

The sport of golf is increasing in popularity among both novice and skilled players alike (Driggers and Sato, 2017; Farally et al., 2003; Kobriger et al., 2006). The repetitive and extended durations of walking offer several health benefits including lowering low-density lipoprotein (LDL) levels, increased aerobic performance, and improved trunk muscle endurance (Palank & Hargreaves, 1990; Schwenk, 2001). Moreover, golfers have several load carriage choices to transport their clubs and cover the course distance. Specifically, golfers can choose to position their bags with both straps above or below the sacrum, one strap over one shoulder, or on a pushcart. Research on load carriage has illustrated loads positioned closer to the center of mass (COM) will elicit decreased energy cost and perceived strain (Boffey, 2019; Holewijn & Lotens, 1992; Legg, 1985; Soule and Goldman, 1969). Furthermore, bearing loads by means of a double strap bag attenuate perceived effort and physiological demands than that of a single strap bag (Malhotra and Gupta, 2007; Ikeda, 2008). Mitigating perceived effort of supporting a golf bag may help sustain a golfer's ability throughout the duration of play. One aspect of reducing a golfer's number of strokes taken at each hole is by maximizing the ball's driving distance. The adopted bag's carrying position may be pivotal in the context of overall performance and metabolic cost. Arguably, a golfer will aim to reduce the effect of carried load to preserve the integrity of his/her swing throughout the duration of play. Of course, employing the assistance of pushcart may relinquish the perceived exertion of golf bag load carriage. By mitigating the perceived effort of carrying the bag, golfing performance may be maintained throughout the game. Moreover, when considering golfing performance, the literature notes that clubhead speed during a swing is largely attributed to the lower body force, thereby being highly influential on clubhead angular velocity (Hellstrom, 2009; Hume, 2005; Leary, 2012). Specifically, the linear displacement of the ball is a function of the linear velocity of the club at impact which is determined by the angular velocity and length of the club lever arm. Components of the countermovement jump (CMJ) such as vertical jump height (VJH), concentric peak force (CPF) , and time to peak force (TTPF) are correlated with sports performance in the literature (McLellan et al. 2011; Shaw et al. 2021) Moreover, CMJ performance is reported determinant of club head speed in the golfing literature (Read, et al. 2013; Sheehan, 2018, Wells et al. 2018). Consequently, research has noted vertical jump performance to suffer following load carriage tasks (Dempsey, 2014; Fallowfield, 2012; McGinnis, 2016; O'Leary, 2018). The constant load transportation required by a round of golf paired with the need to skillfully, and sometimes powerfully, swing the club requires players to strongly consider the method in which their golf bag is transported throughout the course. Research has investigated the metabolic cost and perceived comfort of different golf bags over very short duration walking (Ikeda, 2018). Conversely, a typical game of golf necessitates the capacity to cover a considerable walking distance, both at and between holes, to progress the game. Determining whether the placement of the golf bag during a 4.6-kilometer (km) load carriage task influences perceived effort and jump performance may benefit the community of competitive golfers aiming to optimize performance. However, no evidence exists to determine which golf bag carriage technique presents minimal influence on vertical jump performance and perception of carrying the bag. Therefore, the purpose of the current study is to determine how each golf bag transportation mode affects perception of the prolonged carrying task and unloaded vertical jump performance. It is hypothesized that (i) CPF will be the lowest during the single strap condition, (ii) VJH will be the lowest during the single strap condition, and (iii) RPE scores will be highest throughout the single strap condition.

Extended Introduction

Statement of the Problem*:* Golfers have multiple load carriage modalities at their disposal to transport their clubs during a round of golf. However, it is unclear which load carriage strategy is ideal to sustain golf performance throughout a game. A relationship exists between lower extremity power and clubhead angular velocity. Currently, research investigates how lower extremity kinetics are affected while bearing external loads; however, no evidence exists examining the influence of a golf bag specific load carriage task on RPE and periodic, unloaded performance.

Aim of Research (Purpose)*:* The purpose of this study is to investigate how different golf bag load carriage methods may influence vertical jump performance and perceived exertion.

Research Questions:

RQ_1: How does each golf bag carrying technique affect periodic vertical jump performance over the course of a 4.8 km walk?

RQ_2: How does each golf bag carrying technique affect ratings of perceived exertion over the course of a 4.8 km walk?

Research Hypotheses:

$H_{0\ (null)}$: Concentric peak force will be unaffected regardless of whether no bag or a golf bag loading technique is employed during the 4.8 km walk.

Ia. Concentric peak force will be the lowest during the single strap condition.

$H_{0\ (null)}$: Vertical jump height will be unaffected regardless of whether no bag or a golf bag loading technique is employed during the 4.8 km walk.

Ia. Vertical jump height will be the lowest during the single strap condition.

$H_{0\ (null)}$: RPE will remain unaffected regardless of whether no bag or a golf bag loading technique is used during the 4.8 km walk.

Ia. The single-strap condition will have the lowest scores for RPE

Independent Variables:

1. No bag conditions
2. Single strap bag condition
3. Double strap above sacrum condition
4. Double strap below sacrum condition
5. Pushcart condition

Dependent Variables:

1. Vertical Jump Height (VJH)
2. Concentric Peak Force (CPF)
3. Time to peak force (TTPF)
4. RPE (6-20)

Inclusion Criteria:

1. College-aged between 18-25
2. Some golf experience within the last 6 months
3. Healthy individuals with no musculoskeletal, cardiovascular or metabolic disorders

Exclusion Criteria:

1. Anyone below the age of 18 or over the age of 25
2. Any current musculoskeletal, cardiovascular, or metabolic disorders

Limitations:

1. Ratings of perceived exertion is subjectively reported by the participant
2. The participant's jumping technique may be inexperienced
3. Indoor conditions do not accurately represent the outdoor atmosphere

Delimitations:

1. The BORG (6-20) scale was thoroughly explained during familiarization

2. Demonstrations of the countermovement jump was provided by the researchers

Assumptions:

1. Participants report their RPE honestly

2. Participants provide their best effort during vertical jump testing

CHAPTER 2

METHODS

A convenience sample of 10- college aged (23 ± 2.63 years) participants were recruited for the study. Recruited participants were screened for golf experience. To meet inclusion criteria, participants must possess, at the minimum, some recreational golfing experience (e.g., attending a driving range or family golfing entertainment facility) within the last 6 months. All participants must pass a PAR-Q+ and be deemed ready to exercise. 10 college-aged individuals between the ages of 18 and 30 years old participated in this study. The current investigation was approved by the University's Institutional Review Board and all participants signed an informed consent prior to data collection.

Day one testing procedures were outlined to participants. Participants read and signed the informed consent. Researchers collected individual height, weight, upper and lower limb preference, and the physical activity readiness questionnaire plus (PAR-Q+) from participants.

Next, participants were familiarized with the vertical jump test, and rating of perceived exertion (RPE) scale. The BORG (6-20) scale quantifies a rating of six as no exertion and twenty as maximal exertion provided by the participant. The RPE scale is described as a continuum of effort to participants. Participants were provided an RPE scale to gauge their feeling of provided effort. Furthermore, the RPE scale was instructed to be analogous to heart rate. Typically, resting heart rate is around 60 beats per minute, thus coinciding with a 6 on the RPE scale. Consequently, as the feeling of effort increases, heart rate is expected to increase, thereby increasing reported RPE scores.

During the familiarization session, participants were provided a demonstration of the vertical jump by the researchers. Additionally, participants were able to practice the countermovement jump as many times as needed on familiarization day. To mitigate the effects of premature fatigue, participants were instructed to rest for 1 to 2 minutes between jumps.

Vertical jump testing procedures included measurements of ground reaction forces using an AMTI OR6 Series Force Platform (1000Hz, AMTI, Watertown, MA, USA). Furthermore, 3D motion capture which was recorded using Vicon Motion Capture hardware and software (Vicon Motion Ltd., Version 1.8.5, Oxford, England). Jump height measurements were collected using a Vertec (JumpUSA, Sunnyvale, CA, USA). Load carriage conditions were tested from days 2 through 6. Additionally, the testing order was counterbalanced for each condition.

Procedures- Load Carry

Load carry positions (i.e., position of the golf bag) were tested from days 2 through 6. Testing order was counterbalanced for each load carry position. Participants were tested under one of the five conditions: no bag (NB), single strap (SS), double strap above sacrum (DSAS), double strap below sacrum (DSBS), and pushcart (PC) for an entire testing session. RPE (i.e., 6-20) was reported by participants every .4 km throughout the entire 4.8 km distance. The 4.8 km distance was chosen as it simulated the distance of a 9-hole golf course. The golf bag provided to the participants had a mass of 13.2 kg (29 pounds). Prior to vertical jump testing, participants were asked how much effort they had exerted as a function of the load condition.

Procedures- Vertical Jump Testing

Jump testing consisted of participants performing three, two arm countermovement vertical jumps at every 0.4 km covered. Prior to participation the participants reach height was determined. Upon completion of the distance, participants removed the golf bag (if applicable) and performed a vertical jump on a force plate utilizing a Vertec. Participants were reminded to jump and reach as high as they could to strike the Vertec vanes. Participants were cued "3, 2, 1, Go" for each jump trial. Participants rested for one minute between each jump. The participants jump and reach height was recorded and their reach height was subtracted to determine the jump height. If any retroreflective markers fell off during the jump, they were replaced, and the participant was asked to repeat the jump.

Data Analysis

Independent variable conditions include no bag (NB), single strap (SS), double strap above sacrum (DSAS), double strap below sacrum (DSBS), and. a pushcart (PC) carriage modality (Figure 7). Dependent variables considered are rate of perceived exertion (RPE) and vertical jump height (VJH), TTPF and CPF. All countermovement vertical jumps were performed on a AMTI OR6 Series Force Platform (1000Hz, AMTI, Watertown, MA, USA). Vertical ground reaction force (vGRF) was utilized to gather jump kinetics.

Statistical Analysis

For TTPF and CPF, a 5 x 13 (Condition [control, single strap, dual strap above, dual strap below, pushcart] x distance [Pre, .4km, .8 km, 1.2 km, 1.6 km, 2 km, 2.4 km, 2.8 km, 3.2 km, 3.6 km, 4 km, 4.4 km 4.8 km]) repeated measures ANOVA was employed to determine a bag- or distance-main effect or bag x distance interaction.

Three separate 5 x 7 Friedman's ANOVA by ranks was used to determine whether there were any statistically significant differences between the distributions of load positions at each time point (i.e., pre-test, during, and post-test). Post-hoc pairwise comparisons were conducted when the omnibus test returned p-values below the *a-priori* alpha level set at, α = 0.05. Partial eta squared effect sizes were calculated.

Table 1. Novice golfer's demographics (Mean ± SD), *n = 10*

	Mean ± SD
Age (years)	23 ± 2.63
Mass (kg)	79.3 ± 18.42
Height (cm)	172.3 ± 7.94

Figure 1. Example of testing timeline

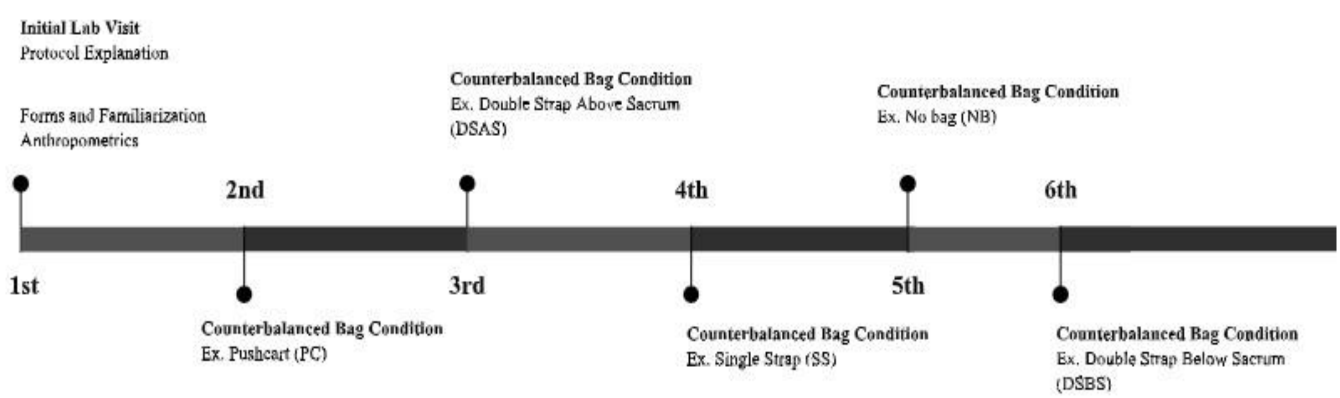


Figure 2. Picture of load carrying strategies

DSAS DSBS SS PC

CHAPTER 3

RESULTS

Concentric Peak Force

Analyses comparing concentric peak force revealed a statistically significant interaction, *F* (48,432) = 1.395, $p = 0.047$, $\eta^2 = 0.134$). Post-hoc comparisons between load types and distance suggest that throughout the walking protocol the PC condition had significantly greater peak force than all other loaded conditions except for the NB condition. Further, after .8 km the differences between the PC and SS condition were no longer significant, and following 1.6 km the differences between the PC and DSBS were no longer significant. Additionally, while the peak forces in the DSAS condition remained significantly lower than the PC, during the final 1.6 km the DSAS peak forces were also significantly lower than all other load conditions and the NB condition at 4.8 km.

Time to Peak Force

Time to peak force was statistically significantly different across bag conditions (F(48,432) = 1.750, $p = 0.002$, $\eta^2 = 0.180$). Follow up analyses for the time to peak force suggest that, like the concentric peak forces, the PC had significantly lower (faster) times compared to the other load conditions but not the NB condition through the first 2.4 km of the walk. Following the 2.4 km mark, there were no statistically significant differences between any conditions.

Vertical Jump Height

Vertical jump height was significantly different across bag conditions (F(48, 432) = 1.699, $p = 0.003$, $\eta^2 = 0.159$). Follow-up analyses for the vertical jump height suggest that the

DSBS condition had significantly higher jump heights compared to the unloaded conditions, NB, and PC during the initial 1.6 km. However, after the 1.6 km mark there were no further statistical differences between any of the load conditions.

Ratings of Perceived Exertion

RPE was statistically significantly different at the 2.4 km mark $\chi2(4) = 16.024$, $p = .003$ and 2.4 km $\chi2(4) = 13.838$, $p = .008$. mark. Pairwise comparisons were performed with a Bonferroni correction factor for multiple comparisons. RPE was statistically significant during the SS condition at the 2.4 km mark ($p = .015$) and at the 4.8 km mark ($p = .03$). No significant interactions for RPE were noted across bag conditions at the pre-time point $\chi2(4) = 4.000$, $p = .406$.

Figure 3. Vertical jump height during the no bag condition

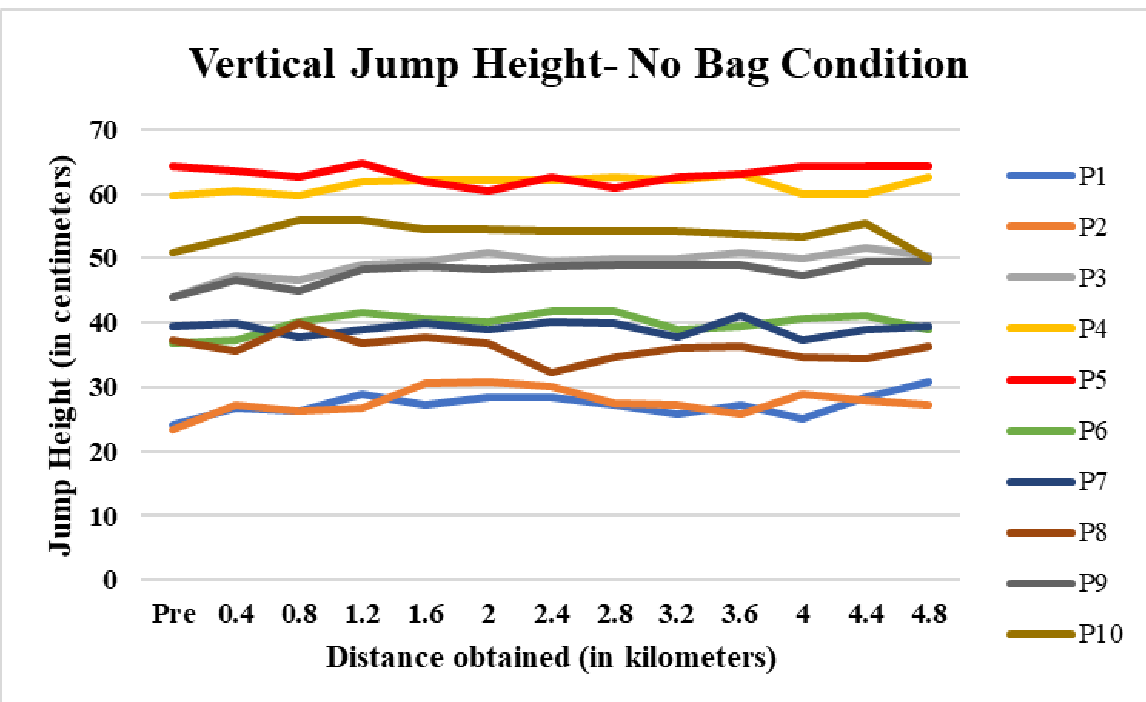


Figure 4. Vertical Jump height during the single strap condition

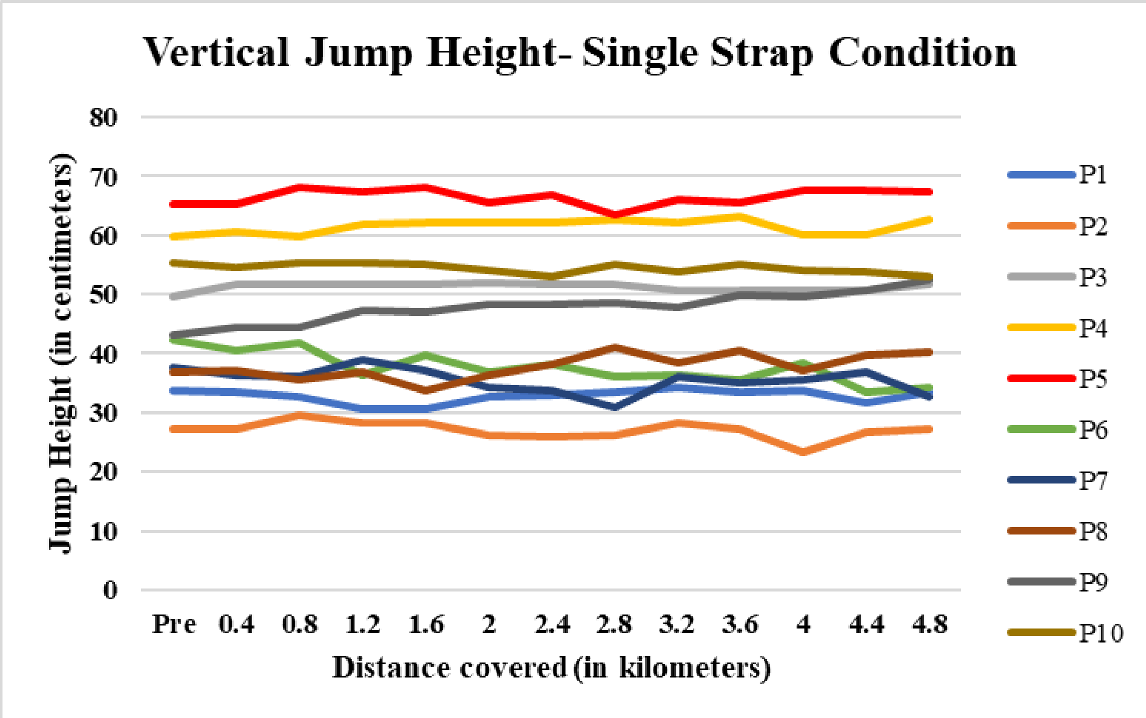


Figure 5. Vertical jump height during the double strap above sacrum condition

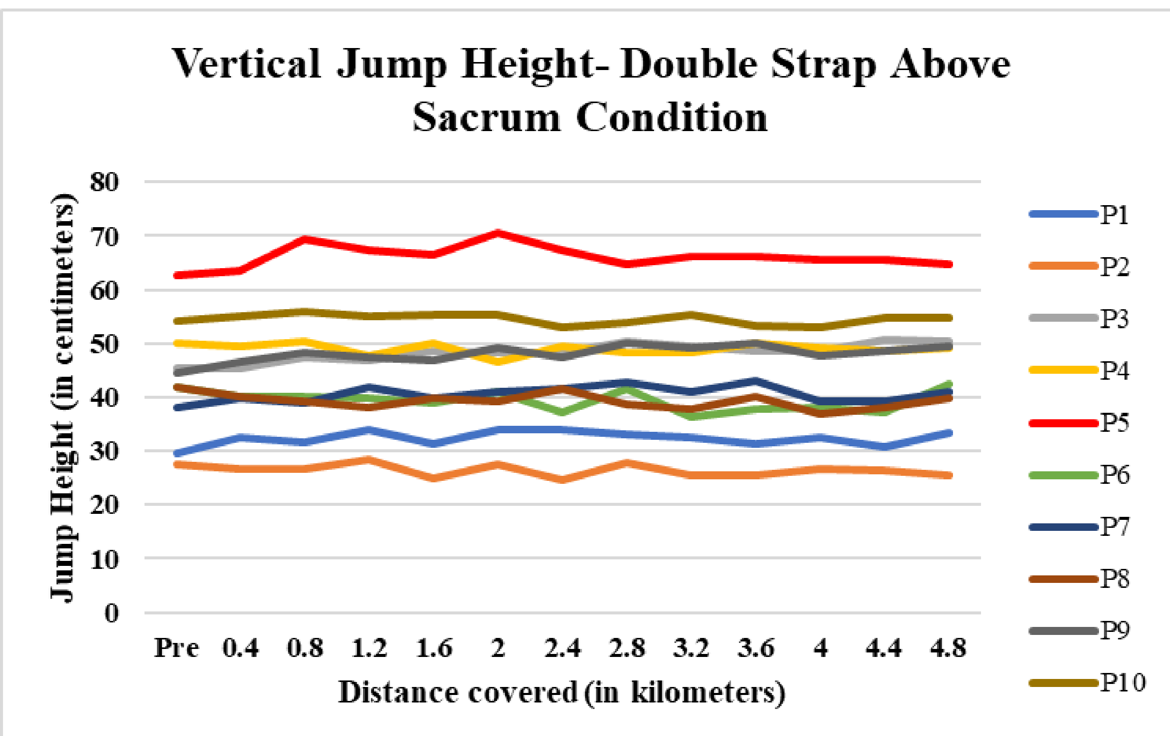


Figure 6. Vertical jump height during the double strap below sacrum condition

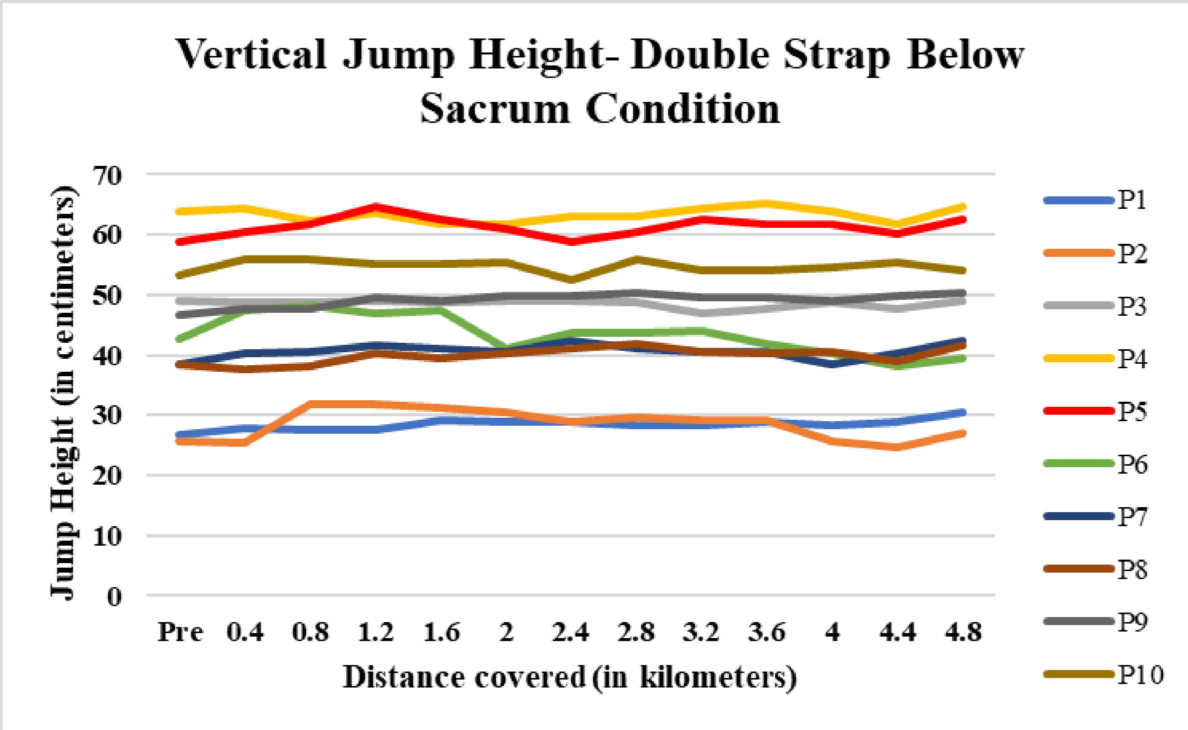


Figure 7. Mean vertical jump height across participants during the pushcart condition

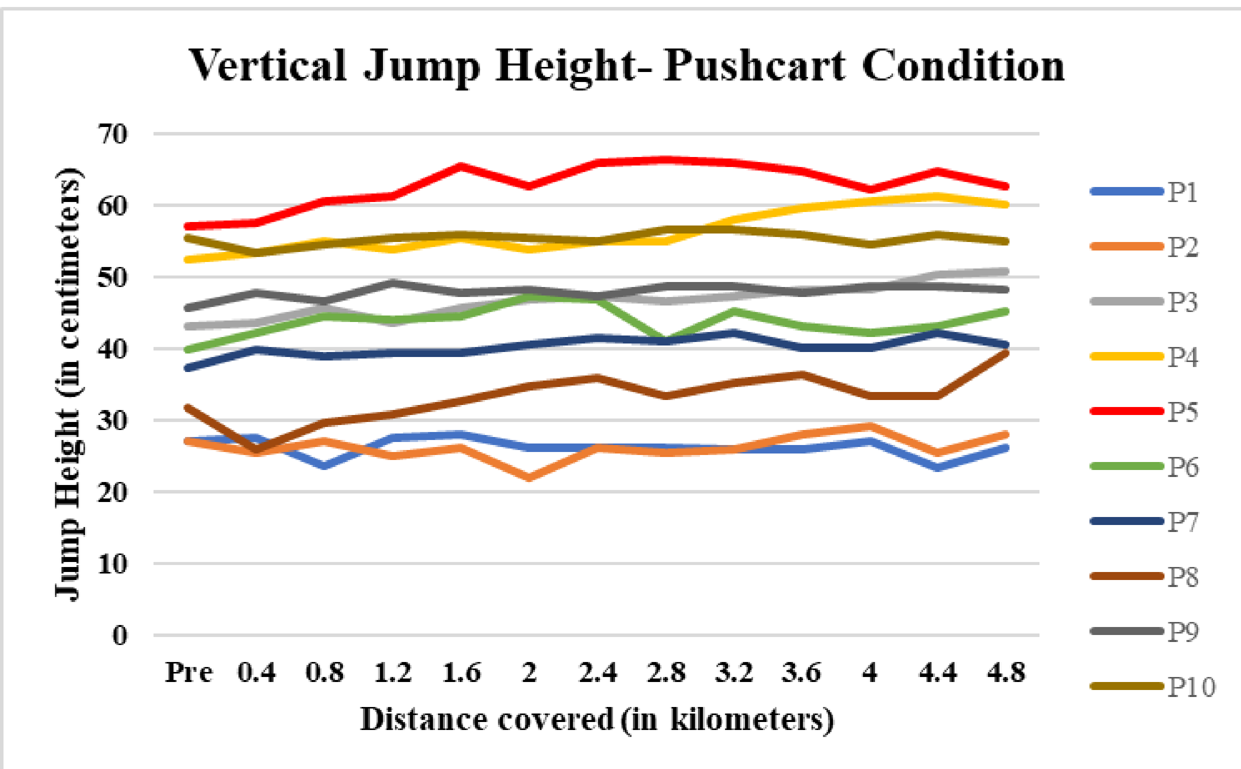


Figure 8. Participant mean vertical jump height across conditions

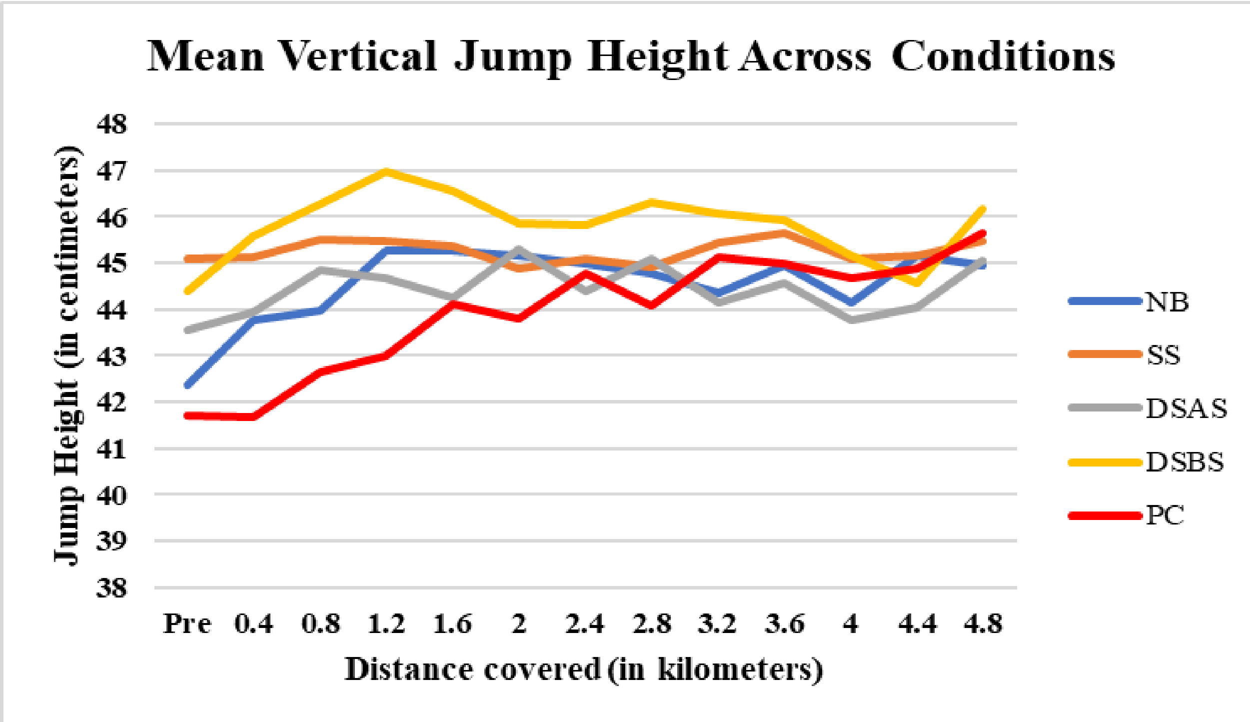


Figure 9. Individual and median RPE during the NB condition

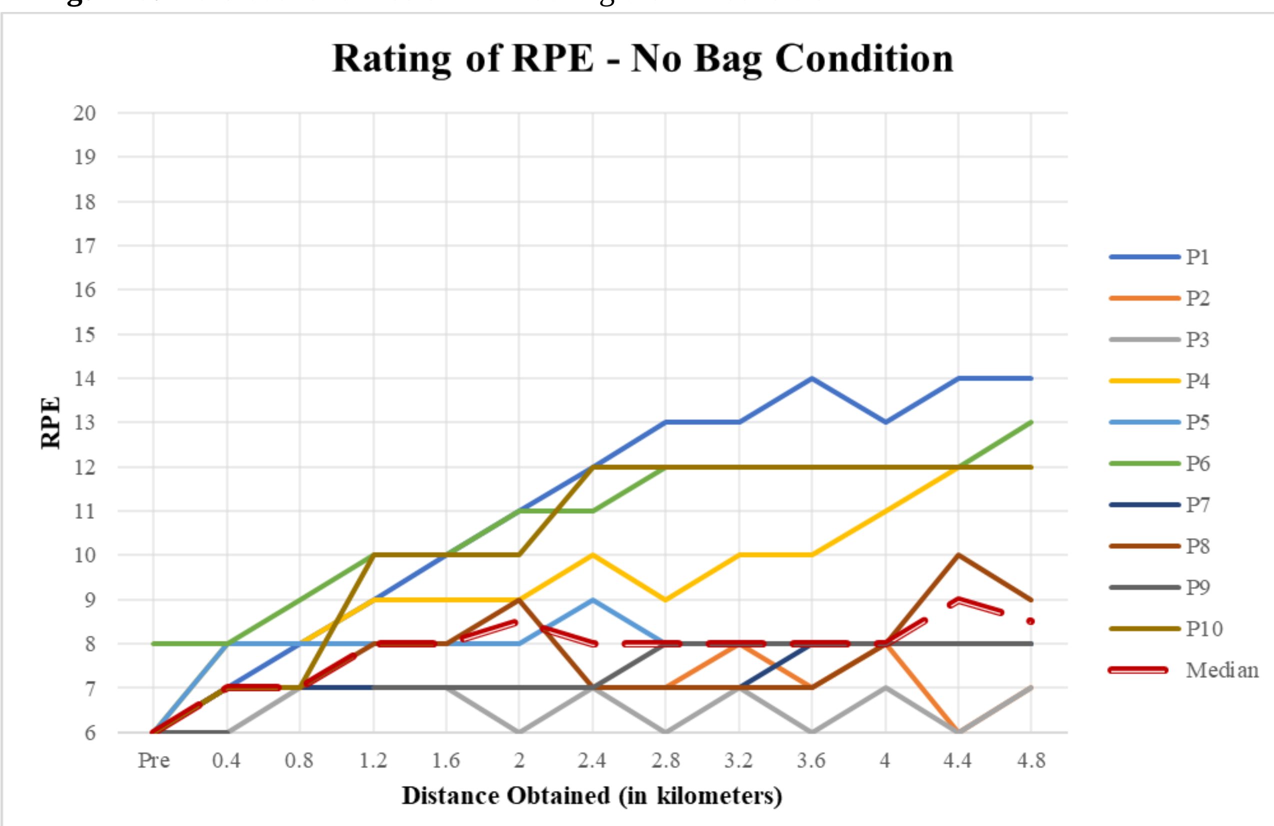


Figure 10. Individual and median RPE during the SS condition

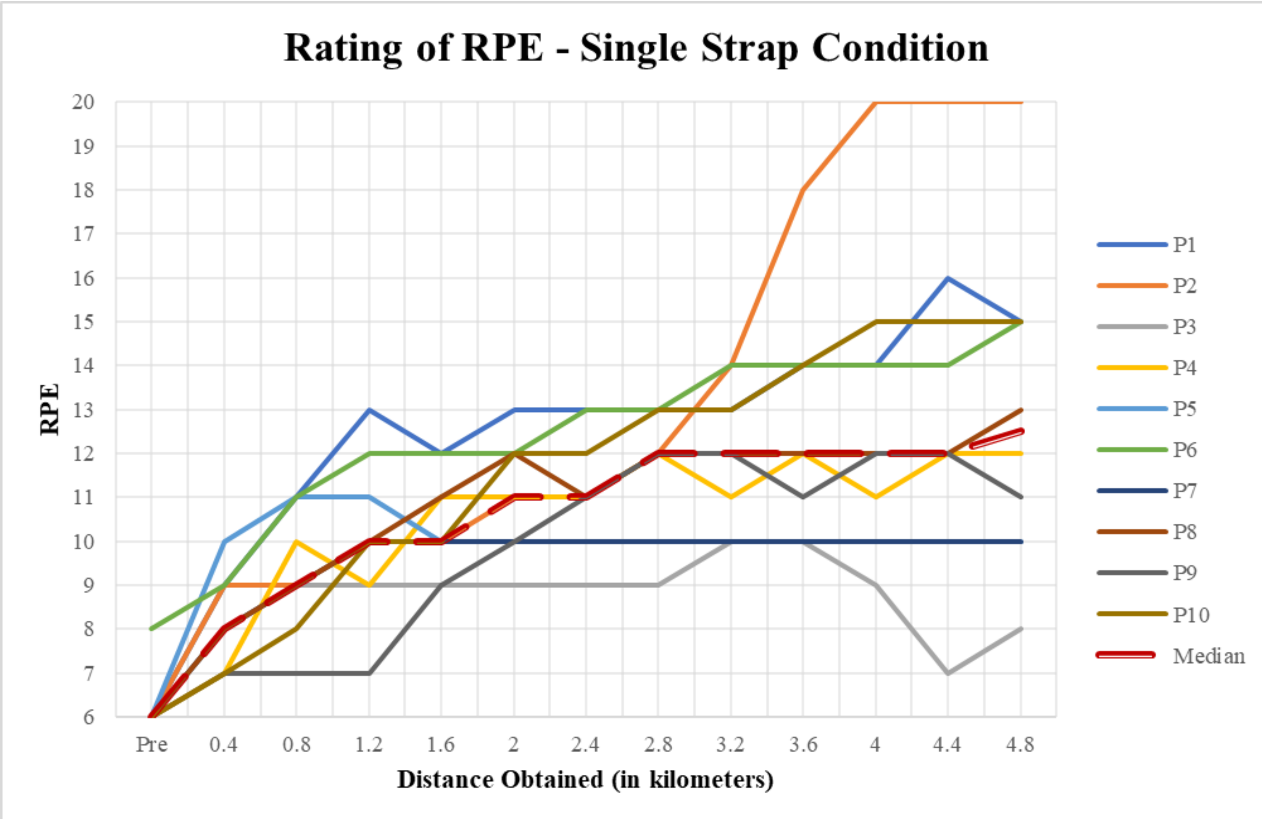


Figure 11. Individual and median RPE during the DSAS condition

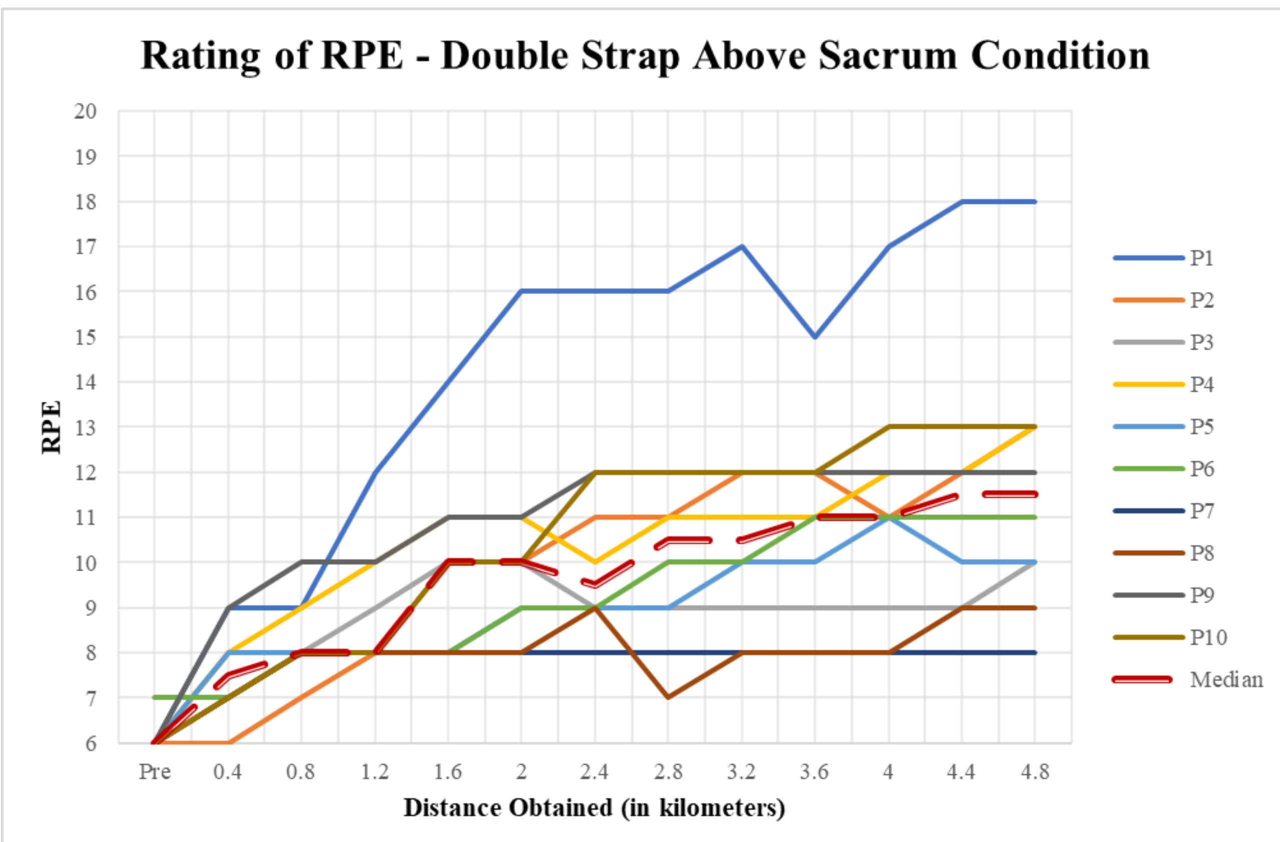


Figure 12. Individual and median RPE during the DSBS condition

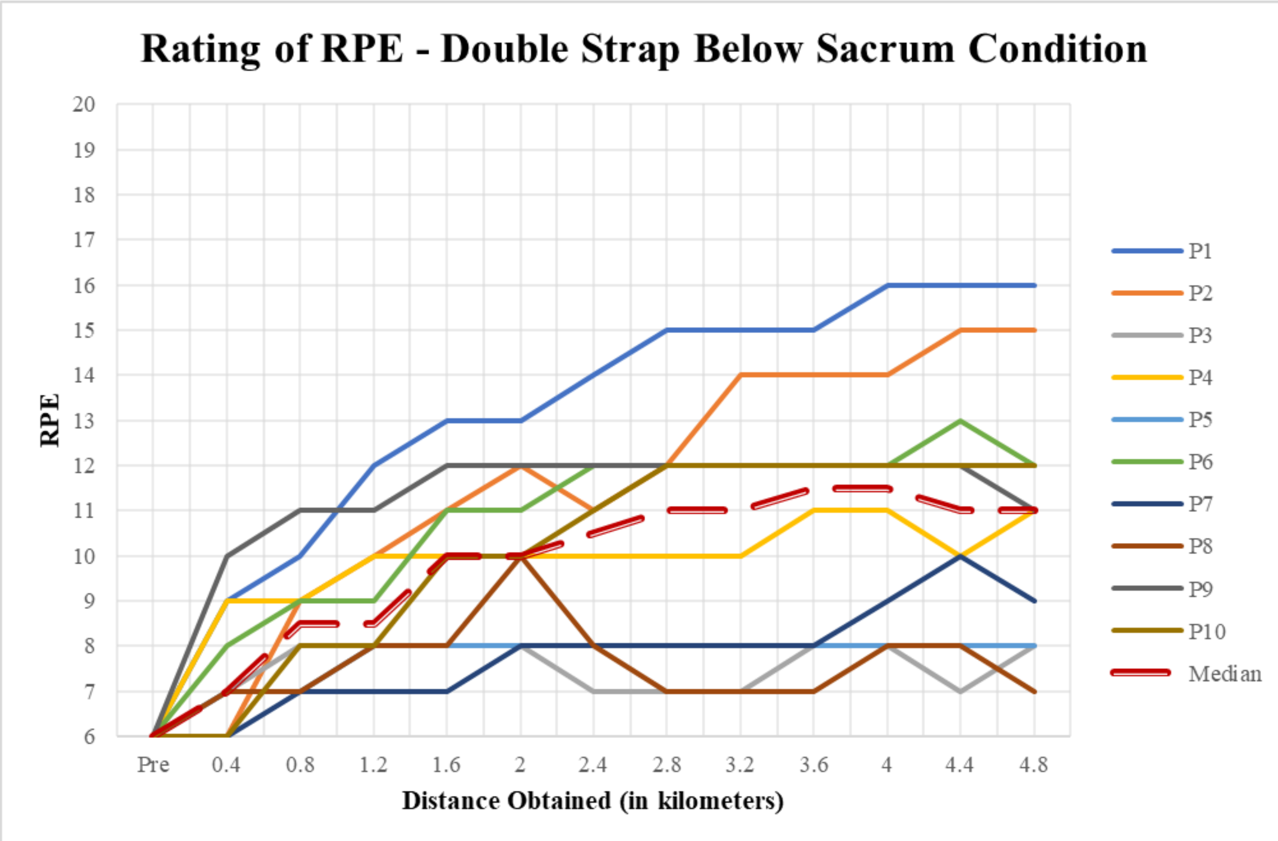
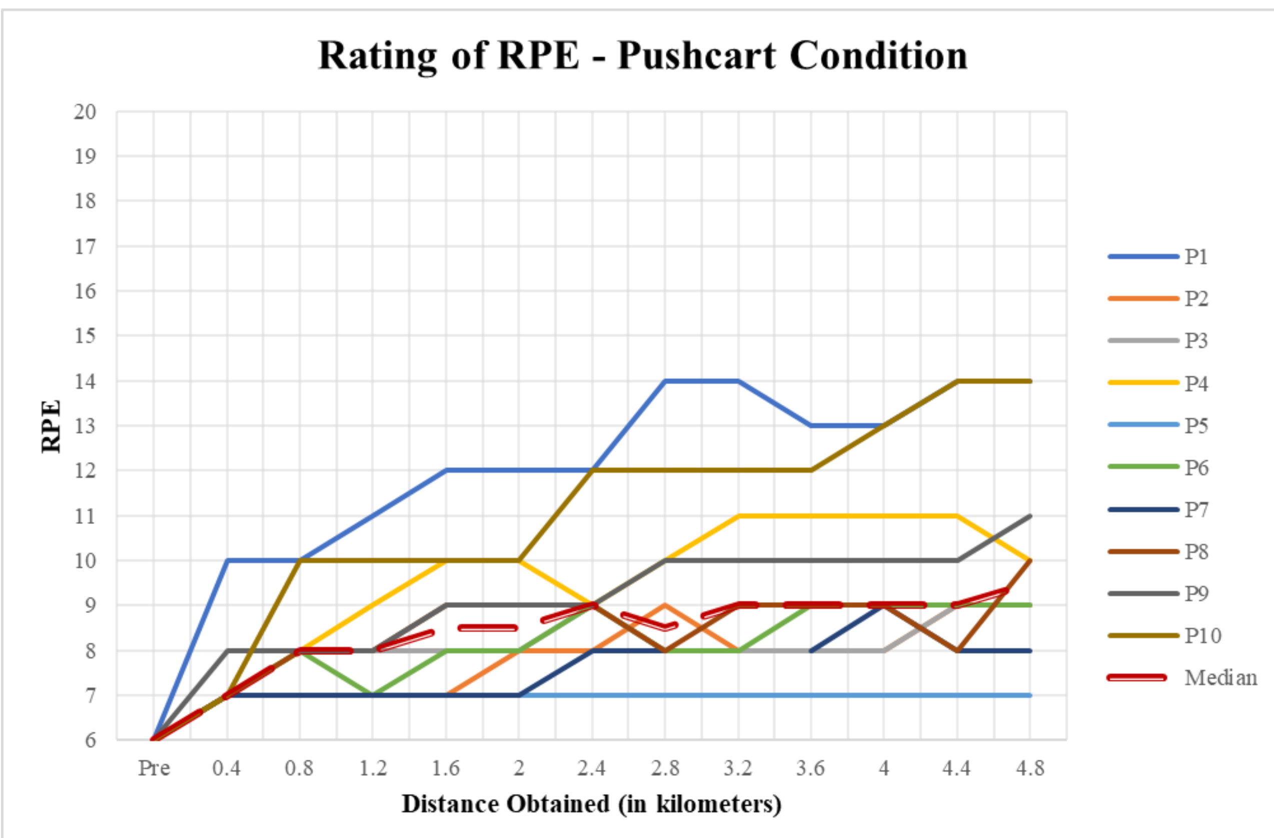


Figure 13. Individual and median RPE during the PC condition



CHAPTER 4

DISCUSSION

The primary aim of this study was to determine how each golf bag transportation mode affected perception of the prolonged carrying task and unloaded vertical jump performance. Our hypothesis that CPF would be lowest during the SS load carriage strategy is not supported in this study. Throughout the load carriage task, the PC condition was characterized as having greater CPF compared to the other conditions with the exception the NB condition. Specifically, CPF for the PC condition was significantly greater than that of the SS condition for the first .8 km covered. Additionally, CPF was also significantly greater throughout the 1.6 km of load carriage during the PC condition compared to the DSBS condition. Interestingly, CPF during the last 1.6 km of the DSAS condition was significantly lower than any other condition despite the DSAS condition positioning the golf bag closest to the COM. Load carriage studies recommend placing loads as close as possible to the COM to reduce physiological demand (Boffey, 2019; Holewijn & Lotens, 1992; Legg, 1985; Soule and Goldman, 1969). A study by Knapik et al. (2004) describes how placing loads closer to the COM mitigates the metabolic expenditure during load carriage tasks. The current study does not report metabolic metrics; however, it is worth noting that the physiological capacity of the lower extremity musculature, responsible for the CMJ, may be negatively impacted while performing a documented, efficient load carriage strategy. It is worth considering the position of the bag is above the sacrum, thus potentially increasing the vertical displacement of the COM. By increasing the vertical displacement of the COM above the base of support, stability is challenged thereby demanding better dynamic postural control of the lower extremity. Additional research observing the postural ability of the lower extremity while utilizing different golf bag loading strategies should be carried out. Similar to CPF, the TTPF was shorter throughout the first 2.4 km of load carriage during the PC condition when compared to all other loaded golf bag conditions.

In addition, the DSBS condition displayed higher jump heights compared to the NB and PC conditions throughout the first 1.6 km. However, following the 1.6 km covered, vertical jump heights did not significantly differ between load carriage conditions. This outcome does not support the hypothesis that the SS condition would have the greatest reduction jump height. In terms of jump height being greater under the DSBS condition, this evidence conflicts with the literary consensus that jump height following load carriage tasks decreases (Dempsey et. al, 2014; Fallowfield et al. 2012; Holewijn & Lotens, 1992). Taylor et al. (2016) reported decreased jump height following loaded conditions compared to unloaded, control conditions.

The results of the current study support the hypothesis that higher RPE scores were reported during the SS golf bag loading condition. Specifically, RPE scores were significantly higher at the 2.4 km mark and 4.8 km mark compared to the NB, DSBS, and PC conditions. This outcome is supported in the literature describing how loads placed further away from the COM induce greater perception of exertion (Boffey, 2019; Holewijn & Lotens, 1992; Legg, 1985; Soule and Goldman, 1969; Knapik, 2004; Ikeda, 2008).

Limitations

It is worth noting the results of this study may be affected by the degree of experience with CMJ of each participant. Furthermore, reports of RPE are subjective and thereby susceptible to incongruence between reported and perceived demands of the load carriage experience. The outcomes of the current study are reflective of indoor, controlled climate conditions. Thus, the results reported are not able to be extrapolated to outdoor, variable climate conditions commonly experience during a round of golf.

Delimitations

Thorough demonstration of the CMJ was conducted during the familiarization session to reinforce the proper jumping technique for participants. Further, participants were reminded at the beginning of each session to report their true feelings of perceived exertion throughout the entire study. Additionally, the path followed around the room was taped off at the corners to keep participants from cutting corners.

CHAPTER 5

CONCLUSION

When observing the impact of golf bag load transportation strategies, the load carriage strategy used may play a key role in preserving jump performance as well as the perception of strain. Through the lens of this study, employing a PC for transporting loads may help maintain higher CPF and lower TTPF over time when compared to other load transportation modalities. Further research should investigate the electromyographic activity of the responsible musculature during the vertical jump task following the aforementioned load conditions. Moreover, this study was limited to a controlled, laboratory setting which does not reflect real world environmental conditions, therefore the next step in this research should be conducted on an actual golf course.

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APPENDIX A

LITERATURE REVIEW

Load Carriage

Subjecting the body to carrying external load varies between populations; however, employing strategies to attenuate unnecessary bodily stress is universally desired. Routine load carriage is practiced by groups as diverse as grade school children to tactical populations (Malhotra and Gupta, 2007; Boffey et al., 2019; Joseph et al., 2004; Wang et al., 2013; Mullins et al., 2015). Varying modes of employable load carriage are contingent upon weight, shape of load, and duration of carriage (Legg, 1985). Primary school children participate in extended durations of load carriage while supporting double the recommended weight for school bags (Hong et al., 2000; Malhotra and Gupta, 2007). Moreover, military personnel may endure external loads upwards of 55kg in weight for considerably long durations (Knapik, 2004). Research conducted by Malhotra and Gupta (2007) determined a dual strap rucksack to be the energy efficient strategy to carry an external load. The current body of literature recommends carrying a load close to the center of mass (COM) to mitigate biomechanical alterations and energy expenditure (EE) (Boffey, 2019; Legg, 1985; Soule and Goldman, 1969).

Push carts pose as an alternative strategy for transporting loads across considerable distances. Haisman et al. (1972) conducted a study to compare the potential energy conservation achievable by use of four commercially available handcarts: mail cart, golf cart, a small and large garden cart, on both a treadmill and asphalt course. Consequently, data for the mail cart suggested potential reductions as large as 88% when compared to the predicted cost of walking while bearing the same load (Haisman, et al. 1972).

Manipulation and complete displacement of loads from the body may mitigate the overall energy cost needed for transportation; however, it is worth noting that unfavorable consequences reflected in athletic performance may occur when moving excess mass. Specifically, fatigue may occur in the lower extremity after subjecting the body to extended durations of load carriage. Muscular fatigue is characterized by decrements in the muscle's ability to generate force and mitigate ground reaction forces (Verbitsky, et al. 1998; Voloshin et al. 1998, Wang et al. 2013). Knapik et al. (1993) noted decrements in leg strength following a 20 km march regardless of whether the soldier was loaded or unloaded. Currently, research investigates how lower extremity kinetics are affected while bearing external loads; however, no evidence was found that examines the influence of a load carriage task on periodic, unloaded performance.

Vertical Jump Performance

Vertical jump performance is an important skill for success in many sports. The countermovement jump (CMJ) is a popular iteration of vertical jumping and delineates specific phases. According to Spägele et al. (1999), a CMJ can be broken up into an upward propulsion phase, flight, and landing phase. CMJ performance considers maximum force generated by the responsible musculature, peak force, and coordination of body segments (Hopkins, 2000; Sargent, 1921). Jump testing is commonly employed as an assessment of fatigue as well as lower-body power (Donahue et. al, 2021; Judelson et al. 2007; McLellan et al. 2011). Fallowfield et al. (2012) noted considerable decrements in vertical jump height and vertical jump power after participants completed a load carriage event. In a study by McGinnis et al. (2016), notable reductions in countermovement jump height occurred across the fatiguing condition. Similarly, O'Leary et al. (2018) witnessed decreases in vertical jump height in British Army recruits following a 9.7 km loaded march. Monitoring changes in peak force may indicate decrements in jump performance, thus affecting sport performance. Moreover, Dempsey et al. (2014) reported decreases in vertical jump height following a loaded run. Wilson et al. (1995) suggests concentric RFD testing as a valid assessment of dynamic muscular ability as it significantly relates to performance. According to Marques et al (2015), percentage of force at maximum RFD contributes significantly to jump performance. Determining how fluctuations in RFD impact jumping performance can help elucidate the association between CMJ power and club head speed in golfing.

Rate of Perceived Exertion

Self-reported effort is a convenient, quick method to obtain how a participant perceives a given task. Specifically, the BORG (6-20) scale is used to estimate exercise intensity in a variety of testing environments. Within several load carriage studies RPE is noted to change with the mass and placement of a load (Goslin & Stafford, 1986; Stuempfle et al, 2004). Stuempfle and colleagues (2004) saw the average RPE increase across conditions when the load was placed at a low (2.8 ± 0.8) central (3.6 ± 0.6), and high (3.7 ± 1.0) position on the back. Moreover, Goslin and Stafford (1986) witnessed increases in RPE as the mass of the load carried increased as a function of the participant's mass. When considering the sport specific application of RPE, the primary task of the sport must be identified so the reported effort reflects the sport-specific activity. During a round of golf, players will walk an extensive distance while bearing the load of their clubs in different positions. Ikeda et al. (2008) noted RPE decreased significantly when carrying a golf bag with two straps as opposed to the same bag with one.

Golf

Golf is a popular sport enjoyed by millions of people all over the world (Farally et al., 2003; Driggers and Sato. 2017; Kobriger et al., 2006). Moreover, a round of golf necessitates players to cope with a range of physically demanding movement patterns (Hume et al., 2005). A golf swing is broken up into four phases: the address, backswing, downswing, and follow-through phase. The backswing is composed of preparatory movements thereby rotating the clubhead away from the ball (Wilson, 2020). Next, the downswing phase initiates at the top of the backswing and terminates once the club contacts with the ball (Wilson, 2020). Finally, the follow-through ensues once ball contact is made (Wilson, 2020). Golf technique has undergone scientific audit to enhance sport performance. The body of literature deems the cumulative result of accuracy and driving distance as the most compelling factors in golf performance. Each swing generates strength and power from the lower extremities through the body towards the club (Hetu et al., 1998). Consequently, a considerable amount of power behind the golf swing is derived from the lower body. Current literature reveals proper swing mechanics be paired with large ground reaction force (GRF), utilization of the stretch-shortening cycle, transfer of bodyweight, and sequential summation of forces to maximize driving distance (Hellstrom, 2009; Hume, 2005; Leary, 2012). The aforementioned factors directly affect clubhead angular velocity (Hume, 2005). Specifically, linear displacement of the golf ball is a function of the linear velocity, which is directly related to the angular velocity and length of the club lever arm. Research by Wells at al. (2009) demonstrated significant correlations between vertical jump and driver ball speed (r=0.50; p= 0.04) and distance (r= 0.62; p=0.01). The association between vertical jump and golf performance measures alludes to leg power as a critically important variable for golfers to develop power during a golf swing (Wells et al., 2009). Similarly, Sheehan et al. (2018) noted significant associations between club head speed and CMJ height (r= 0.55). Simultaneously, a large effect for relative CMJ power (p= 0.03; d= 1.05) is observed as it relates to club head speed (Sheehan, 2018).

APPENDIX B: ABBREVIATIONS

1. NB- No Bag
2. DSAS- Double Strap Above Sacrum
3. DSBS- Double Strap Below Sacrum
4. SS- Single Strap
5. PC- Pushcart

APPENDIX C: IRB DOCUMENTS

Institutional Review Board (IRB)

Application for Research Approval – Expedited/Full Board

Compliance Information
Please indicate which of the following will be used in your research: (applications may be submitted simultaneously)

☒ Human Subjects ☐ Care and Use of Vertebrate Animals (Submit IACUC Application) ☐ Biohazards (Submit IBC Application)	
Please indicate if the following are included in the study (Check all that apply):	
☒ Recruitment delivered to georgiasouthern.edu email addresses ☐ Deception ☐ Prisoners ☐ Children ☐ Individuals with impaired decision making capacity, or economically or educationally disadvantaged persons	☐ Video or Audio Recordings ☐ Human Subjects Incentives ☒ Medical Procedures, including exercise, administering drugs/dietary supplements, and other procedures, or ingestion of any substance
Is your project a research study in which one or more human subjects are prospectively assigned to one or more interventions (which may include placebo or other control) to evaluate the effects of those interventions on health-related biomedical or behavioral outcomes. See the IRB FAQ for help with the definition above. ☐ Yes ☐ No If yes, attach Good Clinical Practice (GCP) CITI training appropriate to the project.	

Instructions: Please respond to the following as clearly as possible. The application should include a step by step plan of how you will obtain your subjects, conduct the research, and analyze the data. Make sure the application clearly explains aspects of the methodology that provide protections for your human subjects. Your application should be written to be read and understood by a general audience who does not have prior knowledge of your research and by committee members who may not be expert in your specific field of research. Your reviewers will only have the information you provide in your application. Explain any technical terms, jargon or acronyms.

DO NOT REMOVE THE QUESTIONS/PROMPTS.

1. Personnel
A. Please list ALL individuals who will be conducting research on this study. This includes the principal investigator, co-investigators, and any additional personnel. Please describe the level of involvement in the process and the access to information/data that each may have.
Austen Arnold (primary investigator, access to all information, Dr. Samuel Wilson (co-investigator, access to all information), Dr. Jessica Mutchler (Investigator, access to all information), Dr. Barry Munkasy (investigator, access to all information), Hui Tang (investigator), Benjamin Paquette (investigator), Petra Kis (investigator), Diego Castro Diaz (investigator), and Jacob Smith (investigator), Abigail Hotchkiss (investigator), Ryan Collins-Smith (investigator) .
B. Please detail the experience of each researcher. Please include any credentials, training, or education that directly relate to the procedures in this research. Specifically address any experience or knowledge that will help mitigate any risks associated with this research.
Austen Arnold (M): Masters student in the Biomechanics Lab experienced in biomechanical data collection techniques. Sam Wilson (F): Faculty advisor. Biomechanics and Motor Control Faculty in the Biomechanics Lab. Experienced in biomechanical data collectiontechniques. Experience in previous balance, gait, sports biomechanics, and golf research.

Jessica Mutchler (F): Athletic Training and Biomechanics Faculty in the Biomechanics Lab. Experienced in biomechanical data collection techniques. Experience in sports biomechanics, injury biomechanics, and athletic training research. Barry Munkasy (F): Biomechanics faculty and lab director of the Biomechanics lab. Experienced in biomechanical data collection techniques. Experienced in sports biomechanics, and vertical jump research.
Hui Tang (M):): Masters student in the Biomechanics lab experienced in biomechanical data collection techniques. Benjamin Paquette (M):): Masters student in the Biomechanics lab experienced in biomechanical data collection techniques and athletic training.
Petra Kis (M):): Masters student in the Biomechanics lab experienced in biomechanical data collection techniques. Diego Castro Diaz (U): Undergraduate student intern in the Biomechanics Lab
Jacob Smith (U): Undergraduate student intern in the Biomechanics Lab
Abigail Hotchkiss (U): Undergraduate Honors Student in the Biomechanics Lab

2. Purpose

Institutional Review Board (IRB)

Application for Research Approval – Expedited/Full Board

A. Briefly describe in one or two sentences the purpose of your research.

The aim of this study is to examine how different golf bag loading strategies influence various biomechanical and physiological performance measures.

B. What questions are you trying to answer in this project? Please include your research question in this section. The jurisdiction of the IRB requires that we ensure the appropriateness of research. It is unethical to put participants at risk without the possibility of sound scientific result. For this reason, you should be very clear about how participants and others will benefit from knowledge gained in this project.

1. Is vertical jump performance affected by varying types of golf specific load carriage?
2. Is human balance affected by varying types of golf specific load carriage?
3. Is human gait affected by varying types of golf specific load carriage?
4. Is human metabolic expenditure affected by varying types of golf specific load carriage?
5. Are ratings of perceived exertion and discomfort affected by varying types of golf specific load carriage?

C. Provide a brief description of how this study fits into the current literature. Have the research procedures been used before? How were similar risks controlled for and documented in the literature? Have your instruments been validated with this audience? Include citations in the description. Do not include dissertation or thesis chapters.

An estimated 12.8 million adult golfers play 8 times a year in the United States (Ikeda, Cooper, Gulick, & Nguyen, 2008). Notable benefits of golf include aerobic conditioning, trunk muscle strength, body composition, and serum lipids. All of these benefits can be attributed to the high volume of walking demanded by the sport. Walking speed, distance, course design, and method of golf bag transportation coincide with the long bouts of walking during a round. Commonly, golfers transport their clubs by means of a strapped bag or a trolley.

The golf swing is considered one of the most complex biomechanical motions in sport to execute and repeat, given the challenging performance requirement to swing a relatively long club at a relatively small ball with maximal velocity (Lindsay, Mantrop, & Vandervoort, 2008). To do this efficiently and effectively, one must maintain optimal posture and balance (Maddalozzo, 1987). Load carriage has been studied extensively in military personnel and carrying backpacks. These studies have looked at the influence of load carriage mass and position on postural sway and balance measures. Schiffman conducted a study and found that the mass of the load in a high and close position was easier for soldiers to control than the low and away position and increased postural sway (Schiffman, Bensel, Hasselquist, Norton, & Piscitelle, The Effects of Soldiers' Loads on Postural Sway, 2004). There is now considerable research relating to load carriage that considers metabolic, kinematic, kinetic, electromyographic, and subjective perceptual differences in golf. A recent examination (Holland & Godwin, 2019), compared the metabolic demands of single and double-strap golf bag, suggesting increased demand while carrying the single strap bag. Further, there is evidence to suggest that various types of load carriage alter human balance and gait kinematics. However, the effects of golf bag specific load carriage on human balance, and gait are currently unknown.

Load carriage has been shown to influence balance measures in a military setting and in adolescents carrying backpacks. Not only does the mass of the load influence balance measures, but the placement of the load influences balance as well. There is little research done on load carriage in golf. The golf swing has been thoroughly examined and the mechanics of a golf swing require optimal balance, and more skilled golfers exhibit higher lower body power, center of pressure movement during the swing. Other studies have been done to determine the metabolic costs of carrying single strap bags versus double strap bags and pushing a cart versus carrying a bag. A decrease in metabolic cost was found in double strap bags compared to single strap bags; however, a pushcart was found to be even more efficient than a double strap bag. There is a gap in the literature when it comes to the influence of load carriage on balance and lower body kinetics during a vertical jump in golf. Because many golfers carry their bags, this study investigates the difference in balance measures, vertical jump measures, metabolic measures, and subjective measures of exertion between four load conditions.

References:

Ikeda, E. R., Cooper, L., Gulick, P., & Nguyen, P. (2008). The metabolic cost of carrying a single- versus double-strap golf bag. *The Journal of Strength and Conditioning Research, 22*(3), 974-977.

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Rice, H., Fallowfield, J., Allsopp, A., & Dixon, S. (2017). Influence of a 12.8-km military load carriage activity on lower limb gait mechanics and muscle activity. *Ergonomics, 60*(5), 649-656. doi:10.1080/00140139.2016.1206624

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Lindsay, D. M., Mantrop, S., & Vandervoort, A. A. (2008). A Review of biomechanical Differences Between Golfers of Varied Skill Levels. *Annual Review of Golf Coaching 2008*, 2-6.

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Holland, C., & Godwin, M. (2020). The Metabolic Demand of External Load Carriage in Golfers: A Comparison of a Single Versus Double-Strap Golf Bag. *The Journal of Sports Medicine and Physical Fitness*, 1963-1967.

Schiffman, J. M., Bensel, C. K., Hasselquist, L., Norton, K., & Piscitelle, L. (2004). *The Effects of Soldiers' Loads on Postural Sway.* Natick: U.S. Army Natick Soldier Center.

3. Outcome

Please state what results you expect to achieve. Who will benefit from this study? How will the participants benefit (if at all)?

Remember that the participants do not necessarily have to benefit directly. The results of your study may have broadly stated outcomes for a large number of people or society in general.

1. The push cart will require the least metabolic expenditure of all loading strategies and possess minimal influence on biomechanical performance variables.
2. The single strap loading strategy may elicit the greatest metabolic demand and impact biomechanical performance variables considerably.

Participants of the study will not directly benefit.

The outcomes of this study may contribute to the growing body of golf performance literature. The effects of each loading strategy may direct the behaviors of seasoned and recreational golfers.

4. Describe Your Subjects
A. Maximum number of participants
20
B. Briefly describe the study population.
Male and female college-aged individuals (18-30) with no current musculoskeletal, metabolic, or cardiovascular disease.
C. Applicable inclusion or exclusion requirements (ages, gender requirements, allergies, etc.)
Inclusion: -Must possess golfing experience within the last six months Exclusion: -Current musculoskeletal, metabolic, or cardiovascular disease
D. How long will each subject be involved in the project? (Number of occasions and duration)
The total number of time for each subject will be approximately 15 hours over 6 sessions (Day 1 ~30 minutes, Days 2-6 ~3 hours each). Each subject will experience 5 different testing conditions with each condition taking place on a different day. The 5 conditions consist of: 1) no golf bag 2) single strap golf bag 3) double strap golf bag worn above the sacrum 4) double strap golf bag worn below the sacrum and 5) a golf bag on a push cart.

5. Recruitment
Describe how subjects will be recruited. (Attach a copy of recruitment emails, flyers, social media posts, etc.) DO NOT state that subjects will not be recruited.
1) Recruitment will be done in person by going to classes within the Department with instructor approval. Verbal recruitment script attached.

6. Incentives
A. Are you compensating your subjects with money, course credit, extra credit, or other incentives? ☐ Yes ☒ No
B. *If yes, indicate how much and how they will be distributed.*
C. *Describe if and how you will compensate subjects who withdraw from the project before it ends and any exclusion criteria from compensation.*

7. Research Procedures and Timeline

A. Which statement best describes the procedures in this protocol (including recruitment, consent, interventions, etc,)? ☐ This data is being collected without ANY in person interactions with participants (ie. online surveys, virtual interviews, etc.) ☐ This data is being collected in person with participants but without any direct physical contact (ie. in person interviews, in person focus groups, etc.). **Safety Plan REQUIRED** ☒ This data requires direct physical contact with participants (ie. placing sensors on a participant, etc.) **Safety Plan REQUIRED**
B. Outline step-by-step what will happen to participants in this study (including what kind of experimental manipulations you will use, what kinds of questions or recording of behavior you will use, the location of these interactions). Focus on the interactions you will have with the human subjects. Specify tasks given as attachments to this document.

All testing procedures will be done within the Biomechanics Laboratory at Georgia Southern University. The testing procedure for each participant will follow the following events.

Day 1:

On the first day, participants will have all testing procedures explained, and will read and sign the informed consent. After which they will fill out a PARQ form and the participants will be familiarized with the static balance tests, as well as the Y balance test, vertical jump, and walking procedures.

Days 2-6:

Days 2-6 will serve as experimental days (separated by 48 hour rest intervals) in a counterbalanced design including all testing conditions (dual strap high, dual strap low, single strap, push cart, and control [no bag]) The bag weighs 11 kilograms (24 pounds). Participants will be outfitted in a spandex shirt and shorts prior to any sensor or marker placements. Spandex clothing articles are treated with hypoallergenic detergent between uses. A heart rate monitor (Polar H9, Kempele, FI) will be secured just below the participant's sternum, and around their back. Next, electromyography (EMG) sensors (Delsys Inc., Natick, MA, USA) will be placed on the participant's medial gastrocnemius head, tibialis anterior, vastus medialis, and semitendinosus muscles on each leg. EMG sensor placement will start with palpating for the muscle belly, cleaning and shaving each site. Furthermore, retroreflective markers will be placed on the participant's lower extremities in a Lower Body Plug in Gait (P.i.G.) to generate a skeletal model in the Vicon Motion Capture software (Vicon Motion Ltd., Version 1.8.5, Oxford, England). Participants will walk along a designated path around the room within the Biomechanics Laboratory in each condition. At each 0.25 mile of distance covered, participants will remove the bag (if applicable) and complete vertical jump testing and report perceived exertion via the Borg (6-20) scale. After testing, participants will put the bag back on (if applicable) and continue walking. At each 0.5 mile of distance covered participants will remove the bag (if applicable) and complete balance testing, vertical jump testing, and report perceived exertion. After testing, participants will put the bag back on (if applicable) and continue walking. This will continue until the participant has completed 3.0 total miles of distance covered. Testing procedures that will be completed at the designated distances are described below.

Perceived Exertion:
Participants will be asked to report their rating of perceived exertion via the Borg (6-20) Scale provided by researchers.

Balance Testing:
The balance test will consist of 12 total trials with each trial lasting 20 seconds in duration, and a rest period of 10 seconds will take place in between each test. Each of the following conditions will be repeated 3 times for the balance trials: 1) eyes open standing on the BTrackS (San Diego, CA, USA), 2) eyes closed standing on the force plate, 3) eyes open standing on the AIREX Balance Pad (Power Systems Inc., Knoxville, TN, USA) positioned on the BTrackS (San Diego, CA, USA), 4) eyes closed on the AIREX Balance Pad.

Y Balance Testing:
In the Y-balance test, tape will be placed on the floor with measurement increments labeled on the tape. The tape will be in a 'Y' formation with the participant in the center. The participant will stand on a single leg in the center of the tape and reach with the other leg as far as possible. A trial must be repeated if the participant loses balance or if they use the free leg to regain their balance. Trials will be repeated until the participant completes three successful trials in each direction on each leg, for a total of 42 trials per visit.

Vertical Jump Testing:
Participants will be instructed to perform a countermovement jump as high as possible while standing on a force plate. The participant's stance and countermovement depth will be self-selected. A total of three jumps will be performed.

C. Identify any activity included in the research description that will occur without modification regardless of the research effort. (E.g., A class exercise that is part of the normal course activities that is not altered for the research about which you will collect data or a team warm-up exercise session that is not altered for the study about which you will collect data.) Answer "N/A" if this does not apply.

N/A

D. Describe how legally effective informed consent will be obtained. (Also, attach a copy of the consent form(s).)

Upon arrival at the Kinesiology Laboratory, participants will be provided with a written and verbal description of the study's purpose, methods, and inclusion criteria. If the participant fits the inclusion criteria and agrees with the study design, he/she will be asked to sign the informed consent. Researchers will answer any questions posed by the participant and remind the participant that participation is completely voluntary.

E. *If minors are to be used describe procedures used to gain consent of their parent (s), guardian (s), or legal representative (s), and gain assent of the minor.*

☒ N/A or Explain:

F. Describe all study instruments and whether they are validated. Attach copies of questionnaires, surveys, and/or interview questions used, labeled accordingly.

The experimental procedure will involve measurements of ground reaction force, muscle activity, 3D motion capture, jump height, metabolic expenditure, and perceived intensity of task using AMTI force plate (Watertown, MA, USA), BTrackS (San Diego, CA, USA), AIREX Balance Pad (Power Systems Inc., Knoxville, TN, USA), Delsys wireless EMG system (Delsys Inc., Natick, MA, USA), Vicon Motion Capture software (Vicon Motion Ltd., Version 1.8.5, Oxford, England), Vertec (JUMPUSA.com, Sunnyvale, CA, USA), GPS tracker, and Borg Scale for Rate of Perceived Exertion (RPE).

G. Describe how you will protect the privacy of study participants.

Participants will receive a unique ID number without free of identifiable information (i.e. a series of random letters and numbers). Additionally, only one participant will be present for each data collection.

8. Data Analysis

A. Briefly describe how you will analyze and report the collected data.

Postural Sway Measures:

Quiet standing center of pressure (COP) will be analyzed using the force platform. The ten conditions on the force platform use participant's COP to quantify postural sway while somatosensory and visual environments are systematically altered. The dependent variables of interest are the sway velocity components in the medial-lateral (M/L) and anterior-posterior (A/P) directions, and root mean square (RMS) of COP displacement in the AP and ML directions. Sway velocity (cm/s), is a measure of the change of the COP per unit time, where the value is representative of changes in the location of the COP in the M/L and A/P directions. Higher values indicate decreased postural stability, as they imply larger position changes of the COP. Previous research has identified sway velocity as an appropriate dependent measure for use in determining postural stability (Wade et al., 2004). RMS (cm) denotes a measure for mean body sway of a specific period of time and a comparison to be made between conditions.

Y-Balance Measure:

In the Y-balance test, tape will be placed on the floor with measurement increments labeled on the tape. The tape will be in a 'Y' formation positioned at 0° anterior, 45° posteromedial (135°), and 45° posterolateral (225°) with the participant in the center. The participant will stand on a single leg in the center of the tape and reach with the other leg as far as possible. A trial must be repeated if the participant loses balance or if they use the free leg to regain their balance. Trials will be repeated until the participant completes three successful trials in each direction on each leg, for a total of 18 trials per visit. Three successful trials on each leg in every direction will be completed and the average of the three trials will be recorded as the reach length. The reach length will be expressed in the results as a percentage of the length of the leg from the anterior superior iliac spine to the distal medial malleolus.

Vertical Jump:

Ground reaction force data was collected using a 600 x 400-mm force platform AMTI force plate (Watertown, MA, USA). Force data will collected at 1,000 Hz. All variables derived from the force platform where calculated using the impulse – momentum method. The propulsive phase of each CMJ trial was identified using methods described by Chavda et al. and McMahon et al. Only the propulsive phase of the CMJ was used in determination of peak and mean values of the force, velocity, and power. Time to peak for each of the previous mentioned variables occurred from the initiation of the propulsive phase to the point at which the peak value was measured.

Additionally, impulse was calculated using force data collected from the force platform. The impulse was calculated at each frame as the mean net force of the current frame and the previous frame multiplied by 0.001 as this was the period of time between frames. All impulse calculations were then summed together from the initiation of the propulsive phase through takeoff to determine propulsive impulse. Reactive strength index was calculated as a ratio of the jump height over time to takeoff. Time to takeoff consisted of the time

from which movement was detected to the time of takeoff using the methods described by Chavda et al. Finally, propulsive duration was calculated as the time from initiation of the propulsive phase to the time of takeoff.

Chavda S, Bromley T, Jarvis P, Williams S, Bishop C, Turner AN, et al. Force-time characteristics of the countermovement jump: analyzing the curve in Excel. Strength Cond J 20(2): 67–77, 2018.

McMahon JJ, Suchomel TJ, Lake JP, Comfort P. Understanding the key phases of the countermovement jump force-time curve. Strength Cond J 40(4): 96–106, 2018.

B. What will you do with the results of your study (e.g. contributing to generalizable knowledge, publishing sharing at a conference, etc.)?

The results from this study will be used in manuscripts for publication and presentations at conferences related to biomechanics and sports medicine.

C. Include an explanation of how the data will be maintained after the study is complete. Specify where and how it will be stored (room number, password protected file, etc.)

All data will be stored in Austen Arnold's office in the Kinesiology Laboratory.

D. If this research is externally funded (funded by non-Georgia Southern funds), student researchers must specify which faculty or staff member will be responsible for records after you have left the university. The person listed below must be included in the personnel section of this application.

Responsible Party:

☒ **N/A**

E. Anticipated destruction date or method used to render data anonymous for future use. Please make sure this in consistent with your informed consent.

☐ Destroyed 3 Years after conclusion of research (minimum required for all PIs)

☒ Other timeframe (min 3 years): 5

Special Conditions

9. Risk
Even minor discomfort in answering questions on a survey may pose some risk to subjects. Carefully consider how the subjects will react and address ANY potential risks.
A. *Is there greater than minimal risk from physical, mental, or social discomfort?*
☒ No *If no, Do not simply state that no risk exists. If risk is no greater than risk associated with daily life experiences, state risk in these terms.* During the static balance trials, researchers will stand behind and on either side of the participant if he/she were to fall. Further, participants will perform a familiarization trial for the vertical jump test to be better acquainted with the task. Additionally, participants will be asked if they are allergic to adhesive tape to determine whether EMG can be placed.
☐ Yes *If yes, describe the risks and the steps taken to minimize them. Justify the risk undertaken by outlining any benefits that might result from the study, both on a participant and societal level.*
B. Will you be carrying out procedures or asking questions that might disturb your subjects emotionally or produce stress or anxiety? If yes, describe your plans for providing appropriate resources for subjects.
No

10. Research Involving Minors
A. Will minors be involved in your research? ☐ Yes ☒ No

B. *If yes, describe how the details of your study will be communicated to parents/guardians. Please provide both parental consent letters and child assent letters (or processes for children too young to read).*
C. *Will the research take part in a school (elementary, middle, or high school)?* ☐ Yes ☒ No
D. *If yes, describe how permission will be obtained from school officials/teachers, and indicate whether the study will be a part of the normal curriculum/school process.*
☐ Part of the normal curriculum/school process ☐ Not part of the normal curriculum/school process

11. Deception
A. Will you use deception in your research? ☒ No Deception ☐ Passive Deception ☐ Active Deception
B. If yes, describe the deception and how the subject will be debriefed. Include a copy of any debriefing materials. Make sure the debriefing process is listed in your timeline in the Procedures section.
C. Address the rationale for using deception.
Be sure to review the deception disclaimer language required in the informed consent. Note: All research in which active deception will be used is required to be reviewed by the full Institutional Review Board. Passive deception may receive expedited review.

12. Medical Procedures
A. Does your research procedures involve any of the following procedures: ☒ Low expenditures of physical effort unlikely to lead to physical injury ☐ High expenditures of physical effort that could lead to physical injury ☐ Ingesting, injecting, or absorbing any substances into the body or through the skin ☐ Inserting any objects into bodies through orifices or otherwise ☐ Handling of blood or other bodily fluids ☐ Other Medical Procedures ☐ No Medical Procedures Involved

B. *Describe your procedures, including safeguards. If appropriate, briefly describe the necessity for employing a medical procedure in this study. Be sure to review the medical disclaimer language required in the informed consent.*
Trained, non-physician exercise specialists certified in CPR, basic life support, and exercise testing will supervise participants undergoing testing. All participants and their guardians will be instructed to report any unexpected problems or adverse events they may encounter during the course of the study to study personnel. Medical care is not available in the event of injury and individuals will be asked to sign liability waivers prior to beginning testing. In the event of an emergency, the following action is taken: 1) Call 911 if participant is unconscious or needs immediate medical attention (e.g., chest pain, acute severe musculoskeletal injury). Explain to the dispatcher what has occurred and what assistance is needed. If needed, use of the automated external defibrillator (AED) which is located in the laboratories where the research will be conducted if the emergency is of a cardiac origin; 2) CPR being performed by the investigators in the absence of the AED or until it arrives; and 3) Follow up with the participant in person the same day to confirm the physical condition/status of the participant.
C. Describe a medical emergency plan if the research involves any physical risk beyond the most minimal kind. The medical research plan should include, but not necessarily be limited to: emergency equipment appropriate for the risks involved, first rescuer actions to address the most likely physical risk of the protocol, further actions necessary for the likely risks.

Institutional Review Board (IRB) *Application for Research Approval – Expedited/Full Board*

WATERS COLLEGE OF HEALTH PROFESSIONS

DEPARTMENT OF HEALTH AND KINESIOLOGY

Informed Consent
The Effect of Golf Bag Load Carriage on Biomechanical and Physiological Performance Measures

You are being invited to participate in **The Effect of Golf Bag Load Carriage on Biomechanical and Physiological Performance Measures** study. The primary investigator is Austen Arnold and is currently a Masters student at Georgia Southern University. The purpose of this research is to investigate the influence of various golf bag loading strategies on biomechanical and physiological performance measures. Specifically, metabolic expenditure, vertical jump performance, perceived effort, and muscle activation patterns will be examined as a result of the type of golf bag used.

In order to participate, you must be between the ages of 18- 30, and meet all of the following criteria: no current musculoskeletal, metabolic, or cardiovascular disease, have some golfing experience within the last 6 months, and are able to walk 3-miles. You will be asked to wear athletic clothing and your preferred athletic, non-high top shoes. After reporting to the Kinesiology laboratory, you will be asked to complete a Physical Readiness Questionnaire (PAR-Q+). Upon completion of these questionnaires, you will have the opportunity to read and ask any questions regarding this document, and testing methods. After signing the consent document, your height and weight will be recorded by the researcher.

Testing session will consist of six visits to the kinesiology laboratory. The initial visit will consist of reading and completing the previously mentioned paperwork, followed by familiarization with the balance, and vertical jump. Each visit will be separated by 48 hour rest intervals. The same testing procedures will be administered for each subsequent visit; however, the loading condition will differ.

In preparation for testing, researchers will place EMG (electromyography) sensors to measure the muscle activity of 4 leg muscles. In order to get a strong EMG signal, we may have to shave, clean, and lightly abrade the placement areas.

Once EMG electrodes are placed on your legs, special markers will be placed on major lower body landmarks, such as hip bones, upper legs, and your feet. These markers will track your body movements with special cameras in the lab. This will allow us to create a virtual skeleton of your body and measure your different movements during the study. Your skeleton will be unidentifiable in the computer. Once the EMG electrodes and reflective markers are placed on you, the researchers will ask you to stand in the center of the room so the cameras can identify specific body parts of your lower body. You will be asked to stand still for one to two minutes.

Next, you will be asked to perform a series of balance tests. During the balance tests you will be asked to stand as still as possible on a platform with hands on hips for 20 seconds a trial. You will perform 3 trials of each condition, with conditions including normal standing with eyes open, normal standing with eyes closed, standing on a foam pad with your eyes open, and standing on a foam pad with eyes closed. For the final balance test, a "Y" will be taped to the floor, and a researcher will ask you to stand where the tape intersects. The researcher will ask you to balance on either your dominant or non-dominant foot, and you will be asked to reach out your other foot towards the three other pieces of tape. Next, you will be asked to balance on the other foot and perform the same movement.

Upon completion of the balance tests, you will be asked to perform jump testing. This jump will require both your legs and arms to move in a specific pattern which will be demonstrated by the researcher. During the jumping test, a tall, metal pole with different colored prongs will be above your head. You will be asked to reach for and hit the highest prong you can. Once all of these tests are completed, the researcher will ask you to score how you feel on a scale from 6-20.

For the next step in the study, you will be equipped with a predetermined, randomized loading condition for the 3-mile walk. Once you have been given the condition, you will be asked to wear it throughout the duration of the walk. Throughout the walk, you will be asked to stop at quarter-mile increments indicated by the researcher to perform a vertical jump and report your perceived exertion on a 6-20 scale. After these tests, you will continue walking to the half mile mark where you will perform the vertical jump, balance, and walking tests. The quarter and half-mile assessments will repeat until the 3-mile walk is completed. Following the walk, researchers will ask you to perform each test one final time.

There is a risk that you might have an allergic reaction to the adhesive tape used for the EMG electrodes, or an adverse reaction to the abrading and cleaning of the EMG electrode sites. There is also a risk of injury during the vertical jump assessment. Prior to being tested for the jump, researchers will demonstrate the movement, and ensure that you are comfortable with performing the jump on your own. Spotters will be present to assist you in case you fall during the test. There is also a risk of falling during the balance assessments. Once more, spotters will be present to assist you in case you lose your balance. You understand that medical care is available in the event of injury resulting from research but neither financial compensation nor free medical treatment is provided.

<u>Precautions will be taken in accordance with current Georgia Southern policies to reduce the risk of the spread of</u>