

Analysis of Energy Expenditure during Game-based Aerobic Exercise among Individuals with Spinal Cord Injury; A Preliminary Study

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INTRODUCTION

- Approximately 15 million people with a spinal cord injury (SCI) worldwide (World Health Organization, 2024)
- Increased risk of secondary health conditions due to reduced physical activity and loss of voluntary movement (Bloemen-Vrencken et al., 2007; Cragg et al., 2013; Lai et al., 2014; Solinsky et al., 2022)
- Lower total daily energy expenditure: greater health risks, emphasizing the need for regular cardiovascular exercise (Buchholz et al., 2003; Nash et al., 2022)
- Limited research on game-based cardiovascular exercise for people with SCI

Purpose: To investigate the influence of game-based aerobic exercise on energy expenditure and enjoyment in people with SCI.

Hypothesis:

H1: Game-based aerobic exercise will elicit greater energy expenditure than conventional cardiovascular exercise in people with SCI.

H2: Game-based aerobic exercise will demonstrate greater interest/enjoyment than conventional cardiovascular exercise in people with SCI.

METHODS

PARTICIPANT CHARACTERISTICS:	n = 6
Age (years)	48.67 ± 16.47
Sex (M/F)	(6/0)
Height (cm)	179.83 ± 3.21
Weight (kg)	89.83 ± 5.83
Mobility Device (Electric/Manual Wheelchair)	(1/5)

DESIGN:

Cross sectional study with repeated measures

SETTING:

University-based adapted physical activity center; Center of Achievement at CSUN

VARIABLES:

Independent:

- Mode of exercise
 - With Active Games
 - Without Active Games

Dependent:

- Energy Expenditure (EE)
- Oxygen consumption (VO2)
- Heart rate (HR)
- Cadence (RPM)
- Interest/enjoyment

INSTRUMENTATIONS:

- Portable Metabolic Analyzer PNOE (Endo Medical Inc., Palo Alto, CA, USA, 2024)
- Intrinsic Motivation Inventory (IMI)

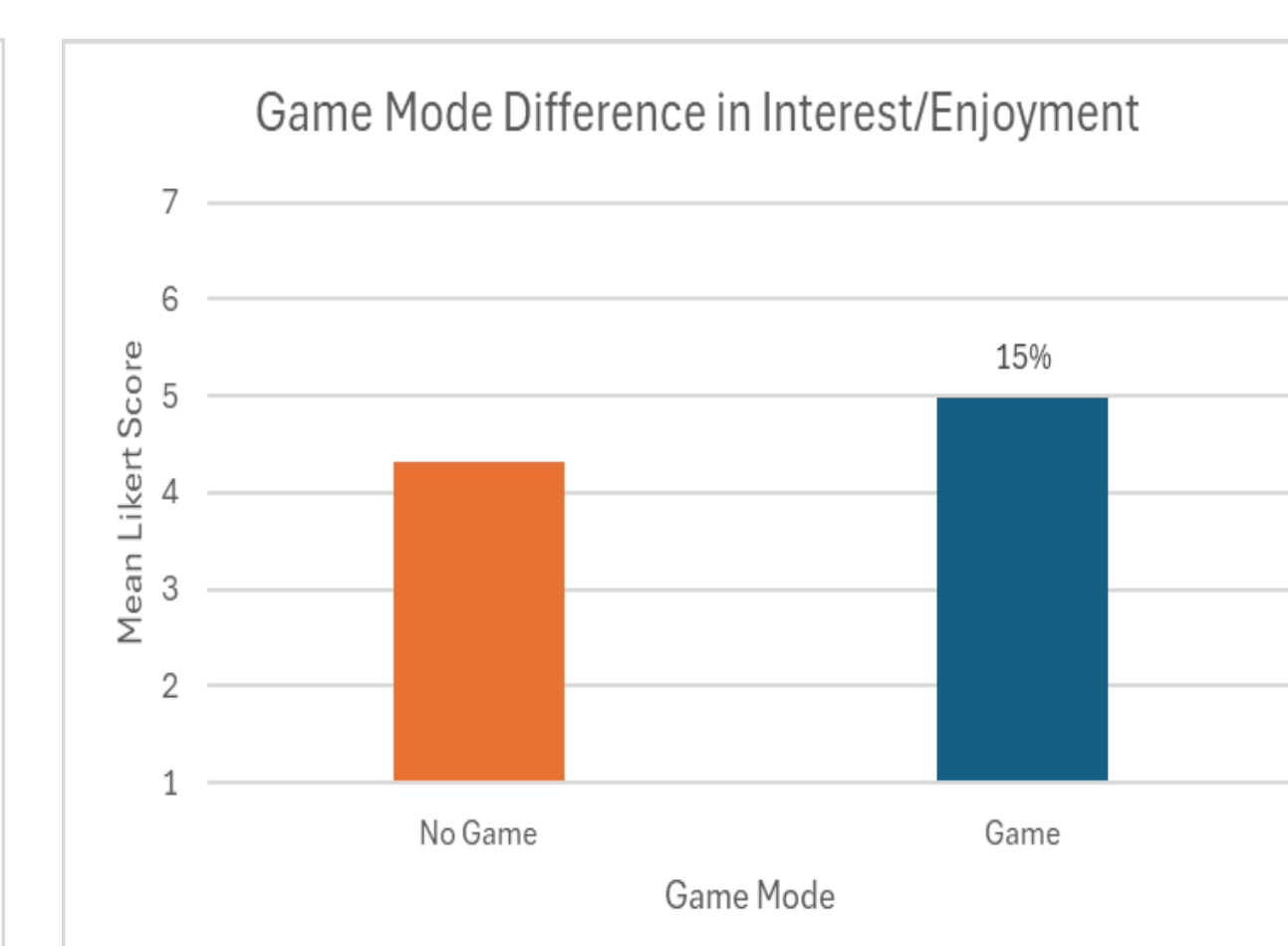
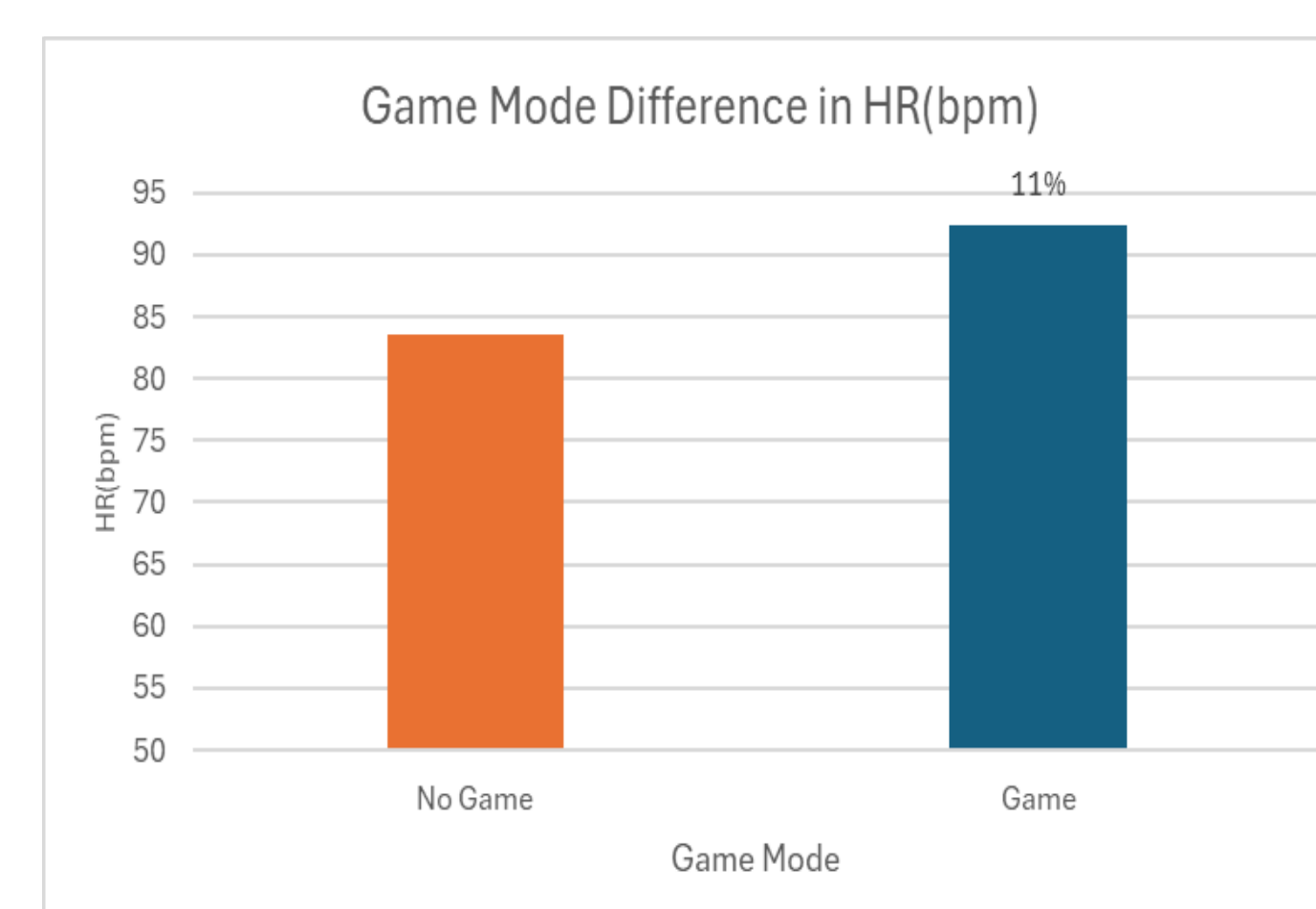
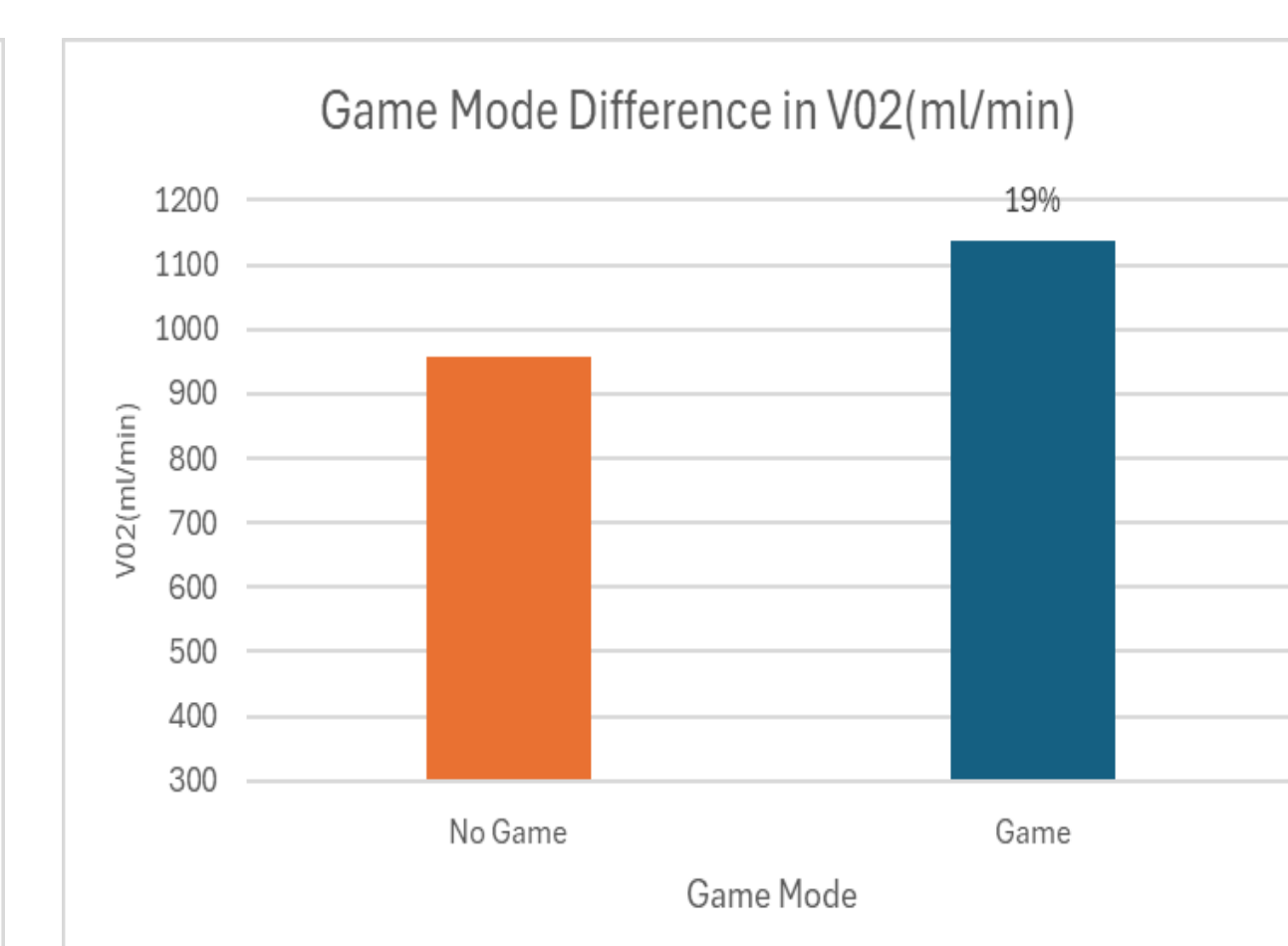
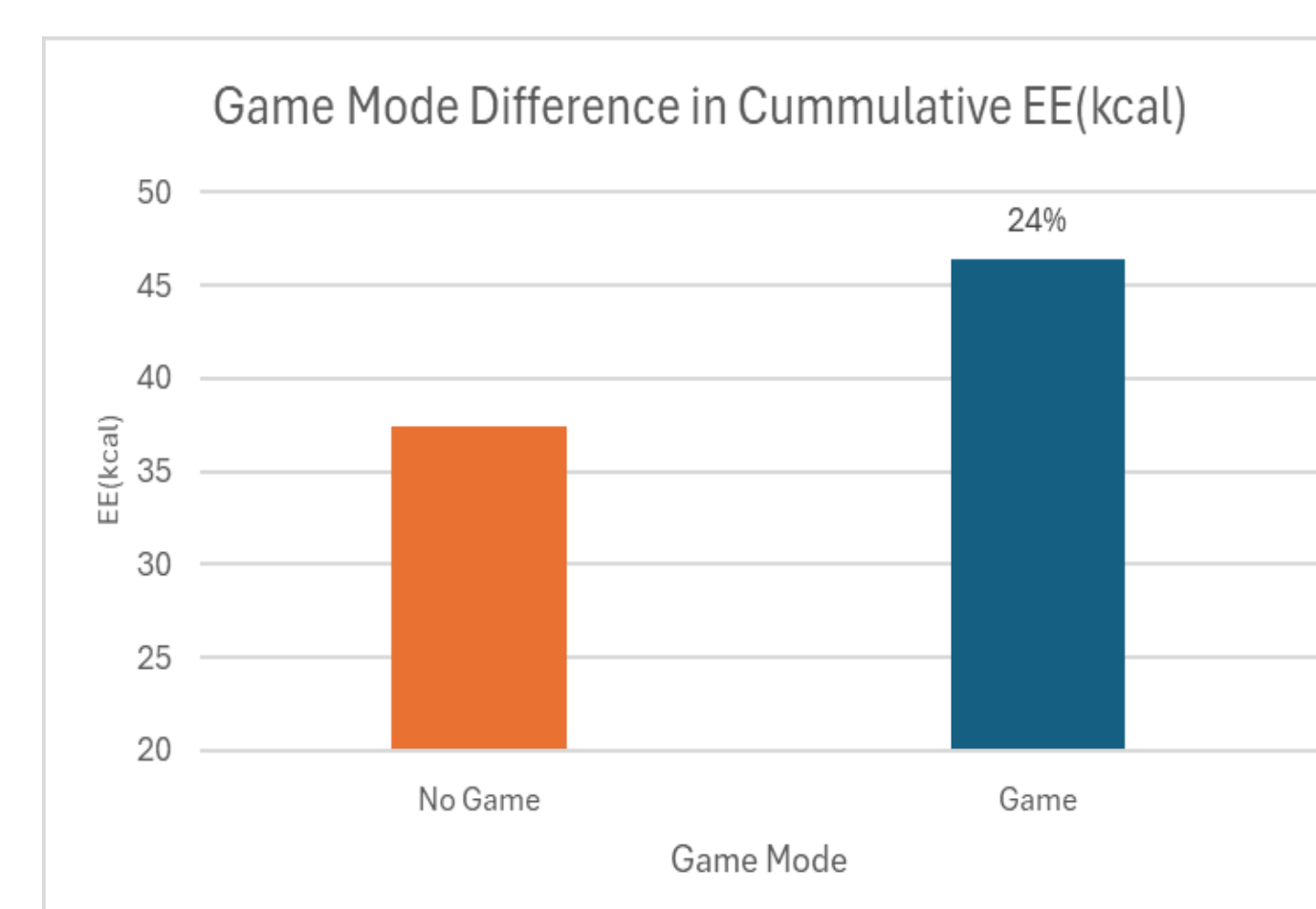
DATA COLLECTION PROCEDURE:

- 3 separate visits
- Randomized order of exercise modes



RESULTS

- H1. No statistically significant difference in EE, VO2 & HR
 - A trend of increased EE, VO2 & HR during game-based aerobic exercise compared to no game condition
- H2. No statistically significant difference in interest and enjoyment
 - A trend of increased interest and enjoyment during game-based aerobic exercise compared to no game condition



DISCUSSION

- People with SCI demonstrated increased energy expenditure & other physiological responses during game-based aerobic exercise compared to conventional stationary wheelchair treadmill exercise.
- People with SCI showed higher interest and enjoyment during game-based aerobic exercise compared to conventional stationary wheelchair treadmill exercise.

LIMITATIONS

- Small sample size
- Cross-sectional observation
- Limited functional levels of participants with SCI



CONCLUSION

- Our findings suggest that game-based wheelchair treadmill exercise can help people with SCI increase energy expenditure and enhance enjoyment of aerobic exercise.

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Recruitment

Initial visit

1st Data Collection

2nd Data Collection

Data Analysis

48 Hours between each visit

a) With Active Games:

- 10 minutes of quiet sitting
- 10 minutes of game-based stationary wheelchair treadmill exercise

b) Without Active Games:

- 10 minutes of quiet sitting
- 10 minutes of stationary wheelchair treadmill exercise

ANALYSIS OF BRAIN ACTIVITY DURING GAME-BASED AEROBIC EXERCISE IN PEOPLE WITH SPINAL CORD INJURIES: PRELIMINARY STUDY

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INTRODUCTION

- Individuals with spinal cord injuries (SCI) show compromised motor and cognitive functions.
- Aerobic exercise with game integration can lead to improvements in cardiovascular (CV) fitness and cognitive functions.
- Limited studies examine the effects of game integration in aerobic exercise on brain functions of people SCI.
- **Purpose:** To analyze brain activity during game based aerobic exercise in adults with SCI.
- **Hypothesis:** Adults with SCI will demonstrate greater brain activation in the prefrontal cortex (PFC) while performing game-based aerobic exercise as compared to conventional exercise.

METHODS

Design: Cross-Sectional Repeated Measures Study
Setting: University based Adapted Physical Activity Center
Participants: n = 5

Inclusion Criteria:	Exclusion Criteria:
>Age of 18	Cardiovascular diseases /heart medication
Medical diagnosis of SCI	Visual Impairments
>1 year post SCI injury	Neurological difficulties
Physician's medical clearance	
Ability to use a manual wheelchair	
Understanding of verbal instructions	
ASIA impairment scale: C or D.	

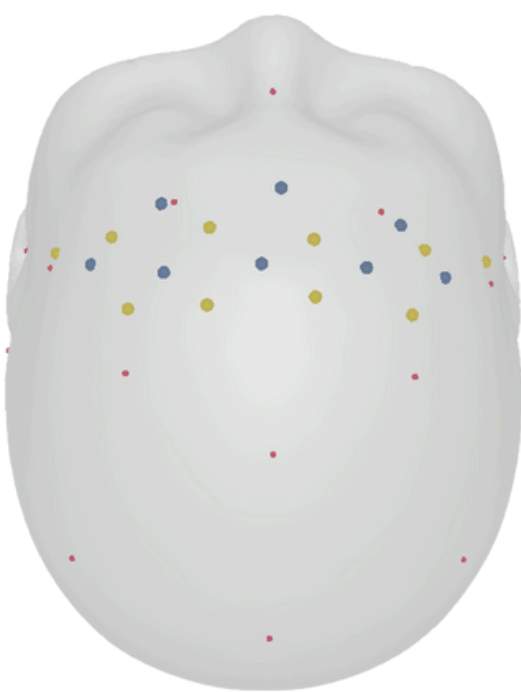
- Research variables:**
- Dependent variables:
Exercise modes (Game vs. No Game)
 - Independent variable:
Brain activation (ΔHbO_2)



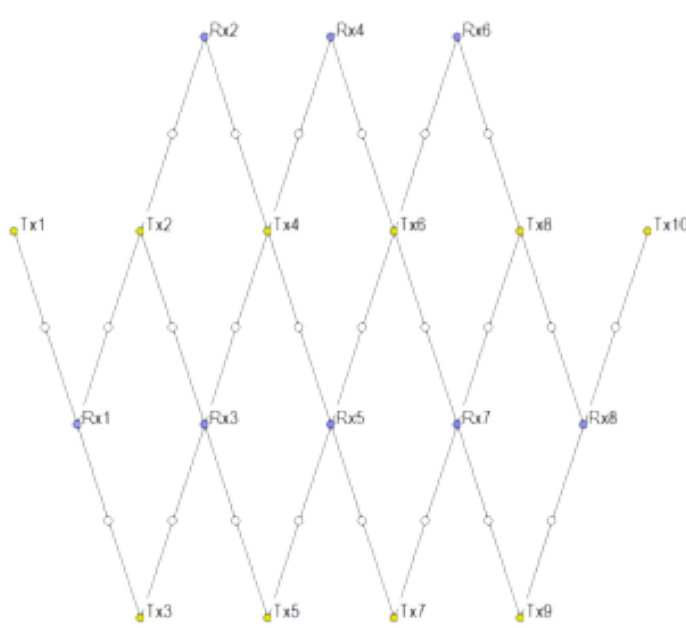
(KANGSTERS; Seoul, S. Korea; 2025)

- Instrumentations:**
- Wheelchair treadmill: Wheely-X
 - Functional Near-Infrared Spectroscopy (fNIRS)

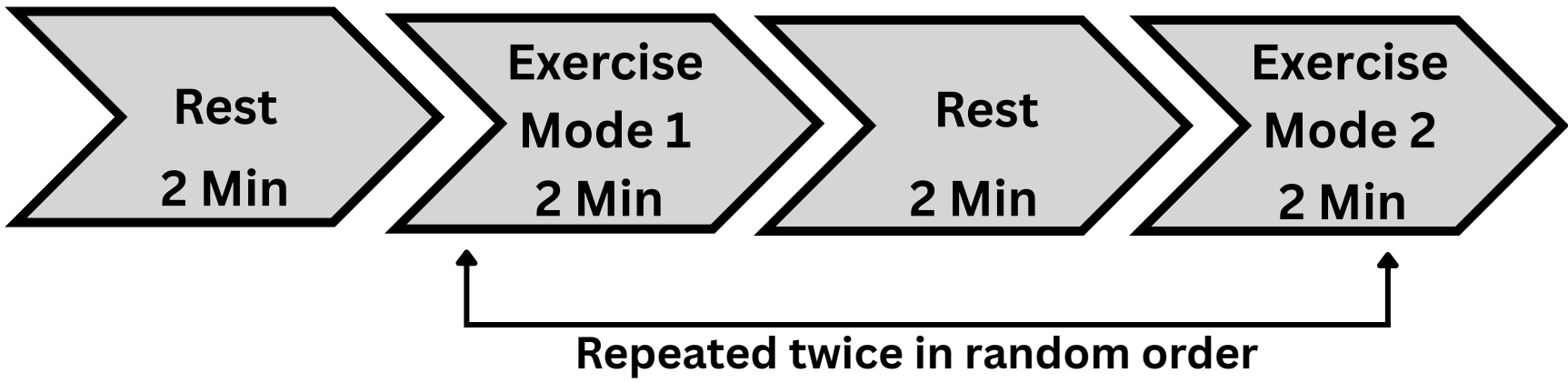
(ARTINIS Medical Systems, Elst, Netherlands, 2022)



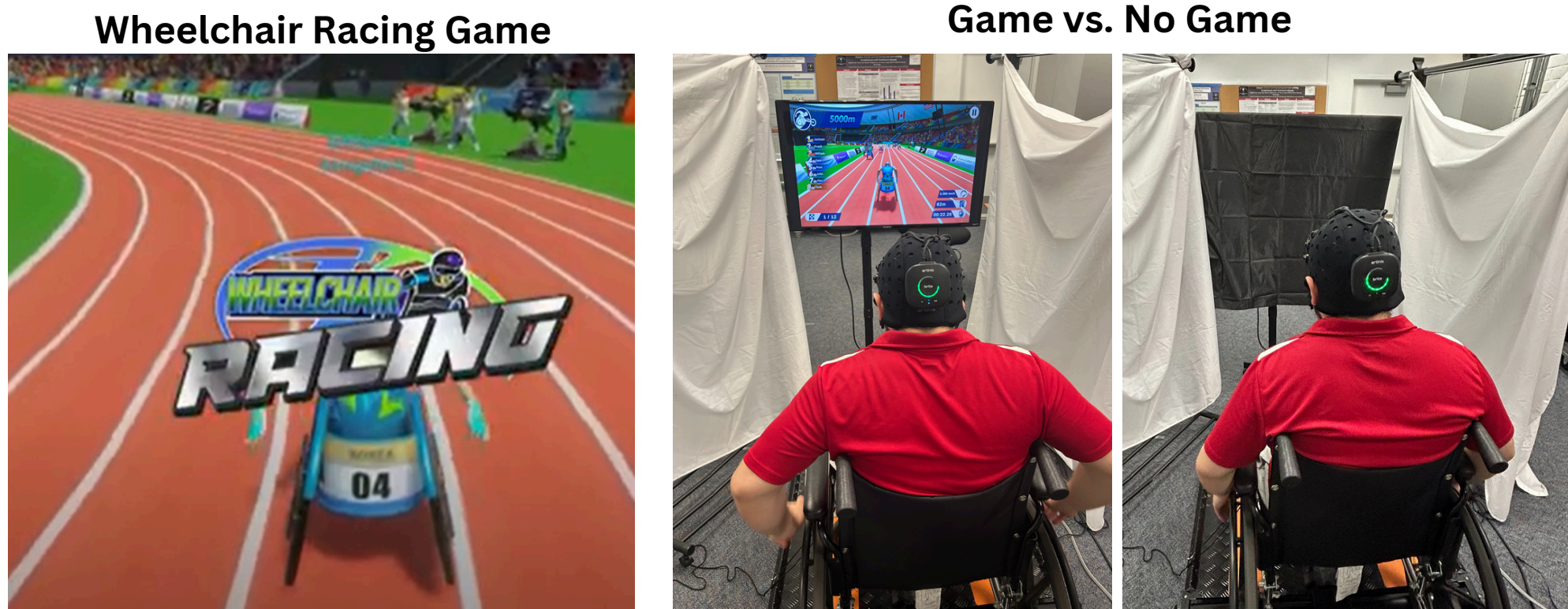
fNIRS Configuration: 24 channels (PFC) at 760 nm wavelengths at 25 Hz.



Data Collection Procedure:

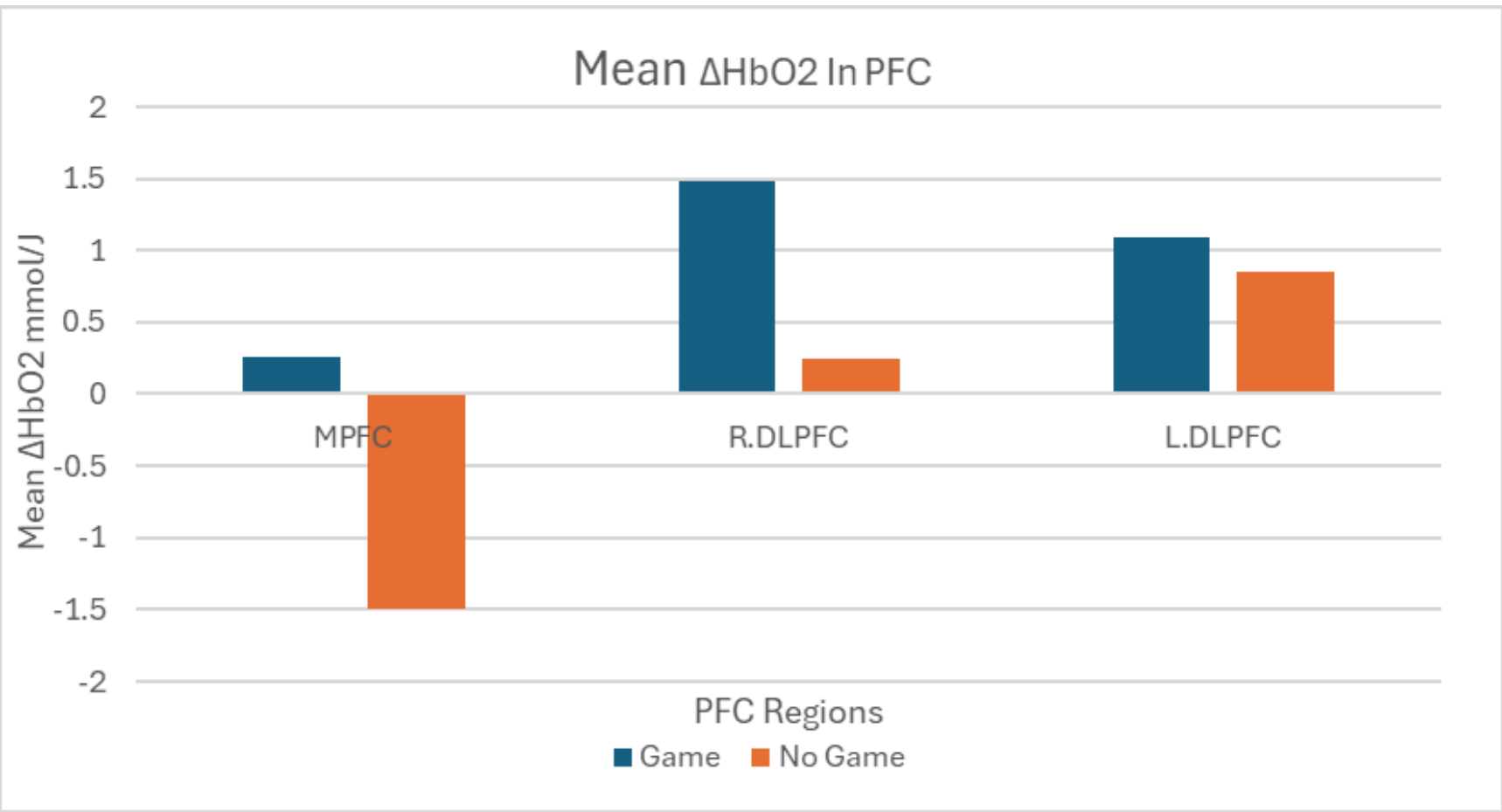


- Self-selected pace for 2 min in each mode
- 2 trials for each mode with 2-min rest in-between
- Pace matched within +/- 5 RPM



RESULTS

- Greater PFC activation in all regions of interest during game mode as compared to no-game.



DISCUSSION

- People with SCI showed increased brain activity when performing game-based aerobic exercise.
- Our findings indicate that game-integrated exercise may require greater demand for executive functions than aerobic exercise without game.

Conclusion:

- Game-based aerobic exercise can help increase brain activation of individuals with SCI while enhancing CV health.

Limitations:

- Small sample size
- Limited areas of interest in the brain
- Mode of game

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