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Eight-Weeks of High Intensity Interval Training (HIIT) Improves Esport Performance Scores in Super Smash Brothers Ultimate (SSBU) Competitors

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Abstract

Multiple theoretical frameworks of gaming competence pose that specific cognitive variables contribute to success in esports. These variables have also been shown to improve due to multiple types of chronic endurance training (e.g., long-slow distance running, interval training etc.). Research on exercise and cognition points to a potential benefit of high intensity interval training (HIIT) on esport performance. However, these relationships have not been tested in a randomized controlled trial. The primary aim of this study was to interrogate the effects of chronic endurance training on esport and visuomotor performance in SSBU competitors as a part of a larger e-sport project. Participants were randomized into the exercise or control group, completed eight weeks of HIIT, and then participated in three semi-round robin SSBU competitions. There was no significant effect of chronic endurance training ($p=0.13$) However, chronic training combined with an acute bout of HIIT points to a combined effect of acute and chronic endurance training on esport performance ($p<0.001$). These findings serve as preliminary evidence of a positive effect of endurance exercise on esport performance.

Keywords: SSBU, esports, exercise, performance

Highlights

- Results serve as evidence of a positive effect of HIIT on esport performance in SSBU Competitors
- There was no significant effect of chronic HIIT alone. However, there was a significant effect of a combination of acute and chronic HIIT on esport performance in SSBU Competitors.
- When compared to our previous work, the combined effect of acute and chronic HIIT on esport performance is greater than the effect of acute HIIT alone.

Introduction:

There has been a recent surge in organized video game competition known as electronic sport (esports). Recent financial opportunities for competitors, advertisers, scholars and organizations alike have increased interest in esport performance research [1]. Cognitive research identifies the primary determinants for success in digital gaming as: 1) visual attention, 2) short-term and working memory, and 3) task-switching [2-8]. Research indicates cognitive performance is higher in gamers [7-10], and cognitive performance has been shown to improve because of video game interventions. Results from these studies align with theoretical frameworks of gaming competence suggesting success in digital gaming relies on problem-solving with a focus on attention and memory [11, 12].

Exercise science research indicates that cardiovascular exercise improves cognitive performance [13-19]. Data from both acute [14, 17, 18] and chronic exercise studies [14, 17, 18] indicate participants improve scores on indices of task switching [20, 21], visual attention [22, 23], and working memory [24, 25]. Furthermore, individuals with greater maximal aerobic capacity tend to score higher on tests of attention, memory, and visuomotor performance when compared to less fit participants [26].

Qualitative studies assessing physical activity suggest that professional and highly ranked esport competitors exceed American College of Sports Medicine physical activity recommendations for the general population (self-reported 1.08 hour daily average), while over 50% of esport athletes believe that physical activity improves their performance [27, 28]. It should be noted that while these competitors exceed step count recommendations, competitors were still classified as “overweight or obese” according to the BMI scale. Researchers also report that professional esport organizations hire personal trainers to design exercise training regimens for their esport athletes [28].

The relationship between cardiovascular exercise and cognitive function associated with success in digital gaming suggests a potential benefit of aerobic activity on esport performance. However, no study to date has observed the effect of a chronic exercise intervention on esport athletes’ performance during competition. This study is part of a larger project examining exercise and e-sport performance [29]. In this study we examine the chronic effects of cardiovascular exercise on both cognitive and competitive esport performance. We hypothesized that participants who completed a prescribed eight-week endurance training program would experience greater improvements in competitive esport performance scores when compared to a non-exercising Control group.

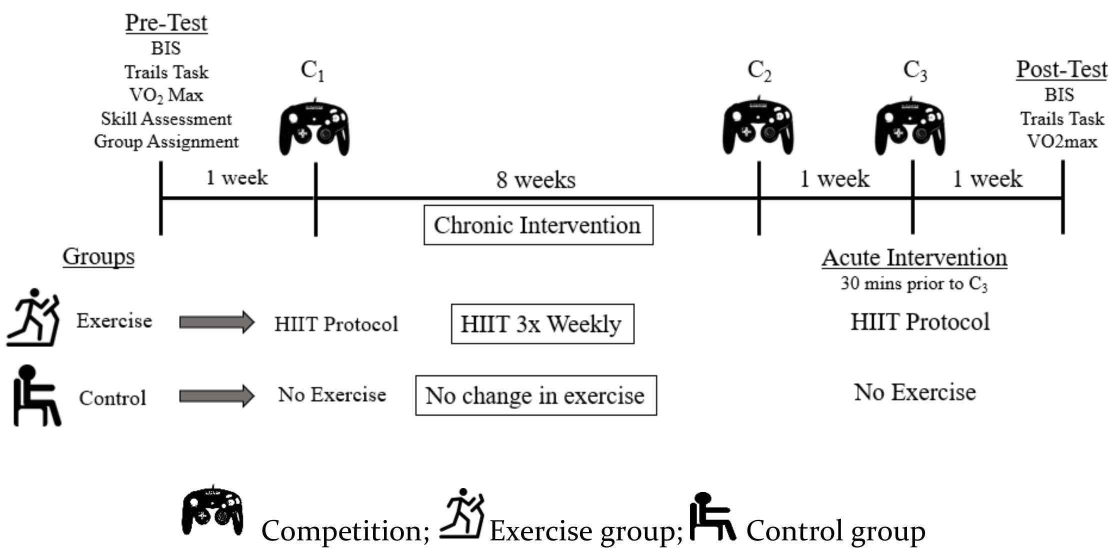
Methods

Participants

Researchers recruited 26 active competitors in the Alabama SSBU esport community ages 17 – 25 (24 male (20.6 ± 2.27), 2 female (21 ± 1)). Researchers obtained written and signed letters of parental assent for any participant under the age of 19 per state research guidelines. Participant height in cm and weight in kg were as follows. Sample height (174.32 ± 10.29), Exercise height (175.71 ± 9.67), Control height (173.03 ± 11.09). Sample weight (81.86 ± 24.08), Exercise weight (79.32 ± 25.87) Control weight (84.23 ± 21.6). Exclusion criteria included any visual, cognitive, or mechanical impairments that would prevent a participant from safely participating in acute exercise, chronic exercise, or an esport competition. Written informed consent was obtained from each participant prior to data collection. All research protocols were approved by the Auburn University Institutional Review Board (Protocol#21-350).

Study Design

Figure 1 — Study Design. BIS, Bioelectric Impedance Spectroscopy; HIIT, High Intensity Interval Training; VO_2, volume of oxygen consumption



A 2 x 3 [group (Control, Exercise) and time (C_1-C_3)] repeated measures design was implemented in this study. Detailed measurement protocols of dependent variables are previously described [29]. Baseline SSBU skill was measured using tournament results for eight weeks preceding the study, while esport performance was assessed using SSBU round robin competition results throughout the course of the study. The dependent variables of esport performance, body fat percent (BF%), cardiorespiratory fitness (VO_2 max), and cognitive performance were assessed through bioelectric impedance spectroscopy (BIS) [30], open circuit spirometry and a treadmill Bruce Protocol, [31], and Trails A and B Tasks [32], respectively. esport performance was assessed at three timepoints (C_1 – C_3), while pre-test/post-test measures included body composition, VO_2 max, and cognitive performance.

Initial Skill Assessment

Tournament results for every participant for the eight weeks prior to the first study timepoint were collected using the Smash Data section of the PGStats website (Panda Global, Detroit, MI, USA). Baseline SSBU participant skill was quantified as a participant's average tournament results expressed as a percentile.

Body Composition

Body composition [body fat % (BF%)] was measured using the SFB7 bioelectrical impedance spectroscopy analyzer (Impedimed; Pinkenba, Queensland, Australia). Participants were instructed to cease all alcohol and caffeine consumption at least 12 hours prior to body composition testing. To ensure participant hydration status, a urine specific gravity test was conducted via portable refractometer (V-Resourcing, Hunan, China). Researchers provided dehydrated participants (i.e., sg < 1.025), with water and re-assessed hydration at 15-minute intervals until participants were properly hydrated.

VO_2 Max Testing

Maximal aerobic power testing was conducted using a modified graded treadmill Bruce Protocol [33], open circuit spirometry, and a metabolic cart (Parvomedics, Salt Lake City, Utah, USA). To observe heart rate, researchers outfitted participants with an eq02+ Life Monitor (EquiVital, Cambridge, UK). Participants followed the Bruce Protocol until volitional fatigue was reached. Validity of tests was determined using volitional fatigue as well as one of the following termination criteria: 1) a respiratory exchange ratio of ≥ 1.15; 2) a plateau in VO_2 determined by a change no greater than 100 ml·min^{-1} in the final 30 seconds of the previous stage; or 3) a heart rate within 10 beats·min^{-1} of the participant's maximal heart rate, as determine by the age-predicted heart rate max equation (220 – age). If volitional fatigue was reached without satisfaction of the additional termination criteria, the participants were asked to redo the test.

Trails Task

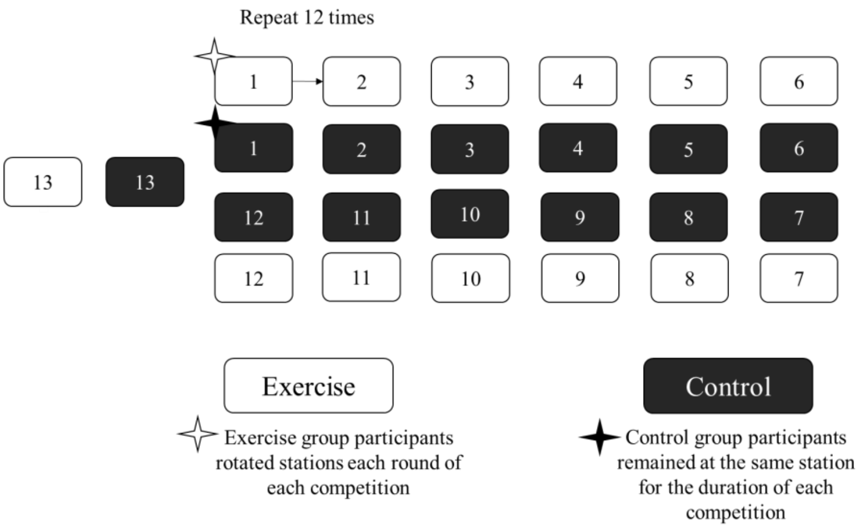
Researchers administered Trails A and B Tasks to assess visuomotor performance [32]. Both Trails Task A and Trails Task B consisted of a 25-item timed trial preceded by an 8-item warmup. The switch cost score was calculated as the difference in time to completion for the two Trails. All Trails A and B testing was performed by the same member of the research staff, in a secluded room free from any potentially distracting auditory or visual stimuli. All conditions for testing were replicated for each participant and from pre- to post-testing, including member of the research staff, auditory stimuli, visual stimuli, and location.

Groups Assignment

Researchers matched participants into pairs based on game skill (described above) and baseline VO_2 max as determined from baseline pre-testing. One participant from each matched pair was randomly assigned via coinflip to either the Exercise or Control group so that n = 13 for each group.

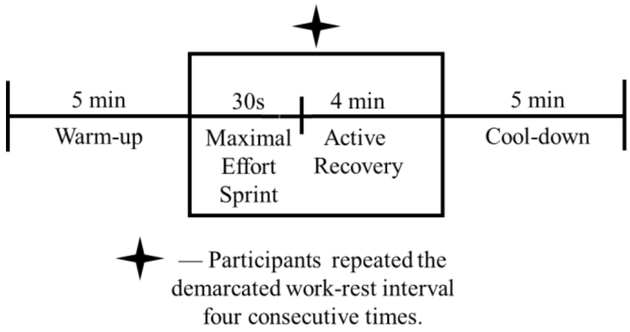
Competitions

Figure 2 — Competition format. Numbers represent individual participants at gaming stations. Exercise participants rotated left, the participants in the Control group remained stationary [29].



Each gaming setup contained a Nintendo Switch, (Nintendo, Kyoto, Japan), gaming monitor, and either a physical or digital copy of SSBU for the Nintendo Switch as previously described [29]. Using their own controller, each participant played a "Best of 3" set against each member of the opposing group using the unified Alabama SSBU ruleset. In a "Best of 3" set, for a participant to be declared the winner, they needed to win two total games against their opponent before they proceeded to the next round of competition. Three competitions were completed for this study, labeled $C_{1\text{-}3}$ respectively (Figure 1). The semi-round robin competition style is diagramed in Figure 2.

***Figure** 3 — Acute high intensity interval training (HIIT) protocol [29]. min, minutes*



Chronic Intervention

During C_1 all participants arrived 24 hours abstained from exercise and participated in the semi-round robin competition style outlined in Figure 2. Following C_1, participants in the Exercise group began an eight-week chronic exercise intervention. Control group participants were instructed to make no changes to their daily exercise habits. Participants in the Exercise group completed an eight-week at home HIIT intervention. They self-selected from the following exercise modalities: 1) stationary bike, 2) elliptical, 3) treadmill, 4) outdoor running, or 5) outdoor cycling. Virtual monitoring via the Discord® social media platform was used for all communication during the study. Every exercise session for every participant was virtually supervised by a member of the research team. Exercise intensity was measured using a Fitness Tracker (Fitbit, San Francisco, CA, USA). During week one of training each participant completed four high intensity bouts of exercise at a self-selected intensity based on heart rate reserve and perceived exertion. Each bout was followed by a four-minute recovery period at a self-selected pace. The intensity of the HIIT and active recovery bouts and the number of exercise bouts increased gradually each week as outlined in Table 3. All workouts were preceded by a five-minute warm-up and concluded with a five-minute cooldown at ≥ 50% heart rate reserve (HRR) or ≥ 5/10 rate of perceive exertion (RPE).

Table 1 — The eight-week HIIT protocol for Exercise group participants. HIIT, high intensity interval training; HRR, heart rate reserve RPE, rate of perceived exertion min, minutes

Week	Format	Active Recovery	HIIT
1	4 HIIT; 4 active recovery	4 Min ≥ 60% HRR or ≥ 6/10 RPE	30s ≥ 90% HRR or ≥ 9/10 RPE
2	4 HIIT; 4 active recovery	4 Min ≥ 60% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
3	5 HIIT; 5 active recovery	4 Min ≥ 60% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
4	6 HIIT; 6 active recovery	4 Min ≥ 60% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
5	6 HIIT; 6 active recovery	4 Min ≥ 70% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
6	7 HIIT; 7 active recovery	4 Min ≥ 70% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
7	7 HIIT; 7 active recovery	4 Min ≥ 70% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE
8	8 HIIT; 8 active recovery	4 Min ≥ 70% HRR or ≥ 6/10 RPE	45s ≥ 90% HRR or ≥ 9/10 RPE

After the eight-week intervention participants competed in competition C_2 after abstaining from exercise for 24 hours, similar to C_1. One week following C_2, participants arrived for C_3.

This final competition involved an acute HIIT intervention prior to the competition similar to our previous work [29]. Thirty minutes prior to C_3, the Control group participants were permitted to perform any activity except exercise or play video games. Participants in the Exercise group met with researchers 30 minutes prior to C_3 to complete a bout of HIIT (Figure 3). Participants completed four bouts of 30 second sprints (nine on the OMNI Scale or 90% of heart rate reserve) and four-minutes of active recovery (six on the OMNI Scale or 60% of heart rate reserve) between each bout. Immediately following the acute exercise bout, C_3 commenced in the same fashion as C_1 and C_2.

In all competitions researchers recorded each participant's number of set wins. Proportion of accumulated wins to total sets played was used as the metric for esport performance at each competition (e.g., if a participant won four sets, their esport performance score was calculated as 4/13 = 0.307).

Researchers scheduled post-testing for all participants one week following C_3. Post-testing repeated the pre-testing assessments. Body composition, Trails Task scores, and VO_2 max results were compared between groups pre- and post-testing. Competitive esport performance was compared both within and between groups across all competitions.

Statistical Analyses

Statistical analyses were performed using R Studios version 3.0.1 (R Studio Team, Boston, MA, USA). Pearson correlation was used to assess the relationship between baseline fitness and game skill. Pearson correlation was also used to assess the validity of the initial skill assessment by investigating the relationship between initial skill and performance at C_1. An r value ≥ 0.9 was used to indicate a very strong correlation.

A two-way repeated measures analysis of variance (ANOVA) was used to assess differences in all pre- to post-test variables within and between groups. An *α priori* alpha level of 0.05 was used to determine statistical significance of effects. If significant interactions were evident for dependent variables, Bonferroni post-hoc analyses were used to decompose the model and identify between and within-group significance.

Logistic regression analysis was used to assess if the exercise interventions increased the probability of a participant winning a set. An *α priori* alpha level of 0.01 was used to determine statistical significance of effects. Three separate logistic regression models were constructed: 1) an acute exercise model, 2) a chronic endurance training model, and 3) a combination model. Log-odds ratios provided by the models were exponentiated for further interpretation. Mean win proportion at C_1 was used as a predictor because it served as a baseline score before any exercise interventions were implemented. Group was used as a predictor to assess the effect of exercise.

Results

There were no significant differences between groups for any pre-test measurement ($p \geq 0.05$). This demonstrates that groups were matched evenly for all cardiovascular, esport, and cognitive variables at baseline. There were no significant differences between groups for any post-test measurement ($p \geq 0.05$), indicating after eight weeks of supervised training there was no improvement in BF%, VO_2 max, or visuomotor performance in the exercise group. There was an effect of time for Trails Task A side ($p = 0.037$), B side ($p = 0.003$) and switch cost ($p = 0.048$) scores in both groups. These cognitive data show a change in visuomotor performance in all participants over time, regardless of group.

Table 2 — Pre and post-test values of all physiological and cognitive variables. # Indicates a significant effect of time. VO_2, oxygen consumption; TTE, time to exhaustion; BMI, body mass index, ml, milliliters; min, minutes; s, seconds

	Exercise (n = 13)		Control (n = 13)	
Measurement	*Pre-test*	*Post-test*	*Pre-test*	*Post-test*
VO_2 max ($ml \cdot kg^{-1} \cdot min^{-1}$)	40.93 ± 7.18	41.97 ± 7.39	41.62 ± 9.17	41.32 ± 11.07
TTE (s)	754.23 ± 81.41	780.00 ± 88.08	760.15 ± 120.01	761.33 ± 121.99
BMI	27.67 ± 6.27	27.09 ± 6.48	26.07 ± 7.52	26.62 ± 8.08
Body Fat (%)	28.58 ± 9.04	28.93 ± 9.25	24.40 ± 9.01	25.01 ± 8.98
Trails A (s)	21.77 ± 9.50	18.00 ± 4.65#	23.46 ± 8.35	18.77 ± 4.59#
Trails B (s)	47.62 ± 17.36	33.85 ± 12.56#	51.23 ± 17.94	38.77 ± 13.30#
Switch cost (s)	25.85± 17.35	15.85 ± 9.49#	26.92 ± 18.99	20.00 ± 12.56#

There was no significant effect of group in the chronic endurance regression model (log-odds ratio = 0.3711, exp = 1.45 p = 0.130). The combination logistic regression model revealed a significant effect of group (p < 0.001, log-odds ratio =1.5476, exp = 4.695984). These results indicate that although there was no effect of chronic endurance training alone, a combination of chronic endurance training and an acute HIIT intervention improved esport performance scores.

*Table 3 — Logistic regression output chronic and combined models. Exp, Exponentiated; CI, Confidence intervals C_1-C_3 indicate esport performance scores (expressed as proportion of accumulated wins to total sets played) at competitions 1-4; respectively. The log-odds outputs are exponentiated for interpretation. * Indicates significance ($p \leq 0.01$).*

Chronic (C_1 | C_2)	Log-Odds	Exp(log-odds)	P value	2.5% CI	97.5% CI
Intercept	-0.213	0.808	0.219	-0.544	0.136
C_1 Win	3.762	43.040	6.4e-14*	2.812	4.784
Group	0.371	1.449	0.130	-0.107	0.857
Combined (C_1 | C_3)	Log-Odds	Exp(log-odds)	P value	2.5% CI	97.5% CI
Intercept	-0.803	0.448	1.9e-05*	-1.166	-0.430
C_1 Win	4.298	73.567	6.1e-14*	3.22	5.47
Group	1.547	4.69	1.85e-08*	1.021	2.102

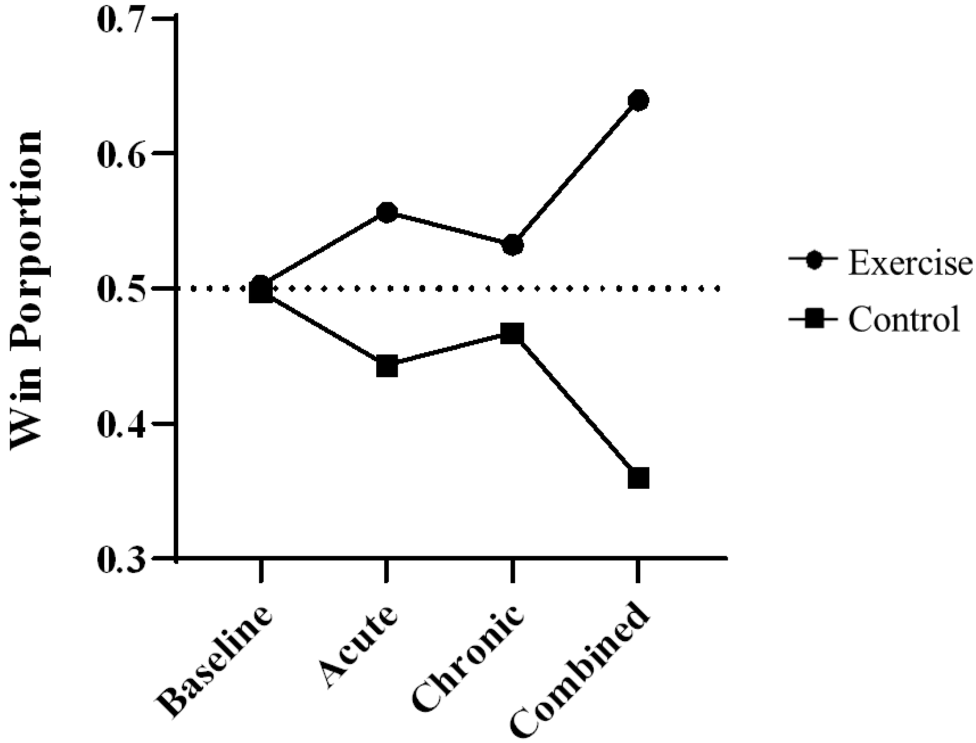
Discussion

The purpose of this study was to determine the effects of chronic endurance training on esport and visuomotor performance. Esport Performance was measured by a proportional win rate in a semi-round robin SSBU Competition. Statistical models were constructed to assess the effect of each intervention.

Chronic effects of HIIT were observed with a logistic regression model using results from C_1 and C_2, and the combined acute exercise and endurance training intervention was observed comparing C_1 to C_3 (Figure 1). The Exercise group participated in the competition after completing an acute HIIT bout at timepoint C_3, similar to our previous work assessing the effect of acute exercise on esport [29]. In the current study the acute HIIT protocol took place after an eight-week chronic endurance training period. Thus, the combined model observed the effect of the acute HIIT bout on esport performance combined with eight weeks of exposure to HIIT, or a "combination" effect of an acute HIIT and chronic HIIT protocols. The logistic regression analysis of each model provided the odds that a participant would win at a specific timepoint (C_2 or C_3), assuming they did not win a single set at timepoint C_1. The logistic regression models were centered around the mean win proportions at C_1 so that the exponentiated intercept log-odds could be interpreted to mean "the percent chance that a member of the Exercise group would win, assuming their win % at C_1 was 50%). The dependent variables measured during pre- and post-testing were not used as an indicator of esport performance improvement, they were used to gauge if changes in esport performance were influenced by changes in cardiovascular fitness or visuomotor performance.

In our previous work we show an acute HIIT bout immediately prior to competition nearly doubles a competitor's chance to win [29]. While the effect of an acute exercise bout on esport performance alone is interesting, a more intriguing finding is present when observing the results of the combination (acute + chronic) exercise model.

Figure 4 — Visualization of esport performance in competitors across all timepoints in this present paper and our previous work. Acute is in reference to a 1-week acute HIIT intervention in our previous work [29]. Chronic is the comparison of win proportions from C_1 to C_2 in the present paper, while Combined is the comparison of win proportions from C_1 to C_3 in the present paper.



The combined logistic regression model includes the effects of both acute and chronic training. The exponentiated log-odds (4.7) indicate that a participant who did not win a single set at C_1 would increase their chance of winning by 4.7 times (28.3% chance of winning) if they were exposed to an acute HIIT bout after eight weeks of chronic endurance training. Acute exercise alone doubles a participant's chance of winning, that effect is compounded if the participant completed an eight-week HIIT program prior to the exercise bout.

Findings from this project present preliminary evidence that a combination of acute and chronic exercise increases chances of winning in SSBU competitors. However, larger studies are needed to accurately estimate the magnitude of this effect. There was an increase in performance following acute exercise in both the acute [29] and combination models. In the present study, the researchers did not assess cognitive function changes after acute exercise. Thus, we are unable to attribute this to the effect of exercise on cognitive function with our current data. The lack of a group effect for any pre- to post-test variable makes it difficult to elucidate the mechanism by which chronic and acute endurance exercise interact.

The change in performance due to chronic exercise was roughly 40% in the expected direction. However, the effect of exercise on esport performance in the chronic model did not reach statistical significance ($p = 0.13$). It is reasonable to assume that the effect of chronic exercise is smaller than can be detected with this sample size. However, our data suggests that if a chronic training effect was detected it would not be explained by changes in the physiological or cognitive variables assessed in this study.

Trails Task switch cost scores assessing visuomotor performance via task switching improved over time in both groups ($p = 0.048$). The lack of group differences for Trails Task times contradicts results from previous studies revealing scores of cognitive function increased after an endurance training program [14, 17, 18]. Furthermore, baseline Trails Task means in the sample studied were comparable to means of normative Trails data in high-school educated participants ages 18-24 (Trails A: 22.93 ± 6.87; Trails B: 48.97 ± 12.96) [32]. This contradicts findings from previous literature that action video game players tend to score higher on tests of cognitive function [8-10]. Action video game interventions have been used to improve scores on tests of cognitive function [3-6]. It is possible that the four competitions, additional regular-season competitions outside of the study, and time spent practicing during the eight-week chronic portion served as a video game intervention that improved the Trails scores in both groups. However, we did not collect average playtime for eight weeks prior to the study as a baseline for playtime so we cannot comment on this interaction. It is also possible that the participants remembered the pattern (learning effect) from the pre-testing Trails Task resulting in faster times. Previous reliability testing on the Trails A and B Task shows that participants improve times on the Trails Task after multiple exposures, even when alternate paths are used [34]. It would be worthwhile for future researchers to measure alternative cognitive variables in this population.

The Exercise group did not experience a significant increase in VO_2 max despite participation in an eight-week endurance training program. The Exercise group had an average pre- to post-test increase in time to exhaustion of 25 seconds, but this increase was not statistically significant. Correlational data from our previous work [29] indicate there may not be a relationship between VO_2 max and esport performance ($r = 0.0005$). However, there were significant issues with VO_2 post-testing that likely impacted this finding.

Perhaps the most important take-away from this research is that the implementation of a chronic exercise program for an esport athlete is overwhelmingly positive. Esport scholars in alternate study models have provided detailed evidence that chronic exercise can improve multiple physiological variables including cerebral hemodynamics, heart rate variability, and oxyhemoglobin saturation in esport athletes. Furthermore, scholars have shown that chronic exercise can elicit improvements to cognitive health and performance such as physical fitness, reactive ability, executive function, and decreased injury risk. [35, 36]. While there was no significant effect of chronic exercise alone, there was no negative effect for any of the participants. This indicates that even though chronic exercise alone may not improve direct measurements of esport performance, it does have multiple health and cognitive benefits with no negative effect on their performance. When keeping in mind conclusions from our previous work, the implications become even more interesting.

While acute exercise nearly doubled chance of winning for some participants [29], it did have a negative effect for others when individual data points were observed. When a combination of acute and chronic exercise was applied, however, this negative effect was mitigated. It appears that, in some participants, if acute exercise negatively impacts their performance, implementation of a chronic exercise program will alleviate these performance decrements. Results from this study should guide esport coaches and organizations when having conversations with competitors. Coaches and organizations can present exercise as not only a means to improve overall health, but also to potentially improve performance. If athletes perceive that exercise is causing a negative effect on their performance, coaches can point to this study to suggest that this negative effect is rare and seems to dissipate as participation in a chronic exercise program progresses.

Limitations

The largest limitation of the study was the obstacles faced during post-testing. Of the 13 participants in the Exercise group, there is an argument for excluding VO_2 max post-test data for seven. Four of the post-tests had to be delayed up to three weeks after the conclusion of the chronic exercise period due to injury, COVID-19, and intoxicating substance use. Prior to VO_2 max testing, all participants were coached on the importance of reaching maximal effort. However, three participants indicated they did not give maximal effort during the VO_2 max test, and all three opted not to redo the test. Four of these seven participants experienced decreases in VO_2 max from baseline despite participation in an eight-week HIIT protocol. These decreases can be explained by not reaching maximal effort during VO_2 max testing, and by a detraining effect that has been recorded to manifest within 14 days of stopping an exercise program [37, 38]. Future efforts to assess the chronic effect of endurance training on esport performance could use a slightly altered study design to avoid an effect of detraining, in which post testing occurs before timepoint C_3. However, this runs a logistic risk of losing the ability to observe the full effect of exercise on esport performance, with an accurate VO_2 max measurement as the trade-off.

Participant motivation can be a factor in esport research in SSBU. This limitation is discussed in detail in our previous work [29]. Briefly, SSBU and fighting games in general feature a roster of multiple characters. Players are permitted to choose any character on the roster during competition, but typically only play one in a tournament setting. Multiple participants did not play their primary tournament character at timepoints at either C_2 or C_3 which may have influenced the results.

There is an argument that data collection methodology in the present study could be strengthened by using alternate instruments. For example, more valuable data overall could be collected by implementing Hydrodensitometry as opposed to BIS. Additionally, use of an arm or cycle ergometer for both training and testing could be an interesting approach given this population. Many esport athletes compete using only their upper body, and nearly all esport athletes compete while seated. Perhaps the use of alternate modalities could elicit more extrapolatable results.

Conclusions and Recommendations

This study was the first to use a randomized controlled trial design to observe the direct effects of chronic exercise on esport performance scores. The results from this study indicate that there is a positive combined effect of acute exercise and chronic endurance training on bracket performance in SSBU competitors. Coaches and organizations should point to this work and the work of other scholars in the field to encourage esport athletes to partake in exercise as a way of improving physical health, cognitive health, and esport performance. Future work should include larger sample sizes and alterations to the study design in which post testing is completed before timepoints C_2/C_3 and cognitive function is assessed after acute exercise. Scholars in this area should also consider blinding participants to both their competitor and the researchers observing them to help limit any potential threats to external and internal validity. Furthermore, this esport and exercise protocol can be easily applied to other esports with similar playstyle. We encourage scholars in all fighting games and 1 vs 1 esports to emulate our study design and protocol so that the findings may be extrapolated to a larger population of interest.

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Declaration of Interest

None of the authors have conflicts of interest regarding the data presented herein.

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