Case Analysis of Sprint Interval Training for Adolescents With Severe Mental Illness

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INTRODUCTION

The use of exercise and/or physical activity (PA) is gaining recognition within psychiatric treatment practices as a component of therapy that contributes to improved health. For many, targeting physical health via aerobic and/or resistance training leads to improved sleep patterns (1), reduced cortisol levels (2), and heightened overall mood (3). Other common effects of exercise training include reduced inflammation, endorphin release (4), and improved levels of fatigue and self-confidence (5).

The positive impact of exercise on overall health and well-being for patients with a severe mental illness (SMI) is established (6,7). Mental health treatment centers may even opt to include routine recreational PA for therapeutic purposes (8). This commonly includes walks or small group activities (9), which are features of treatment supported by the Royal Australian and New Zealand College of Psychiatrists consensus statement (10) emphasizing the importance of patient physical health. Thus, although providing patients with a prescription for exercise training is not currently part of standard of care, it is understood that the physical health of psychiatric patients is important.

The psychological (11) and physiological (12) health benefits that can be gained by emphasizing the importance of PA within adolescent psychiatric units could possibly be strengthened by the addition of structured exercise training. Therefore, given that participation in structured PA yields proven health protective properties (13), the combination of exercise training and PA can be viewed as important complementary features of traditional psychiatric treatment methodologies (14). The present case series reports on 2 selected patients[1] and considers factors that may have influenced treatment responses to a Sprint Interval Training (SIT) intervention.

BACKGROUND

Following hospital ethical approval (HREC16/CRGH/134) and after individuals provided voluntary consent, study participation was conducted at an inpatient adolescent psychiatric facility in eastern Australia. In brief, upon arrival at the inpatient unit, patients were assessed for study suitability by the clinical treating team prior to recruitment and voluntary participation in the broader SIT study (15). Factors considered by the treatment team for study eligibility included ability to demonstrate compliance with verbal instructions, minimal risk of physical violence towards researchers, and clinician judgement based on medical history.

SIT Intervention Overview

A study enrollee was asked to complete SIT (4, 30-second maximal cycling sprints on a stationary bicycle) three times weekly in a one-to-one setting over 8 weeks. Maximal exertion sprints were interspersed by 4 minutes of active recovery, where continued cycling occurred at a relaxed cadence set at 50 watts. Each SIT session protocol lasted approximately 18 minutes with total work recorded.

Case Descriptions

The outcomes of 2 cases are reported herein. Each case was given a pseudonym for anonymity. “Amy” (Case 1) was a

[1]The case-patients examined were not part of the sample examined in the Taylor et al. (2019; 15) study.

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16-year-old white female living at the family home. Amy had presented multiple times to emergency departments for physical self-harm or violence toward others. Amy was given counselling and therapy to quell her emotions, but even then her family reported they needed to protect themselves from Amy's frequent violent outbursts, typically requiring the temporary use of physical restraint devices. Amy's deteriorating mental health ultimately led to an involuntarily admission to the adolescent psychiatric unit.

"Jane" (Case 2) was a 15-year-old white female and only child. Jane often spent days in her room on the second floor of the family home where she once attempted suicide by jumping out of her bedroom window. Following physical rehabilitation and recovery from surgery, she was involuntarily admitted to a psychiatric unit. The cause(s) of her psychiatric symptoms were unknown upon arrival at the unit. Jane did not have a diagnosed mental health condition prior to her suicide attempt.

INTERVENTION

Case 1

Amy's daily scheduled medications included 100 mg oral quetiapine (atypical antipsychotic), 1.5 mg oral risperidone (antipsychotic) and 200 mg oral sertraline (antidepressant). She was also routinely administered 4 mg oral melatonin and prescribed the following as needed: 0.5 mg oral lorazepam (antianxiety), 25 mg oral promethazine (antipsychotic), 50 mg oral quetiapine (atypical antipsychotic).

Amy had an extensive history of severe mental illness and was alleged to have exhibited psychiatric symptoms for more than 10 years. Reports suggest she had been exposed to varying degrees of sexual, physical, and emotional abuse**,** and her symptoms were consistent with schizophrenia and complex PTSD. Amy's delusions, aggression, and lack of self-control were often complicated by panic attacks, significantly disrupting her daily ability to independently function. She was considered high-risk for absconding, exhibiting violence toward others, and sexual abuse.

Amy completed 88% of scheduled SIT sessions, accumulating 529 KJ of work performed. She also completed all cycling sprints within each SIT session. Table 1 lists a summary of her pre-post SIT changes in comparison to group mean difference (σMD) data reported in Taylor et al. (15).

In Table 1, Amy's total positive and negative syndrome scale scores demonstrated an overall pre-post decrease greater than the σMD of Taylor et al. (15). Her estimated Vo_2max and Wingate performances also both improved pre-post intervention. However, on the World Health Organization-5 questionnaire (WHO-5), Amy's self-improvement level was similar to the σMD of Taylor et al. (15).

Amy lost weight over the SIT intervention period (Table 1). This included improvements in body composition scores as indicated by both bioelectrical impedance analysis and dual energy x-ray absorptiometry assessments. Her estimated overall lean body mass increased by +1.06 kg (30.27 to 31.33 kg), including +0.09 kg and +1.23 kg in the legs and trunk.

Case 2

Jane's daily scheduled medications included 10 mg oral olanzapine (antipsychotic) in the morning, followed by 5 mg oral aripiprazole (atypical antipsychotic) and 20 mg oral olanzapine (antipsychotic) in the evening. Her medications prescribed as needed included: 5 mg oral olanzapine (antipsychotic), 1 mg oral lorazepam, and 5 mg intramuscular injection midazolam. Jane was also prescribed 1000 mg oral metformin aimed at counteracting her antipsychotic-associated weight gain.

Jane was not consistently compliant with her medications, but this did not raise concerns that she posed a physical threat to staff. Jane's quiet nature and willingness to follow instruction, along with the treating team's concern about recent weight gain, led to her study eligibility.

Prior to Jane's suicide attempt, she had no documented history of mental illness. The attempt resulted in facial disfiguration requiring plastic surgery to reconstruct her jaw in addition to a femoral shaft fracture requiring intramedullary nailing (i.e., where a metal rod was inserted to assist movement of the femur movement and recovery). Following psychiatric assessments and interviews with Jane (and family), her psychiatric symptoms included untreated hallucinations and severe depressive symptoms, meeting Diagnostic and Statistical Manual of Mental Disorders-5th edition (DSM-5) diagnostic criteria for schizophrenia and major depressive disorder.

Jane demonstrated low compliance to the SIT intervention as she completed 42% of scheduled sessions and totaled 463 KJ of work performed for the entire study. This was consistent with her only completing 31% of maximal sprints within each session. Table 2 lists a summary of Jane's pre-post SIT changes in comparison to σMD data reported in Taylor et al. (15).

In Table 2, Jane's total positive and negative syndrome scale scores showed larger decreases than Amy and the σMD data reported in Taylor et al. (15). On the WHO-5, her self-improvement level was also smaller than that of Amy and the σMD data reported in Taylor et al. (15).

Jane demonstrated negligible pre-post intervention changes in estimated Vo_2max and Wingate performance (Table 2). She also exhibited trivial pre-post changes in body weight. This was consistent with modest improvements in body composition as indicated by bioelectric impedance analysis assessment. She was not compliant with instructions during skinfold measurements or dual energy x-ray absorptiometry scanning.

DISCUSSION AND CLINICAL IMPLICATIONS

Amy and Jane exhibited unique psychiatric characteristics at baseline and demonstrated vastly different psychiatric and physiological responses to the SIT intervention. Factors contributing to differences in SIT responses likely included a combination of psychiatric context, symptom severity, and adherence to the intervention. These non-physiological precursors might enhance clinical decision-making because of

TABLE 1. A summary of Amy's pre-post SIT intervention changes on psychological, physiological, anthropometric, and blood profile measures relative to broader group mean changes.

	Pre	Post	Δ	σ MD	MD Score
Psychological					
PANSS					
Positive	10	9	−1.00	3.00	−4
Negative	8	8	0.00	1.50	−1.5
General	35	31	−4.00	4.25	−8.25
Total	53	48	−5.00	8.75	−13.75
WHO-5	68	72	4.00	6.50	10.5
Physiological					
Resting Heart Rate	88	73	−14.21	5.57	−19.78
Resting Blood Pressure (mm Hg)					
Systolic	117	118	0.33	−13.17	13.5
Diastolic	77	75	−2.00	−7.92	5.92
Estimated Vo_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	34.9	37.8	2.95	−6.05	9
PWC_{170} (watts)	90.51	103.45	12.94	−20.07	33.01
Wingate Test					
Peak Sprint (watts)	225	298	73	−48.25	121.25
Average Sprint (watts)	151	197	46	24.00	22
Anthropometrics					
Body Mass (kg)	53.9	52.2	−1.74	0.60	−2.34
Height (cm)	156.07	156.53	0.46	−0.25	0.71
BMI ($kg \cdot m^{-2}$)	22.1	21.3	−0.84	0.27	−1.11
Skinfolds					
Sum of 4 (triceps, subscapular, supraspinal, medial calf)	63.2	60.3	−2.90	2.35	−5.25
Sum of 7 (excludes iliac crest)	148.2	139.0	−9.20	7.95	−17.15
Sum of 8	169.2	158.5	−10.70	8.75	−19.45
Waist Circumference (cm)	72.9	71.8	−1.13	1.12	−2.25
Hip Circumference (cm)	94.7	94.3	−0.47	0.62	−1.09
Waist-Hip Ratio	0.77	0.76	−0.01	0.01	−0.02
BIA Body Fat % Estimate	27.5	24.1	−3.40	1.85	−5.25
DXA					
Body Fat % Estimate	39.8	37.3	−2.50	–	–
Blood Profile					
Triglycerides ($mmol \cdot L^{-1}$)	0.57	1.10	0.53	−0.25	0.78
HDL Cholesterol ($mmol \cdot L^{-1}$)	1.40	1.20	−0.20	0.03	−0.23
LDL Cholesterol ($mmol \cdot L^{-1}$)	3.10	3.00	−0.10	−0.12	0.02
Total Cholesterol ($mmol \cdot L^{-1}$)	4.10	3.90	−0.20	−0.05	−0.15
Glucose ($mmol \cdot L^{-1}$)	3.90	3.50	−0.40	0.40	−0.8
CRP ($mg \cdot L^{-1}$)	2.70	2.50	−0.20	0.08	−0.28

Δ = pre-post change; σMD = sample mean difference; BIA = bioelectric impedance analysis; BMI = body mass index; CRP = C-reactive protein; DXA = dual-energy x-ray absorptiometry; HDL = high-density lipoprotein; LDL = low-density lipoproteins; MD score (15) = individual change – population change; PANSS = positive and negative syndrome scale; PWC_{170} = physical work capacity 170 test; WHO-5 = World Health Organization-5 questionnaire

TABLE 2. A summary of Jane's pre-post SIT intervention changes on psychological, physiological, anthropometric, and blood profile measures relative to broader group mean changes.

	Pre	Post	Δ	σ MD	MD Score
Psychological					
PANSS					
Positive	24	19	−5.00	3.00	−8
Negative	29	26	−3.00	1.50	−4.5
General	56	48	−8.00	4.25	−12.25
Total	109	93	−16.00	8.75	−24.75
WHO-5	24	26	2.00	6.50	8.5
Physiological					
Resting Heart Rate	103	95	−7.17	5.57	−12.74
Resting Blood Pressure (mm Hg)					
Systolic	98	110	12.00	−13.17	25.17
Diastolic	62	71	8.33	−7.92	16.25
Estimated Vo_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	16.2	16.5	0.26	−6.05	6.31
PWC_{170} (watts)	58.56	61.76	3.20	−20.07	23.27
Wingate Test					
Peak Sprint (watts)	213	218	5	−48.25	53.25
Average Sprint (watts)	150	131	−19	24.00	−43
Anthropometrics					
Body Mass (kg)	77.5	78.2	0.78	0.60	0.18
Height (cm)	160.10	160.00	−0.10	−0.25	0.15
BMI ($kg \cdot m^{-2}$)	30.2	30.6	0.34	0.27	0.07
Skinfolds					
Sum of 4 (triceps, subscapular, supraspinal, medial calf)	X	X	X	2.35	X
Sum of 7 (excludes iliac crest)	X	X	X	7.95	X
Sum of 8	X	X	X	8.75	X
Waist Circumference (cm)	88.3	88.1	−0.20	1.12	−1.32
Hip Circumference (cm)	107.5	107.0	−0.50	0.62	−1.12
Waist-Hip Ratio	0.82	0.83	0.00	0.01	−0.01
BIA Body Fat % Estimate	38.9	37.4	−1.50	1.85	−3.35
Blood Profile					
Triglycerides ($mmol \cdot L^{-1}$)	1.20	1.10	−0.10	−0.25	0.15
HDL Cholesterol ($mmol \cdot L^{-1}$)	1.85	1.61	−0.24	0.03	−0.27
LDL Cholesterol ($mmol \cdot L^{-1}$)	2.50	2.80	0.30	−0.12	0.42
Total Cholesterol ($mmol \cdot L^{-1}$)	4.90	4.90	0.00	−0.05	0.05
Glucose ($mmol \cdot L^{-1}$)	5.70	5.10	−0.60	0.40	−1
CRP ($mg \cdot L^{-1}$)	3.80	3.70	−0.10	0.08	−0.18

Δ = pre-post change; σMD = sample mean difference; BIA = bioelectric impedance analysis; BMI = body mass index; CRP = C-reactive protein; HDL = high-density lipoprotein; LDL = low-density lipoproteins; MD score (15) = individual change – population change; PANSS = positive and negative syndrome scale; PWC_{170} = physical work capacity 170 test; WHO-5 = World Health Organization-5 questionnaire

their possible associations with adherence to exercise training interventions. Accordingly, for psychiatric patients there may not be prognostic value in performing traditional cardiopulmonary exercise test assessments to evaluate benefit gained from an exercise training intervention.

Whether focusing on improving specific clinical psychiatric symptoms or general health indices, structured exercise or PA for adolescents receiving inpatient psychiatric treatment is beneficial (15,16). Broader SIT intervention evidence suggests SIT can be a possible mental and physical health strengthening catalyst, helping initiate specific physiological (17) and psychological changes (16) while also proving beneficial for general cardiovascular function (2). Integrating exercise or PA as a core component of adolescent inpatient psychiatric treatment prescription could help change health trajectories and prevent comorbidity development. Nonetheless, a standard SIT exercise prescription template is unlikely to be appropriate and beneficial across patients. Main challenges are to identify when SIT is most appropriate for adolescent patients, when SIT protocols may need to be adapted, or when other exercise or PA approaches need to be applied to best meet the needs of the patient.

Prior to considering implementing SIT as an adjunct component to standard of care practices, clinicians should first consider developing a patient screening tool to identify factors conducive to *responsive* behaviors. This should include a combination of questions relating to individual background (e.g., nature and history of trauma, PA history, family support), history of psychiatric diagnoses and symptom severity, adherence to medical therapies, and present physical health and functioning. Responses given for these questions may be predictive of whether a patient is likely to adhere to and benefit from a structured exercise training intervention such as SIT. Pre-exercise prescription screening can also act to enhance clinical decision-making processes, thereby optimizing the allocation of practitioner time and facility resources to best serve the individual needs of all patients.

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