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Exercise recovery practices of wheelchair court sports athletes

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Exercise recovery practices of wheelchair court sports athletes

Recovery in wheelchair court sports

Abstract

Research that describes the practices of Paralympic athletes beyond training and competition, and how they periodise recovery is limited. This study investigated if and why athletes in wheelchair court sports (basketball, rugby and tennis) use recovery strategies, what types of strategies they use, and if the period of the season influences prevalence of use. A cross sectional questionnaire was developed to acquire data pertaining to individual characteristics, recovery habits, reasons for use/non-use, information on each specific recovery strategy used and lifestyle habits. 144 athletes (92 = international, 52 = national/club) completed the questionnaire online. In total, 85% (n = 122) of athletes reported using at least one type of recovery strategy, yet most specific types of recovery strategies were not popularly used (< 34% of recovery strategy users). The most commonly used type of recovery strategy was stretching (n = 117), while both stretching and heat-related recovery were the most highly rated types of recovery strategies ($\mu = 4.2/5$). The three most prevalent reasons for use across all strategies were “reduces muscle soreness”, “reduces muscle tightness” and “reduces muscle spasms”. The prevalence of sleep complaints was also highlighted by 38% (n = 55) of respondents. This study highlights that while the frequent use of well-known recovery practices is positive, the lack of diversity in strategies implemented may have implications due to the specific requirements of exercise recovery. Therefore, strength and conditioning professionals should educate wheelchair-athletes further around this area and increase the range of recovery- and impairment-specific strategies used.

Keywords: Paralympic, sport, sleep, disability

INTRODUCTION

Temporary exercise-induced damage, also known as functional overreaching, is required for performance enhancement¹. The stress of exercise mediates numerous signalling cascades which are responsible for the beneficial adaptations to exercise^{2,3}. Despite the requirement of stress for positive adaptations, appropriate recovery between periods of exercise is necessary to ensure non-functional overreaching and overtraining do not occur⁴. As a result, many post-exercise recovery options are now available for many athletes, which include active recovery techniques, compression, water immersion, heat application and nutritional strategies⁵.

Although it is widely agreed that recovery strategies are implemented from club to international level in a variety of able-bodied sports, only a small number of studies have assessed the prevalence of recovery strategy use⁶⁻⁹. However, these studies within team sports including basketball and rugby and the sport of tennis do provide a general overview of the recovery habits adopted by able-bodied athletes. In contrast, there is currently little data available investigating recovery strategy practices in Para-sports, with the emphasis on sports nutrition¹⁰. However, the needs of Para-athletes may differ, for example, using a wheelchair can reduce energy expenditure which could reduce post-exercise nutritional needs¹¹, and can also present practical challenges when attempting to use specific strategies that require transferring out of the wheelchair. Thus, caution must be applied when extrapolating information from able-bodied research. Moreover, wheelchair court sports provide an interesting case because the sports of basketball, rugby and tennis have different medical conditions (spinal cord injury, cerebral palsy, arthrogryposis, etc.) that are eligible to participate in each sport and subtle differences exist in the physical demands across both sport and those that compete^{12,13}. Therefore, the use of recovery strategies may also differ within and between Para-sports.

The number of recovery strategies and commercially available units continue to increase despite insufficient scientific evidence to support their use. In addition, growing evidence suggests dampening inflammation may reduce the adaptive response to exercise¹⁴. Thus, periodisation of recovery strategies across a competitive season is important. Although the Paralympic movement is

continuously growing, it is still understudied compared to able-bodied sports. The frequency and timing of recovery strategy use will help reveal the knowledge athletes in Para-sports possess. Athletes with a physical impairment may use recovery strategies for different reasons than able-bodied athletes, for example, due to impairment specific benefits or a disparity in knowledge regarding the benefits a recovery strategy provides.

Another factor that may influence exercise recovery is an athlete's daily lifestyle habits. Prolonged or strenuous exercise is accompanied by glycogen utilisation and fluid loss ^{15,16} both of which can limit subsequent performance if not replenished ^{17,18}. Moreover, habitual sleep also plays an important role and is regarded as a major factor for peak performance and recovery ¹⁹. Therefore, the aims of this study were to determine the (1) prevalence of recovery strategy use in wheelchair court sports; (2) reasons for use and non-use; (3) whether age, gender, impairment, performance level or sport influence recovery strategy use; (4) habitual habits that are pertinent to exercise recovery; (5) and with this information provide a reference tool for strength and conditioning coaches and sports practitioners to use to inform and expand their practices.

METHODS

Experimental approach to the problem

A cross sectional questionnaire was developed to gain an insight into the current recovery habits of athletes that compete within wheelchair court sports. The design was adapted from a combination of previously published questionnaires on Para-sports and exercise recovery ^{7,20}. The questionnaire was reviewed by several academics and practitioners with expertise in Paralympic sports. A pilot version of the questionnaire was completed by a small group of wheelchair athletes (n = 3) and coaches (n = 1) to assess their ability to understand and complete the main sections within it and the length of time taken. The finalised questionnaire included questions requiring a combination of; 1) closed and open-ended; 2) multiple-choice; 3) Likert scale; 4) and free text responses. It acquired data pertaining to individual characteristics (e.g. sport, gender, impairment, age etc.), recovery habits, reasons for use

and non-use, and specific information for each main recovery strategy used. Impairments were categorised as; 1) impaired muscle power e.g. spinal cord injury, spina bifida, peripheral neuropathy; 2) impaired coordination e.g. cerebral palsy, traumatic brain injury; 3) impaired range of movement/limb deficiency e.g. amputation, arthrogryposis, Roberts syndrome. The questionnaire took up to 25 minutes to complete depending on the answers provided.

Subjects

Participants were recruited during the 2018/19 athletic season via the local research centre newsletter, promotional flyers, social media sites, through existing contacts in the Paralympic field and at training camps and competitions. The sports that were targeted were specific to wheelchair court sports (basketball/rugby/tennis) at all levels of participation. Questionnaires were completed using an online link to the Bristol Online Survey website. Only athletes with a physical impairment, over 18 years of age, who participate in the aforementioned sports were included. Approval for the study was obtained from the local ethical advisory committee and all participants were informed of the benefits and risks before providing consent.

Procedures

The term “recovery strategy” was defined in the questionnaire as “any activity used during exercise or following its cessation intended to diminish the negative effects of that exercise and prepare for the subsequent performance”. The first section of the questionnaire consisted of demographic information. To conclude the section participants were asked to answer “yes” or “no” to whether they used recovery strategies. Participants who did not use recovery strategies were asked to indicate why they did not, using a multiple-choice checkbox, and were directed to section three. Conversely, those participants that answered “yes” carried on to the second section. The second section investigated the types of recovery strategies used by participants. Participants were asked to answer “yes” or “no” to whether they performed any of the following recovery strategies; active land based, stretching, cold-related, contrast hot/cold, compression, sleep/nap, nutrition, heat-related or additional.

Examples of each recovery strategy were provided for clarification purposes. The strategies were chosen as they were regularly cited in the literature and are anecdotally known to be used. If participants answered “yes” for any of the recovery strategies they were directed to further questions depicting the details of that recovery strategy (e.g. description, duration, rating, reasons for use etc.). The final section consisted of lifestyle related questions that are relevant to the recovery process. Information regarding food, hydration and sleep were obtained mainly through a combination of closed, open-ended, multiple-choice, and Likert scale questions.

Statistical analysis

Analysis were conducted using the Statistical Package for Social Sciences (IBM SPSS version 23, Chicago, IL, USA). All descriptive data were presented as frequencies (% , n). Recovery strategy use and lifestyle habits were evaluated by age, gender, physical impairment (impairment muscle power, impaired coordination, impaired range of movement/limb deficiency), performance level and sport using chi-square (χ^2) analysis. Statistical significance was determined at $p < 0.05$.

RESULTS

Recovery strategies and habits

A total of 144 athletes (81% male, 19% female) across 3 impairment categories (57% impaired muscle power, 16% impaired coordination, 27% structural impairment/deficiency), 3 sports (52% wheelchair rugby, 28% wheelchair basketball, 20% wheelchair tennis) and 15 nationalities (65% British, 13% American, 10% other, 6% Irish, 3% Canadian, 3% French) completed the questionnaire. Athletes were aged (years) 18 – 25 (32%), 26 – 35 (39%), 36 – 45 (19%), 46 + (10%), and reported average weekly training hours of 0 – 10 (48%), 11 – 20 (35%) and 21 + (17%). 64 % (n = 92) and 36 % (n = 52) reported playing internationally (representing country at any level) and nationally (national competitions, club participation), respectively. 77% (n = 71) of those that reported playing internationally were at a senior level, 12% (n = 21) were at a development/junior level.

In total, 85% (n = 122) of athletes reported using recovery strategies. 69% (n = 100) of recovery strategies were used during/after competition, 56% (n = 80) were used during/after pre-season training, and 72% (n = 103) were used during/after in-season training. Recovery strategies were considered “very important” by 67% (n = 96), “important” by 27% (n = 39), “moderately important” by 5% (n = 7) and “of little importance” by 1% (n = 2). A list of the various types of recovery strategies, specific recovery strategies, their frequency of use and their mean ratings are presented in Table 1. The most commonly used type of recovery strategy was stretching (96%, n = 117). 75% (n = 108) of athletes reported using static stretching, 58% (n = 83) used dynamic stretching, 17% (n = 25) used proprioceptive neuromuscular facilitation (PNF) stretching and < 1% (n = 4) were unaware of the type of stretching they did. Although stretching activities were the most commonly used, both heat-related and stretching recovery strategies were the most highly rated type of recovery strategy ($\mu = 4.2/5$). The most highly rated specific recovery strategy (with n > 5) was resistance band stretching followed by deep tissue therapy (i.e. foam rolling and massage) and whole body stretching with mean scores of 4.5/5, 4.3/5 and 4.2/5, respectively. Specific nutrition related recovery strategies were not included due to the wide variability that existed. However, certain elements were captured including supplement use (55%, n = 47), protein supplement use (54%, n = 46), whole food protein and carbohydrate ingestion (38%, n = 32 and 23%, n = 20, respectively), and hydration/sport drinks use (15%, n = 13). The timing of recovery strategy use was also reported, see Table 2.

Table 1. The frequency of use of different recovery strategies types, specific recovery strategies (italic) and their mean ratings.

Recovery strategy	Frequency ((%) (n))	Rating ((1 – 5) (μ))
Active land based	67 (82)	3.8
<i>Pushing</i>	59 (72)	3.8
<i>Stationary bike</i>	2 (2)	4.0
<i>Handcycle/arm crank</i>	6 (7)	3.3
<i>Rowing machine</i>	1 (1)	4.0
Stretching	96 (117)	4.2
<i>Upper and/or trunk</i>	52 (63)	4.1
<i>Lower and/or trunk</i>	2 (2)	4.5
<i>Whole body</i>	13 (16)	4.2

<i>Resistance band</i>	8 (10)	4.5
<i>Unspecified</i>	20 (25)	4.0
Cold-related	21 (26)	3.9
<i>Ice pack</i>	12 (15)	4.0
<i>Cold shower</i>	5 (6)	3.5
<i>Hand immersion</i>	1 (1)	3.0
<i>Cold bath</i>	2 (2)	4.0
<i>Ice bath</i>	2 (2)	4.5
Heat-related	14 (17)	4.2
<i>Hot bath</i>	6 (7)	3.9
<i>Hot shower</i>	3 (4)	4.8
<i>Sauna</i>	1 (1)	3.0
<i>Other (heat pack/infrared)</i>	3 (4)	4.3
Contrast hot/cold	11 (13)	3.7
<i>Hot shower/cold bath</i>	2 (2)	4.5
<i>Hot/cold shower</i>	9 (11)	3.6
<i>Ice pack/hot shower</i>	1 (1)	4.0
Compression	16 (20)	3.8
<i>Body compression top</i>	5 (6)	4.0
<i>Compression sleeves</i>	4 (5)	3.6
<i>Compression sleeves + socks</i>	2 (2)	3.0
<i>Compression/cold</i>	2 (2)	5.0
<i>Pulsing compression</i>	2 (3)	3.7
<i>Bandage</i>	1 (1)	2.0
<i>Unspecified</i>	1 (1)	5.0
Sleep/nap	33 (40)	4.1
<i>Nap</i>	25 (31)	4.0
<i>Sleep extension</i>	4 (5)	4.0
<i>Relaxation techniques</i>	3 (4)	4.8
Nutrition	70 (85)	4.1
Additional	11 (13)	4.4
<i>Medication</i>	2 (2)	4.5
<i>Deep tissue treatment</i>	8 (10)	4.3
<i>CVAC pod</i>	1 (1)	5.0

145

146 Table 2. The prevalence (% of participants) of using recovery strategies during different periods of the

147 season. Only recovery strategies with n > 5 are included.

148

Recovery strategy	Competition period			Pre-season period			In-season period		
	Always	Sometimes	Rare/never	Always	Sometimes	Rare/never	Always	Sometimes	Rare/never
Active land based (n = 82)	67	26	7	65	33	2	57	39	4
<i>Pushing (n = 72)</i>	71	24	6	65	32	3	60	36	4
<i>Handcycle/arm crank (n = 7)</i>	43	71	29	57	43	0	29	72	0
Stretching (n = 117)	62	35	3	62	32	7	55	40	5
<i>Upper and/or trunk (n = 63)</i>	67	32	2	64	32	5	59	35	6
<i>Whole body (n = 16)</i>	63	38	0	81	19	0	56	44	0

<i>Resistance band (n = 10)</i>	30	60	10	40	40	20	50	50	0
Cold-related (n = 26)	8	62	31	4	46	50	0	54	46
<i>Ice pack (n = 15)</i>	13	67	20	0	53	48	0	60	40
<i>Cold shower (n = 6)</i>	0	67	33	17	67	17	0	83	17
Heat-related (n = 17)	29	59	12	24	53	24	29	47	24
<i>Hot bath (n = 7)</i>	14	57	29	57	29	14	14	43	43
Contrast hot/cold (n = 13)	7	64	29	14	50	36	14	43	43
<i>Hot/cold shower (n = 11)</i>	0	73	27	9	55	36	9	46	46
Compression (n = 20)	40	45	15	30	30	40	25	30	45
<i>Body compression top (n = 6)</i>	50	50	0	50	33	17	50	17	33
<i>Compression sleeves (n = 5)</i>	60	40	0	20	40	40	20	40	40
Sleep/nap (n = 40)	33	55	13	28	45	28	25	40	35
<i>Nap (n = 31)</i>	19	68	13	16	48	36	13	42	45
Nutrition (n = 85)	59	39	2	48	51	1	39	55	6
Additional (n = 13)	54	39	8	39	62	0	39	54	8
<i>Deep tissue treatment (n = 10)</i>	50	40	10	40	60	0	40	50	10

149

150

151 *Reasons for use/non-use*

152 The reasons for use and non-use of each recovery strategy type is reported in Table 3. The reasons for

153 using recovery strategies varied depending on the type of recovery strategy used. The three most

154 popular reasons for using recovery strategies were “reduces muscle soreness”, “reduces muscle

155 tightness” and “reduces muscle spasms”. Each recovery strategy type was used for a combination of

156 either physical, physiological or psychological reasons (top 3), except for sleep/nap and nutrition

157 recovery strategies which were solely psychological reasons (“it improves my energy”, “it improves

158 my mood”, “reduces stress and anxiety”; and “it improves my energy”, “reduces muscle soreness”, “it

159 improves my mood”, respectively). When participants selected “other” they were given a text box to

160 provide their alternative reason. Reasons included and were interpreted as; using it as part of a daily

161 routine (1%; stretching), increase blood pressure (5%; compression), can’t help it occurring (2.5%;

162 sleep/nap), muscle development (1%; nutrition), reduce hunger (1%; nutrition), reduce acid reflux

163 (1%; nutrition) and decrease general pain (6%; contrast).

164

*

165 Table 3. Reasons for use (%) and non-use (% , n) of recovery strategies in ranked in order of frequency
 166 of selection.

167

Reasons for use	ALB (n = 82)	Stretching (n = 117)	Cold (n = 26)	Heat (n = 17)	Contrast (n = 13)	Compression (n = 20)	Sleep/nap (n = 40)	Nutrition (n = 85)
Reduces muscle soreness	79	88	73	94	77	80	28	42
Reduces muscle tightness	76	81	39	100	78	60	33	27
Reduces muscle spasms	40	48	23	59	54	30	23	13
Improves my ROM	48	66	0	65	46	35	18	6
It improves my energy	24	19	19	12	23	20	88	67
Reduces swelling	20	20	46	24	39	50	13	6
Reduces stress and anxiety	24	26	12	35	23	15	60	12
It improves my mood	16	13	4	24	15	20	73	28
Decrease body temp.	16	13	46	12	46	35	18	1
Coach/practitioner told me to	42	38	19	0	31	20	8	16
Gives me time to reflect	39	27	4	29	15	15	15	9
Reduces heart rate	31	23	4	12	31	15	28	4
Reduces blood pressure	17	12	8	18	23	15	15	2
Other athletes do so	26	21	4	0	15	5	5	17
My teammates told me to	16	15	4	0	15	0	3	7
Gives me time to socialise	12	11	0	0	0	0	0	6
I don't know	1	0	0	0	0	0	5	5
Reasons for non-use (n = 22)								
I do not know enough about them (68%, n = 15)	I believe they are ineffective (9%, n = 2) They are too time consuming (9%, n = 2)							
I am concerned about the health effects (9%, n = 2)	My teammates do not use any (9%, n = 2) They were ineffective when I tried (5%, n = 1)							
I do not need them (9%, n = 2)								

168 Abbreviations: ALB, Active land based; and ROM, Range of motion.

169

170 *Comparison by impairment, age, sport, gender and performance level*

171 Multiple chi-square analysis revealed that whether an athlete used recovery strategies did not
 172 significantly differ by impairment ($p = 0.29$), age ($p = 0.72$), sport ($p = 0.18$) or gender ($p = 0.21$). For
 173 performance level, international level athletes trained significantly more hours per week than their
 174 national level counterparts ($p < 0.01$) but this did not translate to being more likely to use recovery
 175 strategies ($p = 0.15$). However, when international level was confined to “elite” level i.e. senior level
 176 internationals (excluding development/junior), those that were “elite” were significantly more likely
 177 to use recovery strategies than the other respondents ($p = 0.04$).

178 *Lifestyle related habits*

179 38% (n = 55) of athletes reported having difficulty sleeping. The most prevalent answer when asked
180 “What causes the difficulty” was “I don’t know, I just can’t sleep” (40%, n = 22). The full list of
181 responses are presented in Figure 1. Impairment category did not impact whether an athlete had
182 difficulty sleeping ($p = 0.71$). However, when individual impairments were assessed, differences did
183 exist. Tetraplegic athletes were more likely to have difficulty sleeping compared to the other athletes
184 within the “impaired muscle power” category ($p = 0.04$). 47% (n = 20) of athletes with tetraplegia and
185 50% (n = 9) of athletes with a limb deficiency reported difficulty sleeping. Whether an athlete had
186 difficulty sleeping did not differ by gender, sport or performance level ($p > 0.05$) but it was associated
187 with age. Athletes aged 18 – 25 years old were less likely to report having difficulty sleeping compared
188 to their older teammates ($p = 0.01$).

189 Protein (food sources) was the main nutrient included in a post-exercise meal (76%, n = 110), followed
190 by carbohydrates (food source) and protein supplements. Although sport did not significantly
191 influence the main nutrients consumed in a post-exercise meal, 44% (n = 33) of wheelchair rugby
192 athletes did not consume whole food carbohydrates in this meal compared to 29% for both wheelchair
193 tennis and wheelchair basketball, respectively. When the athletes were asked “How often do you
194 consume breakfast”, 68% (n = 98) reported that they “always” consumed breakfast, 19% (n = 28)
195 reported “sometimes”, 9% (n = 13) reported rarely and 4% (n = 5) reported “never”. Water (63%, n =
196 91), water and electrolytes (24%, n = 34) and sports drinks (8%, n = 11) were the most common sources
197 of rehydration.

198

199 **DISCUSSION**

200 This study was the first to provide a comprehensive insight into the exercise recovery habits of Para-
 201 sports populations, specifically the wheelchair court sports of basketball, rugby and tennis. The
 202 findings highlight the prevalence of exercise recovery in the aforementioned sports as 85% of
 203 respondents declared using some form of recovery strategy.

204 It appears initially that the use of recovery strategies in Para-sports could be slightly more common,
 205 since able-bodied data from team sports reported that only 57% of athletes used one or more recovery
 206 strategies, however, conflictingly work in tennis noted 80% of athletes used multiple post-match
 207 recovery strategies ^{6,7}. Nonetheless, the research completed in team sports was most closely related
 208 to this study due to the similarities between both questionnaires ⁷. Our respondents were mainly
 209 athletes that competed at an international level (64%), and as the present study showed that senior
 210 international athletes were significantly more likely to use recovery strategies, this could explain the
 211 higher frequency of use. In agreement, all able-bodied international athletes in the study by Crowther
 212 *et al.* (2017) used at least one form of recovery strategy. Nonetheless, athletes with a disability

commonly report more sport-related pain as their training volume increases and some individuals have indicated that pain can limit exercise more than their disability²¹. Therefore, the use of recovery strategies may be used more often in this population to mitigate pain. Although the use of recovery strategies was high, it is worth mentioning that an additional 9% of athletes considered recovery strategies either “very important” or “important”. Despite acknowledging the benefits of recovery strategies, some athletes will still choose not to use them.

Recovery strategies were reported as being used more often following in-season compared to pre-season training. This is encouraging as it may suggest athletes are aware of periodising recovery strategies depending on the time of season, in line with the endurance Para-sports of paratriathlon and handcycling where this has already been well understood^{22,23}. Using recovery strategies in-season will promote recovery and readiness for subsequent competitions. In addition, although not conclusive, the reduction seen in recovery strategy use following pre-season training could be to ensure the positive adaptations from exercise are achieved. For example, techniques such as ice baths, have been shown to dampen the long-term adaptive responses to strength training²⁴. Therefore, during pre-season training when adaptation is a priority, the use of recovery strategies could be minimised. Nonetheless, despite these positive findings, it may not be this clear as it cannot be ignored that during in-season periods there is likely greater attention on the participation in sport in general, which may include the increased use of recovery strategies. In addition, it may be slightly concerning that recovery strategies are adopted less often after competition (69%). An increase in exercise intensity before and during a competition period can leave an athlete vulnerable to injury and illness^{25,26}.

Stretching was the most commonly used type of recovery strategy (96%), which is in line with findings from able-bodied research⁷. Nutrition strategies and active land based techniques were also frequently used, however, all other types were not which is in contrast to able-bodied research from both team and court sports^{6,7}. For example, the fourth most used type of recovery strategy was

sleep/nap techniques which was only used by 33% of the respondents. The disparity in prevalence may be attributed to a combination of factors. Firstly, stretching and active land based recovery require minimal equipment, are common practice, and can be self-administered or completed as a team. Likewise, nutrition strategies are easily implemented and receive support from marketing campaigns. For example, the most commonly used nutrition strategy was supplements (55%) which are commonly advertised online, in sports facilities and by sponsored individuals. Moreover, other recovery strategies may not be well understood. Outside of international programmes, support for Paralympic sports is likely lacking compared to their able-bodied counterparts. Therefore, further education on the potential benefits of different recovery strategy types may need to be considered by practitioners in the field. In addition, practical and impairment specific limitations may play a role. For example, autonomic dysreflexia, a sudden uncontrollable onset of high blood pressure, is common in people with a SCI ²⁷. Extreme temperatures or quick temperature changes can offset this condition; thus, cooling or heating strategies may be reluctantly used. From an alternative perspective, although the majority of respondents were international level athletes the most commonly reported training hours were within the lowest category (0 -10 h). These values are considerably lower than what may be seen in similar level able-bodied sportspersons and may highlight the original roots of wheelchair sports as an integral part of rehabilitation and transition within society ²⁸. Therefore, when the attitude is changed from performance to clinical and mental health outcomes the use of recovery strategies may not be a priority.

Heat-related and stretching recovery activities both scored as the most effective recovery strategy type (4.2/5). Specific heat-related strategies used included “hot shower”, “hot bath”, “sauna” and “heat pack”/infrared heat pack”. The main reasons provided by the athletes for using heat-related recovery strategies were physical or psychological in nature, with the most common responses being “reduces muscle tightness”, “reduces muscle soreness” and “improves my range of motion”. Heat application has been shown to be an effective way to improve range of motion and reduce muscle tightness when combined with stretching ²⁹, while its ability to reduce pain has been therapeutically

used and is mechanistically supported³⁰. Stretching was also considered a highly effective recovery strategy type. Able-bodied team sports research found stretching to be rated highly effective in most groups assessed⁷. The three main reasons for use were identical to the heat-related strategies but ordered slightly differently. Although stretching has been found to improve range of motion³¹, it does not appear to be an effective strategy for reducing muscle soreness³², suggesting the benefits may be misunderstood. Although cold-related and contrast water therapy were rated highly by able-bodied athletes, they were not as popular or commonly used (<22%) in this study. Furthermore, international able-bodied athletes considered sleep followed by massage as the most effective strategies⁷. The differences may again be explained by limited education around the benefits of sleep and/or a disability specific impairment of sleep quality, thus, acting to perceive it as a less effective strategy^{33,34}. Massage was both highly rated and used by all international level athletes, which is in stark contrast to the athletes of this study. Massage requires an affiliated team practitioner or an individually sourced service, therefore, differences in accessibility and funding are plausible explanations for the discrepancies found.

Whether an athlete used recovery strategies or not did not differ by impairment, age, sport or gender. This may be because a large proportion of the respondents used recovery strategies. If instead, differences in the types of recovery strategies used were assessed, this may have highlighted differences between the groups. However, this would require a larger sample of users for each type of recovery strategy assessed. For example, only thirteen respondents used contrast water therapy (11%) which does not provide enough statistical power to compare differences across groups. Similarly, no differences in use between genders may be considered surprising as gender can have an influence on the physiological responses to exercise and the recovery period³⁵. One example is that females have been shown to have a greater reduction in arterial blood pressure following exercise compared to males, and thus, could plausibly gain a greater advantage from post-exercise strategies targeted at a circulatory level³⁶. However, the limited number of females sampled and lack of specificity in comparing the types of recovery strategies used likely accounts for the lack of differences

observed but remains an area that requires more focus in the future. An increased number of female respondents would have been of great benefit to this study; however, the lower numbers may reflect the smaller cohort of female across each sport, particularly within wheelchair rugby. International level athletes trained significantly more than national and club participation athletes. Initially, performance level didn't influence whether an athlete used recovery strategies. However, when development/junior internationals were combined with national/club athletes, those that played at senior international level were significantly more likely to use recovery strategies. A difference in the use of recovery strategies between international and national level athletes is expected due to the higher demands. However, athletes at a development or junior level may need further education as they progress.

Of further interest, comparable literature also exists which depicts the use of recovery strategies in able-bodied court sports ^{6,8}. Research investigating competitive tennis players showed that the athletes were most likely to use foam rolling as a recovery strategy ⁶. Although foam rolling may not be considered by some wheelchair athletes due to practicality reasons, it is a strategy that should present limited barriers for certain athletes (e.g. single limb amputee). In addition, for the specific types of recovery areas assessed, a subset of basketball players recorded over a season were most likely to engage in nutrition related recovery behaviours showing similarities to this study ⁸. However, surprisingly stretching and cooldowns were one of the least used types of strategies. The reasoning behind this difference is hard to explain given that these strategies are easily implemented and performed with the staff before the end of a session, however, this study was conducted with six athletes which would not reflect the sport as whole. The authors noted that even within this subset there were large variations in individual strategies and preferences, and thus, suggested the importance of individualised plans. Furthermore, stretching, for example, could be considered an essential component of recovery for wheelchair athletes with tightness and spasm related issues due to the aforementioned benefits on range of motion.

Another interesting finding of this study was that 38% of the respondents reported having difficulty sleeping. Venter *et al.* 2011 reported that 41% of elite able-bodied team athletes experienced problems falling asleep at night. However, elite athletes commonly experience problems with their sleep related to hyperarousal, changes in training load and scheduling surrounding training/competition³⁸. As this research included non-elite athletes the results could be regarded as high. Moreover, the respondents reported “I don’t know, I just can’t sleep” as the main reason for sleeping difficulty (40%), while “muscle pain” (27%) and “impairment specific” (20%) reasons followed. Although “I don’t know, I just can’t sleep” may fall under hyperarousal the participants did not mention they were stressed, worried or ruminating. Muscle pain may be from exercise but could also be a consequence of the respondent’s impairment, as the two were not distinguished within the questionnaire. Impairment specific reasons included muscle spasms, phantom pain and neuropathic pain, and could help explain the higher number of athletes reporting difficulty sleeping. For example, phantom pain has been known to commonly disturb sleep in those with a limb deficiency³³. Tetraplegic athletes were significantly more likely to have difficulty sleeping than the other athletes within the “impaired muscle power” group with 47% reporting problems. Clinical research has shown that this population frequently report trouble sleeping³⁹. Interestingly, core temperature and melatonin circadian cycles are altered in tetraplegic individuals and has been postulated as a contributor to the disrupted sleep experienced^{40,41}. A circadian rhythm disorder could contribute to an inability to fall or maintain sleep, explaining why a respondent might report “I don’t know, I just can’t sleep” as a reason. As the majority of athletes reported being uncertain why they couldn’t sleep there appears to be a gap in knowledge that exists, such that, further research is needed to help decipher the disruptions reported.

PRACTICAL APPLICATION

Based on the information attained from this study it is clear that a diverse range of recovery strategies are not typically implemented in wheelchair court sports particularly when compared to able-bodied

sports. This finding has potential implications due to the specificity of exercise recovery needs. Furthermore, sleep complaints also appear to be prevalent, which could hinder the restorative processes associated with sleep. Therefore, several recommendations are provided for strength and conditioning professionals, many of whom, work with both able-bodied- and Para- athletes. Firstly, strength and conditioning professionals should consider delivering informal sessions on recovery to their Para-athletes, that include information describing the types of recovery strategies that exist, and how and when to administer them. Secondly, strength and conditioning professionals should consider increasing the range of recovery strategies used and tailor them to the Para-athlete's specific recovery needs while considering impairment type. Lastly, collecting information relating to their Para-athletes sleeping habits, such as bedtimes, wake times, night-time awakenings, and daytime sleepiness, may be particularly useful. This would allow the strength and conditioning coach to understand if their athlete is attaining appropriate sleep quantity and quality, and whether sleep disturbances may apply to them or not.

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FIGURES

Figure 1: Reasons for sleeping difficulties among participants