Console Gaming Indicates Low Risk for Repetitive Strain Injury

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Research Question

How does console gaming affect muscle fatigue as a factor of RSI risk, derived from the power of a frequency band when compared to a baseline test, through the use of an EMG on the extensor carpi radialis brevis and flexor digitorum superficialis?

Hypothesis

Continuous gaming will demonstrate higher change in frequency band powers over 15 minutes, compared to interspersed gaming or relaxed hand positions, showing increased muscle fatigue and a higher risk for hand-related disorders.

Project Overview

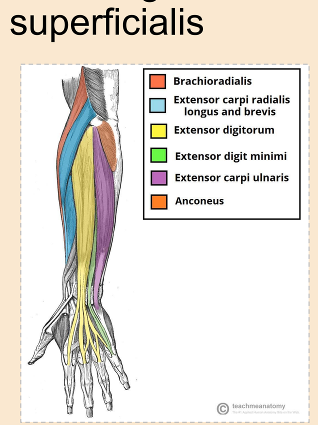
Objective: Determine the extent to which console gaming affects muscle fatigue, derived from the change in power of a frequency band.

Aim 1: Determine muscle fatigue levels for interspersed gaming

Aim 2: Determine muscle fatigue levels for continuous gaming

Controlled variables

Muscle groups
- extensor carpi radialis brevis
- flexor digitorum superficialis

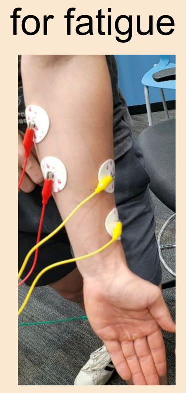


Independent variable

Timed Gaming
- Control Group
- Interspersed
- Continuous

Dependent variable

Muscle fatigue
- Normalized 136-400Hz Frequency Band Power:
- Expect decrease over time for fatigue



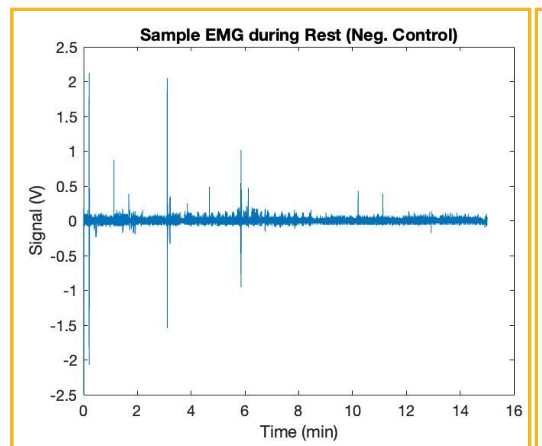
Procedure

Participant is hooked up to EMG circuit → Participant remains at rest for 15 minutes →

Participant play a continuous game of Super Smash for 15 minutes → Rest 5 Minutes → Participant play an interspersed game of Super Smash for 15 minutes (3 minutes of play followed by 2 minutes rest)

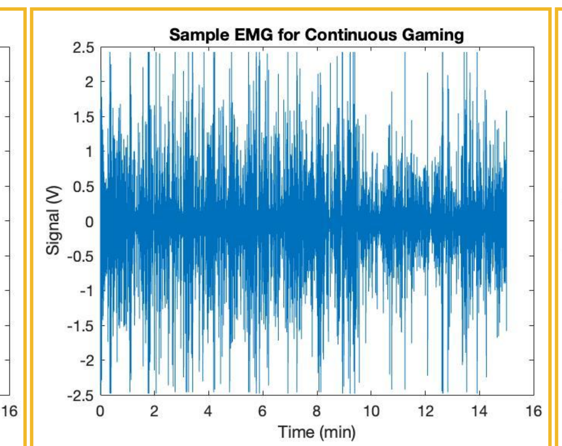
Data Collection

Negative Control*



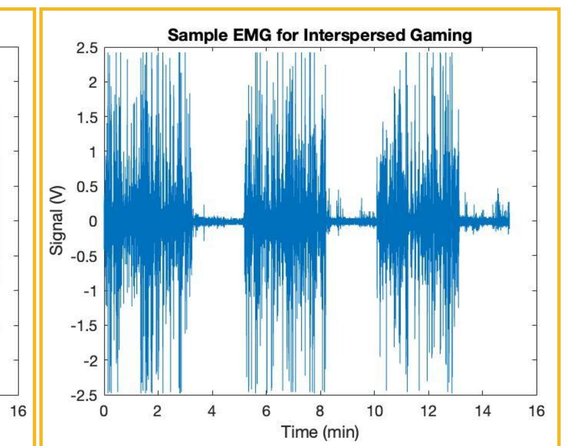
Negative Control: subject leaves right arm at rest. Low amount of high frequency content present.

Experimental Group #1: Continuous Gaming*



Continuous Gaming: EMG of subject's right forearm while playing console game. High frequency signal with decreasing relative magnitude of high frequencies.

Experiment Group #2: Interspersed Gaming*

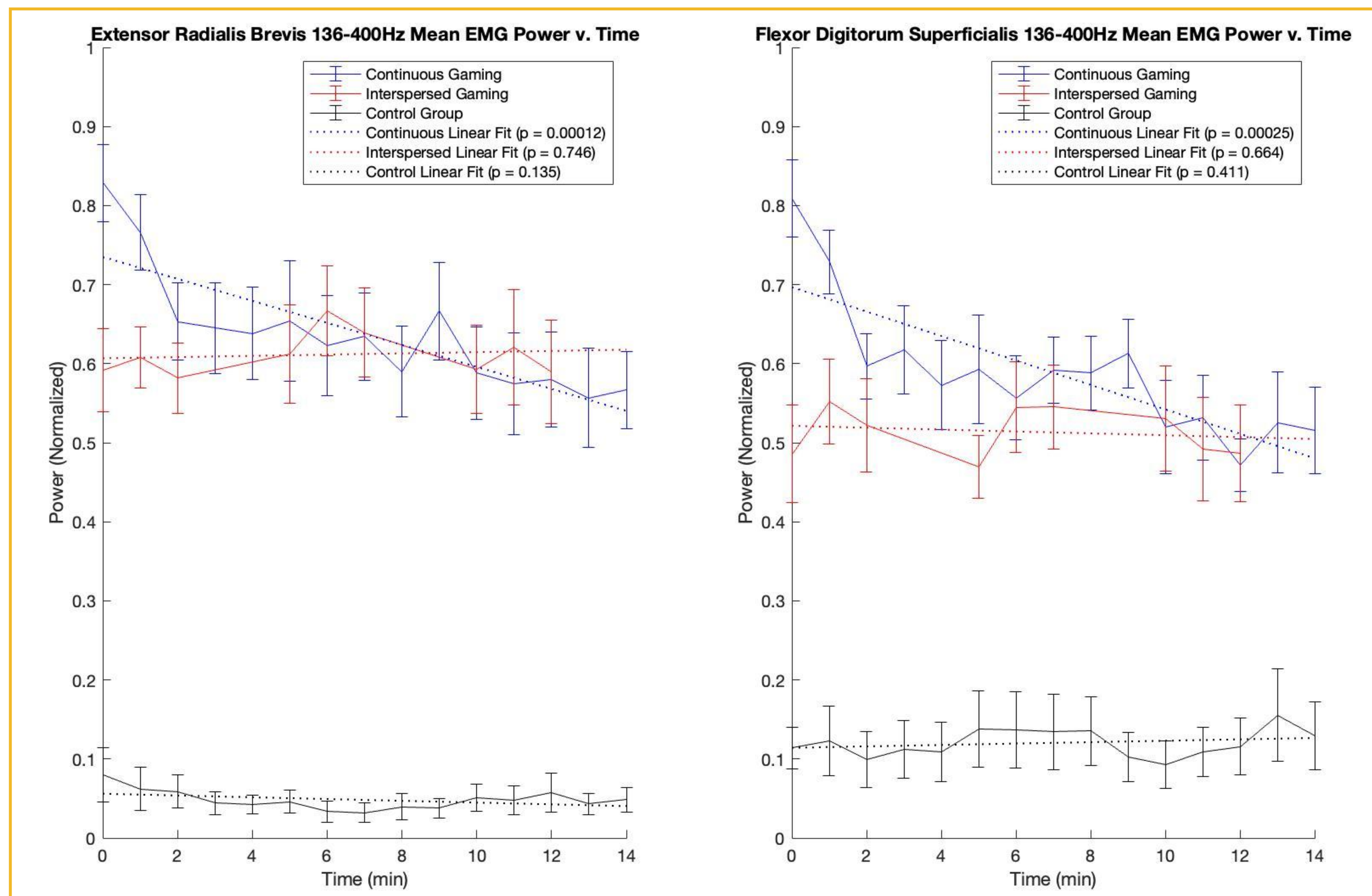


Interspersed Gaming: EMG of subject's right forearm playing console game in 3-minute bursts. Minimal observable change over time during active periods.

**extensor and flexor muscles studied showed similar results for above samples*

Results

Regression Modeling of Normalized Powers over Time



Regression Plots: display normalized power for each experimental group over 15 minute time period. Each line plot shows the average power at every given time point for all participants' EMGs (n=12). Error bars reflect standard error from mean. Linear regression demonstrates significance in the trendline slope at significance level α=0.05 for the continuous gaming groups for both muscles, but not for interspersed gaming or the control (see table below).

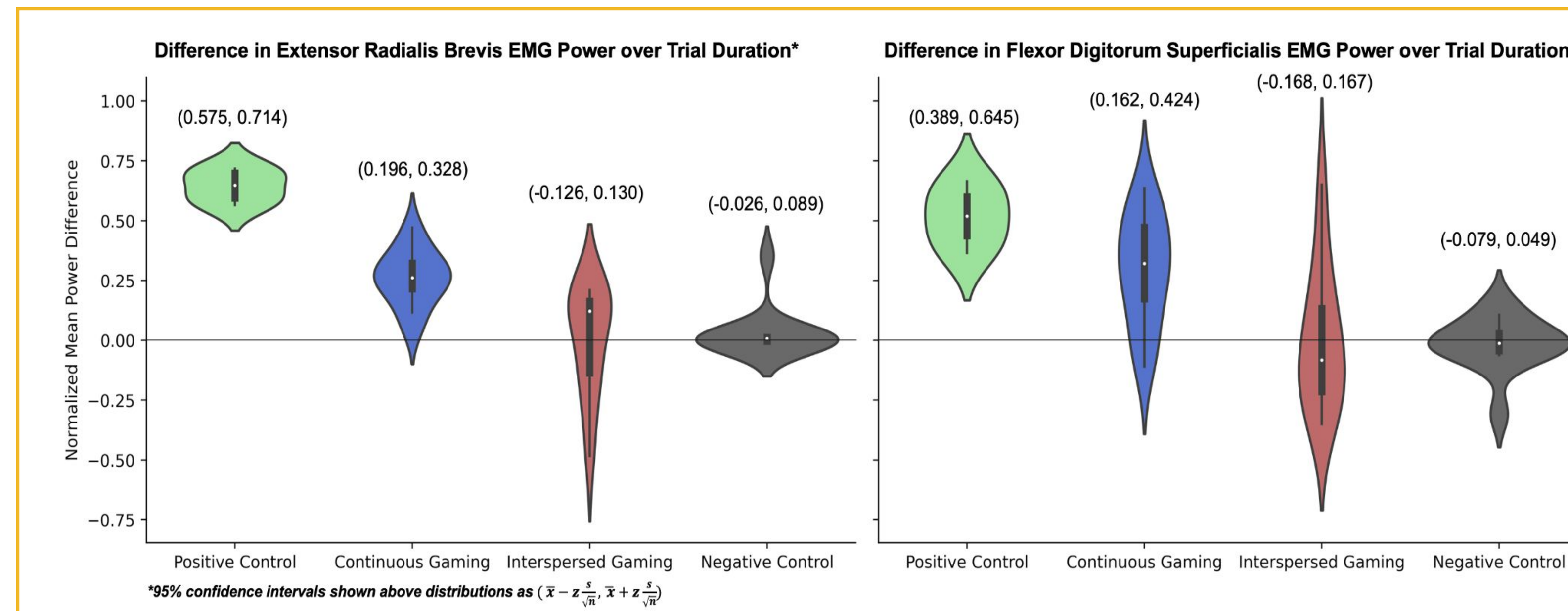
Regression Statistics Table for Normalized Powers over Time

	Extensor Radialis Brevis			Flexor Digitorum Superficialis		
	Continuous Gaming	Interspersed Gaming	Control Group	Continuous Gaming	Interspersed Gaming	Control Group
Mean Slope**	-0.0139	0.00078	-0.0011	-0.0155	-0.001	0.0009
R^2	0.693	0.016	0.164	0.657	0.028	0.052
p-value	0.00012	0.746	0.135	0.00025	0.664	0.411

***mean slope for linear regression model, reflects the change in proportion of normalized power per minute*

Results Continued

Violin Distribution Plots of of Normalized Differences in Powers over Trial Durations



Violin Distribution Plots: displays sample distributions of the normalized mean power differences for each experimental group.
- Mean power difference calculated as the difference between normalized frequency power for the first and last time interval of EMG recording.
- Higher difference values demonstrate higher muscle fatigue.
- Positive control: the average fatigue that occurs over 60 seconds of maximal voluntary grip strength
- Negative control: fatigue occurring during 15 minutes of rest.

Discussion

Console gaming causes muscle fatigue
- Metric: Shift of fast-twitch fibers to slow-twitch fibers causes decrease in high frequency band powers
- Interspersed condition:
  - Confidence interval (CI) for mean differences over time centered around 0
  - No statistically significant claims can be made about change in power over 15 minutes.
  - Low likelihood of accumulated muscle fatigue
- Continuous condition:
  - CI for mean differences fully positive
    - Not to the level of the positive control
  - High likelihood of accumulated muscle fatigue
- Neither aim showed muscle fatigue to the level of the positive control
  - RSI risk low

Muscle Differences
- Flexor: higher RSI risk
  - Overlap in 95% CI for continuous gaming normalized power difference and positive control
  - Flexor may be better indicator of RSI

Sources of Error
- Sample size lower than expected due to complications with data collection
  - Over-saturation with some EMG readings
- Order of experimental groups tested may have caused lower power levels for interspersed gaming
- Positive control only tested for 4 participants

Conclusion

- 15 minutes of continuous gaming insufficient for RSI risk
- Interspersed gaming does not lead to accumulated muscle fatigue
- More research into longer lengths of time or other risk metrics
- Significance: First EMG research into console gaming danger for hand muscles
  - Results show a different trend than computer gaming

Works Cited

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