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RESEARCH ARTICLE



Changes in body satisfaction during and after a 5-month handcycle training period and associations with physical capacity and body composition in individuals with a physical impairment

Ingrid Kouwijzer^{a,b} , Sonja de Groot^{a,b} , Christel M. C. van Leeuwen^c, Linda J. M. Valent^d ,
Janneke M. Stolwijk-Swüste^c , HandbikeBattle group*, Lucas H. V. van der Woude^{e,f}  and Marcel W. M. Post^{c,f} 

^aDepartment of Human Movement Sciences, Faculty of Behavioural and Movement Sciences, Vrije Universiteit Amsterdam, Amsterdam Movement Sciences, The Netherlands; ^bAmsterdam Rehabilitation Research Center | Reade, Amsterdam, The Netherlands; ^cCenter of Excellence for Rehabilitation Medicine, University Medical Center Utrecht Brain Center, University Medical Center Utrecht and De Hoogstraat Rehabilitation, Utrecht, The Netherlands; ^dResearch and Development, Heliomare Rehabilitation Center, Amsterdam, The Netherlands; ^eCenter for Human Movement Sciences, University of Groningen, University Medical Center Groningen, Groningen, the Netherlands; ^fCenter for Rehabilitation, University of Groningen, University Medical Center Groningen, Groningen, the Netherlands

ABSTRACT

Purpose: To investigate: (1) changes in body satisfaction during five months of handcycle training and one year after the training period; (2) whether longitudinal changes are dependent on sex, waist circumference and severity of the physical impairment; (3) associations between changes in physical capacity or body composition, and body satisfaction.

Materials and methods: Individuals ($N=143$) with health conditions such as spinal cord injury filled out the Adult Body Satisfaction Questionnaire: at the start of the training (T1), directly after the training period (T2); and four months (T3) and one year after the training period (T4). At T1 and T2, physical capacity was determined with an upper-body graded exercise test, and waist circumference was measured. Handcycling classification was used as a proxy for the severity of impairment.

Results: Multilevel regression analyses showed that body satisfaction significantly increased during the training period and significantly decreased back to pre-training levels at follow-up. Individuals with more severe impairments showed a larger decrease at T4. Improvements in physical capacity and waist circumference were significantly associated with improvements in body satisfaction.

Conclusions: Body satisfaction significantly increased during the training period, but significantly decreased during follow-up. Additional efforts might be necessary to keep individuals engaged in long-term exercise.

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> IMPLICATIONS FOR REHABILITATION



- Body image disturbances are frequently described in individuals with a physical impairment.
- An increase in body image can be achieved by improvements in physical capacity and waist circumference as a consequence of training.
- It is important to keep individuals engaged in exercise, as body satisfaction decreases after termination of the training period.
- For individuals with severe physical impairments additional efforts are necessary to keep them engaged in exercise.

Introduction

Body image is a complex multidimensional concept that encompasses one's body-related self-perceptions and self-attitudes, including thoughts, beliefs, feelings, and behaviours [1]. These perceptions and attitudes encompass both body appearance and

body functioning and can be experienced positively (e.g., satisfaction) or negatively (e.g., dissatisfaction) [2,3].

In the general population, women are generally less satisfied with their body appearance and function than men [3]. In addition, body composition measures (e.g., body mass, body fat) and physical capacity are, respectively, negatively and positively associated with body

CONTACT Ingrid Kouwijzer  i.kouwijzer@vu.nl  Department of Human Movement Sciences, Vrije Universiteit, Van der Boerhorststraat 7-9, 1081 BT Amsterdam, The Netherlands.

***HandbikeBattle group name:** Paul Dobbelsteijn, Adelante Zorggroep, Hoensbroek, the Netherlands. Eric Helmantel, University Medical Center Groningen, Center for Rehabilitation Beatrixoord, Groningen, the Netherlands. Esther Belsler, Heliomare Rehabilitation Center, Wijk aan Zee, the Netherlands. Linda van Vliet, Rehabilitation Center De Hoogstraat, Utrecht, the Netherlands. Christian van Niekerk, Libra Rehabilitation and Audiology, Eindhoven, the Netherlands. Lise Wilders, Sint Maartenskliniek, Nijmegen, the Netherlands. Ludwine van Orsouw, Amsterdam Rehabilitation Research Center | Reade, Amsterdam, the Netherlands. Wilbert Snoek, Rehabilitation Center Revant, Breda, the Netherlands. Saskia Maas, Rijndam Rehabilitation Center, Rotterdam, the Netherlands. Bram van Gemen, Roessingh Rehabilitation Center, Enschede, the Netherlands. Edwin Blom, Rehabilitation center Tolbrug, Den Bosch, the Netherlands. Anniek van Vilsteren, Vogellanden, Zwolle, the Netherlands.

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satisfaction [3]. In individuals with a physical impairment, body image disturbances are frequently described [2,4,5]. Changes in body function and physical appearance, pain and discomfort, weight gain as well as changes in psychological factors, such as self-efficacy and acceptance, as a consequence of having a physical impairment, have all been shown to be associated with body image disturbances [4,6–10]. Consequently, the severity of the impairment has previously been described to be associated with body image [6,9,11]. Additionally, disturbances in body image can negatively affect the performance of activities of daily living, work, social roles, and quality of life [2,12–14].

Previous studies with individuals with spinal cord injury (SCI) describe the adjustment period (immediately following after the injury) as the most negative time period with respect to body image [6,8,9,14,15]. After this, body image seems to improve with increasing time since injury (TSI) as individuals seem to adjust to their changed body [6,8,14–16]. In addition, minimizing musculoskeletal pain (e.g., correcting abnormal posture or exercise), may contribute to a positive body image [8]. Cross-sectional SCI studies by Bassett et al. showed that women (TSI: 15 ± 13 years) have lower scores on body appearance and function than men (TSI: 15 ± 10 years) [14,15]. In women with SCI, a higher appearance satisfaction was associated with a smaller waist circumference and lower percentage of body fat [15]. Although these cross-sectional differences between men and women with SCI are apparent, it is unknown whether men and women with SCI show similar changes in body image as a response to exercise. A study with able-bodied participants showed that men and women show similar improvements in body image during a strength-training program [17].

Several studies highlighted the positive effects of exercise or physical activity on body image in the general population and in individuals with a physical impairment [3,8,11,15,17–22]. Suggested mechanisms are objective and subjective improvements in muscle strength and body composition as a result of exercise, causing people to feel better about themselves as they are approaching their body ideal [17]. Bailey et al. described engaging in exercise as part of adaptive self-care behaviour in individuals with SCI; a concept which in itself is associated with positive body image [8]. Moreover, in individuals with SCI, exercise interventions have shown to cause an increase in body satisfaction, alongside quality of life and functional independence [11,18,20]. Unfortunately, it is unknown whether these improvements in body satisfaction are preserved after the exercise intervention [23].

The objectives of the current prospective cohort study were to examine: (1) changes in body satisfaction during five months of handcycle training, at four months after the training period and at one year after the training period, (2) whether these longitudinal changes are dependent on sex, waist circumference and severity of the impairment, and (3) associations between changes in physical capacity or body composition, and body satisfaction during the handcycle training period. It was hypothesized that (1) body satisfaction increases during the training period and remains stable during follow-up; (2) men and women show similar trajectories of body satisfaction, but that individuals with an unhealthy waist circumference or more severe impairment show greater improvements in body satisfaction during the training period; (3) the increase in body satisfaction during the training period is associated with improvements in physical capacity and body composition.

Materials and methods

The HandbikeBattle project

The HandbikeBattle event is an annual uphill hand-cycling race (20.2-km length and 863-m elevation gain) in the mountains of

Austria among teams of twelve Dutch rehabilitation centers [24]. The event was created to stimulate an active lifestyle by means of hand-cycling with peers and to push the participant's physical and mental boundaries. Each team consists of former rehabilitation patients with a chronic disability such as an SCI, leg amputation, or cerebral palsy. At the start of the five-month training period, most participants are relatively untrained hand cyclists. Guidance during the training period was provided by therapists from the respective rehabilitation centers, for example, with a group training session each month. The training period was free-living, that is, no specific training program was provided by the researchers. Connected to, but not part of, the HandbikeBattle is an observational cohort study that was initiated to monitor the effects of participation in the training period and the event.

Participants

Inclusion criteria for the HandbikeBattle event were (1) being a former rehabilitation patient from one of the twelve rehabilitation centers, (2) impairment of the lower extremities, and (3) commitment to the HandbikeBattle challenge. The exclusion criterion included any contraindication to participate as diagnosed during the medical screening before the training period. An additional inclusion criterion for the HandbikeBattle study was sufficient knowledge of the Dutch language to understand the instructions. In the present study, data were used from participants of the HandbikeBattle 2017–2019 cohorts.

Procedure

Measurements were performed at the start of the training period (January, T1); after the training period, prior to the event (June, T2); and at follow-up, four months (October, T3) and one year (June, T4) after the event (Figure 1). Measurements included questionnaires at all time points and physical measurements at T1 and T2. Participants were invited by e-mail with a link and could fill out the questionnaires online. Participants of the 2019 cohort were not asked to fill out the questionnaire at T4 (June 2020) due to Covid-19, as the pandemic might have had an effect on health, physical activity and other related factors. At T1, a medical screening was performed by a rehabilitation physician at the rehabilitation center. The screening comprised a medical anamnesis, physical examination, and a handcycling or arm crank-graded exercise test (GXT). During the screening it was assessed whether it was safe for individuals to start training and to participate in the HandbikeBattle event. The screening was, therefore, a prerequisite at the start of the training period. At T2, the GXT was repeated with the same protocol and equipment. All participants voluntarily signed an informed consent form. The study was approved by the local ethics committee of the Center for Human Movement Sciences, University Medical Center Groningen, the Netherlands (ECB/2012_12.04_1_rev/MI).

Outcome measures

General information

General participant information was collected at T1 and included age (y), sex, and impairment type. The hours of sports participation per week were reported by the participant at T2, T3, and T4.

Body satisfaction

The 9-item Adult Body Satisfaction Questionnaire[3] was used to measure satisfaction with their body function and body

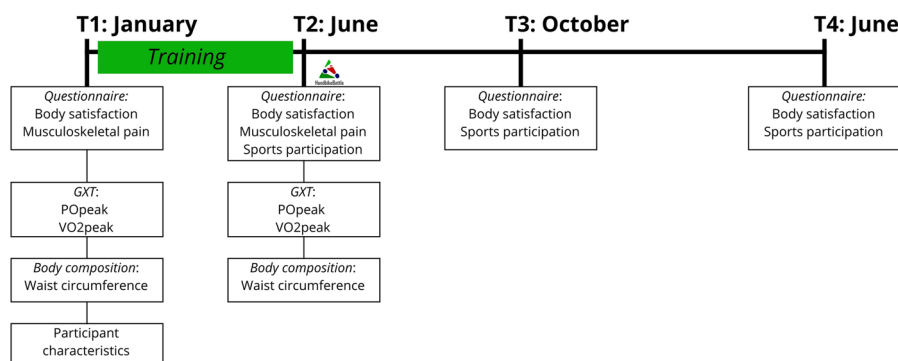


Figure 1. Study design. Measurements are performed at the start of the training period (January, T1); after the training period, prior to the event (June, T2); and follow-up, four months after the event (October, T3) and one year after the event (June, T4). abbreviations: GXT=graded exercise test, POpeak=peak power output, VO₂peak=peak oxygen uptake.

appearance. In concordance with previous studies that measured body satisfaction in a wheelchair-using population, a 10th item was added to measure satisfaction with arm muscle strength [11,14,15,18,20]. Each item is rated on a 7-point scale ranging from -3 (very dissatisfied) to +3 (very satisfied). The questionnaire has two subscales: functional satisfaction (average of seven items, e.g., level of endurance) and appearance satisfaction (average of three items, e.g., weight). This measure has shown adequate internal consistency for both subscales ($\alpha > 0.70$) [3,14,18].

Determinants

Upper body physical capacity was measured during a GXT to volitional exhaustion at T1 and T2. Details on equipment and testing protocols have been described in a previous study [25]. Either a 1-min stepwise protocol or continuous ramp protocol was used, and was individualized for each participant. The set-up and protocol choice were dependent on the available equipment in the rehabilitation centers, but were consistent within participants over time. Power output (PO, in Watts (W)) and gas exchange were measured during the test. For the 1-min stepwise protocol, peak PO (POpeak) was defined as the highest PO that was maintained for at least 30s. For the ramp protocol, the highest PO achieved during the test was considered POpeak. Peak oxygen uptake (VO₂peak, l/min) was defined as the highest 30-s average for oxygen consumption.

At T1 and T2 waist circumference (cm) was measured with measuring tape at the level of the umbilicus and with participants in supine position. The average of three measurements was used for analysis. To study interaction effects (objective 2), waist circumference was dichotomized (healthy (men ≤ 102 cm, women ≤ 88 cm) and unhealthy (men > 102 cm, women > 88 cm)) [26].

Confounding variables

Possible confounding variables included in the analyses were age, sex, musculoskeletal pain, and handcycling classification.

Musculoskeletal pain comprised seven locations: left and right hand and wrist, left and right elbow, left and right shoulder, and the neck. Pain was graded with a range from 1 (no pain) to 6 (very severe pain). Having moderate-severe pain was defined as ≥ 4 (moderate pain) at ≥ 1 locations. Two groups were created: (1) no-mild pain, (2) moderate-severe pain.

Handcycling classification was used as a proxy for severity of impairment and determined by a certified para-cycling classifier. The classification resulted in five different classes, ranging from H1 (most impaired) to H5 (least impaired) [27]. H1 and H2 handcyclists

have limitations in arm-hand function, trunk, and lower limbs; whereas H3 handcyclists have intact arm-hand function and limitations in the trunk and lower limbs. H4 and H5 handcyclists have limitations in lower limbs only. Handcyclists with (potentially) impaired heart rate response to exercise are represented in class H1–H3. For the analyses in the present study, participants were divided into two groups of equal size: (1) H1–H3 and (2) H4–H5.

Statistical analysis

The analyses were performed with SPSS (Version 27.0; IBM Corp, Armonk, NY) and MLwiN version 2.36 [28]. Descriptive statistics were calculated for outcome measures and determinants. Data were tested for normality with the Kolmogorov-Smirnov test with Lilliefors significance correction, combined with z scores for skewness and kurtosis. To ascertain possible response bias, characteristics of included participants in the present study were compared with non-participants (i.e., drop-outs or those who did not fill out all questionnaires) using *t* tests, Mann-Whitney U tests, and chi-square tests.

Multilevel models with three levels were created; with observations within participants as first level, participant as second level, and rehabilitation center as the third level. Multilevel analyses were conducted to be able to make adjustments for the dependency of the observations within participants and participants within centers. An additional advantage of multilevel analyses is the robustness of missing data [29].

Two models were created to examine the longitudinal trajectory of body satisfaction (hypothesis 1): one with functional satisfaction and one with appearance satisfaction as dependent variable. Time (T1, T2, T3, T4) was included as a categorical variable with three dummies and T2 as reference category.

To test hypothesis 2, interaction terms with the time dummies were investigated in a series of separate models for each of the following determinants: sex (reference: male), waist circumference (reference: healthy), and handcycling classification (reference: H1–H3).

To test hypothesis 3, four models were created to examine longitudinal associations between functional satisfaction and appearance satisfaction, and changes in two determinants (POpeak, waist circumference). POpeak was chosen to represent physical capacity, as it had the least missing data and there was a high correlation ($r = 0.84$) between POpeak and VO₂peak. These models were created as hybrid models for the training period (T1, T2) to be able to distinguish between the between-subject (cross-sectional) component and the within-subject (longitudinal) component of the association [30]. Possible confounders, age, sex (reference: male), musculoskeletal pain (reference: no-mild pain),

and handcycling classification (reference: H1-H3) were added separately to each model first. A confounder was included in the final model if its inclusion changed the regression coefficient(s) with more than 10% [31].

Results

In total, 205 individuals started training. Twenty-five individuals dropped out due to medical reasons ($N=14$), motivational problems ($N=4$), being too busy with work/family ($N=4$) or personal/unknown reasons ($N=3$). Thirty-seven individuals did not fill out questionnaires at any time-point ($N=22$), or only at one time-point ($N=15$). Hence, data from 143 participants were included in the present study, whereas 62 individuals were defined as non-participants.

Participants were on average older and had more often an acquired impairment such as SCI or leg amputation, in contrast to non-participants, who had more often spina bifida or cerebral palsy (Table 1). Descriptive data of the outcome measures, determinants over time, and potential confounders are depicted in Table 2.

Longitudinal trajectory of functional satisfaction and appearance satisfaction

Functional and appearance satisfaction showed a significant increase between T1 (start of training) and T2 (after training), whereas a significant decrease was found for both outcome measures during follow-up (Table 3). When the models were recalculated with T1 as reference category, there were no significant

Table 1. Characteristics and outcomes at T1 for participants and non-participants.

Characteristics	N	Participants	N	Non-participants
Sex (male/female) (%male)	143	96/47 (67%)	62	44/18 (71%)
Age (years)	143	43 ± 13*	60	37 ± 12*
Acquired/congenital impairment (%acquired)	143	119/24* (83%)	55	37/18* (67%)
Time since injury (years)	116	9 ± 12	33	11 ± 10
Impairment type	143	*	54	*
Spinal cord injury		74 (52%)		27 (50%)
Tetraplegia		17 (12%)		3 (6%)
Paraplegia		57 (40%)		24 (44%)
Leg amputation		21 (15%)		3 (5%)
Multi trauma		5 (3%)		1 (2%)
Spina bifida		11 (8%)		8 (15%)
Cerebral palsy		4 (3%)		8 (15%)
Other		28 (19%)		7 (13%)
Functional satisfaction	134	0.69 ± 1.18	30	0.38 ± 1.22
Appearance satisfaction	134	0.57 ± 1.70	30	-0.02 ± 1.75
POpeak (W)	140	109 ± 37	56	107 ± 47
VO ₂ peak (l/min)	137	1.74 ± 0.49	55	1.76 ± 0.60
Body mass (kg)	137	78.9 ± 17.3	52	76.6 ± 18.0
Waist circumference (cm)	127	95.0 ± 13.6	43	92.7 ± 16.4
Musculoskeletal pain (no-mild/moderate-severe) (%no-mild)	135	89/46 (66%)	33	19/14 (58%)
Handcycling classification (H1-H3/H4-H5) (%H1-H3)	143	70/73 (49%)	49	27/22 (55%)

Data represent N (%) or mean (SD). POpeak: peak power output; VO₂peak: peak oxygen uptake. Musculoskeletal pain: two categories: (1) no-mild pain and (2) moderate-severe pain. Handcycling classification: two categories: (1) H1-H3 and (2) H4-H5.

*Significant difference with $p < 0.05$ between participants and non-participants.

Table 2. Descriptive data and outcome measures of participants at all time points.

	N	T1	N	T2	N	T3	N	T4
Functional satisfaction	134	0.69 ± 1.18	136	1.48 ± 0.92	119	0.88 ± 1.24	67	0.79 ± 1.49
Appearance satisfaction	134	0.57 ± 1.70	136	1.18 ± 1.57	119	0.61 ± 1.69	67	0.32 ± 1.70
POpeak (W)	140	109 ± 37	136	132 ± 44				
VO ₂ peak (l/min)	137	1.74 ± 0.49	134	2.04 ± 0.59				
Waist circumference (cm)	127	95.0 ± 13.6	116	91.6 ± 12.6				
Musculoskeletal pain (no-mild/moderate-severe) (%no-mild)	135	89/46 (66%)	136	92/44 (68%)				
Sports participation (h/week)	-	-	127	7.3 [5.5-10.0]	112	5.0 [3.0-7.0]	65	6.3 [3.0-8.3]

Data represent N (%), mean (SD) or Median [IQR]. POpeak: peak power output; VO₂peak: peak oxygen uptake. T1: start of the training period. T2: after the training period, prior to the HandbikeBattle event. T3: follow-up measurement, four months after the event. T4: follow-up measurement, one year after the event.

Table 3. Longitudinal trajectory of body satisfaction ($N=143$).

	Functional satisfaction			Appearance satisfaction		
	Regression coefficient	SE	p value	Regression coefficient	SE	p value
Constant (reference T2)	1.468	0.099		1.155	0.141	
Δ T2-T1	-0.766	0.106	< 0.01*	-0.604	0.126	< 0.01*
Δ T2-T3	-0.606	0.110	< 0.01*	-0.540	0.131	< 0.01*
Δ T2-T4	-0.666	0.135	< 0.01*	-0.862	0.161	< 0.01*

T1: start of the training period. T2: after the training period, prior to the HandbikeBattle event. T3: follow-up measurement, four months after the event. T4: follow-up measurement, one year after the event. *Significance with $p < 0.05$. The Δ T2-T1 = a negative regression coefficient representing an improvement of the dependent variable over time. The Δ T2-T3 and Δ T2-T4 = a negative regression coefficient representing a deterioration of the dependent variable over time.

Table 4. Longitudinal trajectory of body satisfaction of groups with different sex, waist circumference or handcycling classification and interaction effects (time * group).

	Sex	Waist circumference	Handcycling classification
Functional satisfaction			
Constant (reference: T2)	1.532 (0.119)	1.509 (0.136)	1.348 (0.140)
Δ T2-T1	-0.659 (0.127)*	-0.738 (0.148)*	-0.877 (0.151)*
Δ T2-T3	-0.463 (0.132)*	-0.512 (0.152)*	-0.665 (0.159)*
Δ T2-T4	-0.615 (0.163)*	-0.700 (0.184)*	-0.983 (0.187)*
Determinant	-0.192 (0.209)	-0.214 (0.214)	0.237 (0.194)
(Δ T2-T1) x determinant	-0.332 (0.225)	-0.130 (0.232)	0.218 (0.210)
(Δ T2-T3) x determinant	-0.446 (0.234)	-0.198 (0.241)	0.110 (0.219)
(Δ T2-T4) x determinant	-0.156 (0.285)	-0.025 (0.309)	0.663 (0.267)*
Appearance satisfaction			
Constant (reference: T2)	1.341 (0.168)	1.514 (0.176)	1.220 (0.201)
Δ T2-T1	-0.546 (0.153)*	-0.437 (0.174)*	-0.733 (0.179)*
Δ T2-T3	-0.547 (0.159)*	-0.424 (0.179)*	-0.653 (0.190)*
Δ T2-T4	-0.838 (0.196)*	-0.941 (0.218)*	-1.277 (0.224)*
Determinant	-0.566 (0.295)	-1.087 (0.277)*	-0.121 (0.280)
(Δ T2-T1) x determinant	-0.183 (0.270)	-0.474 (0.273)	0.249 (0.250)
(Δ T2-T3) x determinant	0.020 (0.281)	-0.185 (0.284)	0.214 (0.261)
(Δ T2-T4) x determinant	-0.071 (0.344)	-0.015 (0.365)	0.852 (0.320)*

Data represent regression coefficient (SE). For both outcome parameters (functional satisfaction and appearance satisfaction), three separate models were created (one model for each determinant). Each model consisted of the time dummies, one determinant, and the interaction effect between time and determinant. Sex: M/F, reference: male. Waist circumference at T1: healthy (men \leq 102 cm, women \leq 88 cm) and unhealthy (men $>$ 102 cm, women $>$ 88 cm), reference: healthy. Handcycling classification as a proxy for severity of the impairment: H1-H3/H4-H5, reference: H1-H3. T1 start of the training period. T2: after the training period, prior to the HandbikeBattle event. T3: follow-up measurement, four months after the event. T4: follow-up measurement, one year after the event. The Δ T2-T1 = a negative regression coefficient representing an improvement of the dependent variable over time. The Δ T2-T3 and Δ T2-T4 = a negative regression coefficient representing a deterioration of the dependent variable over time. *Significance with $p < 0.05$.

changes between T1 and T3 and between T1 and T4 (functional satisfaction T1-T3 regression coefficient: 0.160, SE: 0.111, $p = 0.15$; T1-T4 regression coefficient: 0.100, SE: 0.135, $p = 0.46$; appearance satisfaction T1-T3 regression coefficient: 0.064, SE: 0.132, $p = 0.63$; T1-T4 regression coefficient: -0.258, SE: 0.162, $p = 0.11$).

Longitudinal trajectory based on sex, waist circumference and impairment severity

Participants with a more severe impairment showed a significant decrease in functional and appearance satisfaction during follow-up compared to participants with a less severe impairment (Table 4, Figure 2). Sex and waist circumference showed no interaction effects.

Longitudinal associations between physical capacity or body composition and body satisfaction

POpeak showed significant positive longitudinal associations with functional and appearance satisfaction. Waist circumference showed significant negative longitudinal associations with both outcome measures of body satisfaction (Table 5).

Discussion

The present study showed that both functional and appearance satisfaction significantly increased during five months of handcycle training, but significantly decreased to pre-training levels during follow-up. Furthermore, it was shown that participants with more severe impairments showed a decrease in functional and appearance satisfaction during follow-up compared to participants with less severe impairments. The improvements in body satisfaction were longitudinally associated with improvements in POpeak and waist circumference.

In the present study, the baseline value of functional satisfaction (0.69) was higher compared to the values between -1 and 0 reported by several previous SCI studies [11,20]. This might be due to longer TSI and less severe impairment (e.g., fewer individuals with a tetraplegia) in the present study. Previous studies among participants with a longer TSI (i.e., 15 years) showed similar values for functional satisfaction (0.65-0.97) [14,15]. Similarly, appearance satisfaction ranged between -1 and +1 in previous studies [11,14,15,20,22], which is comparable to or slightly lower than the baseline value in the present study (0.57).

During the training period body satisfaction significantly increased, which is in accordance with previous SCI studies [11,18,20]. An increase in POpeak, as well as a decrease in waist circumference, were longitudinally associated with an increase in both functional and appearance satisfaction. In addition to the objective physical effects of exercise (e.g., gaining strength, losing weight), it is hypothesized that engaging in exercise and physically pushing oneself might change people's perceptions of their physical characteristics [8,17,32]. These subjective effects of exercise are shown to be associated with positive body image [8,17,23,32]. In addition, the increase in body satisfaction might partly be explained by the increase in social support by peers during the training period [8,23]. Being part of a homogenous group has been shown to be associated with body acceptance, appreciation, and gratitude in individuals with SCI [8].

During follow-up, body satisfaction decreased to levels comparable with baseline. This was in contrast to our hypothesis that body satisfaction would remain stable during follow-up. Unfortunately, it is unknown whether this decrease is associated with corresponding changes in POpeak and waist circumference. To our knowledge, this is the only study with follow-up measurements of body satisfaction after a training period. Possible explanations for the decline in body satisfaction could be a decrease in exercise during the follow-up period, and consequently, a decrease in physical capacity and functional independence, an increase in

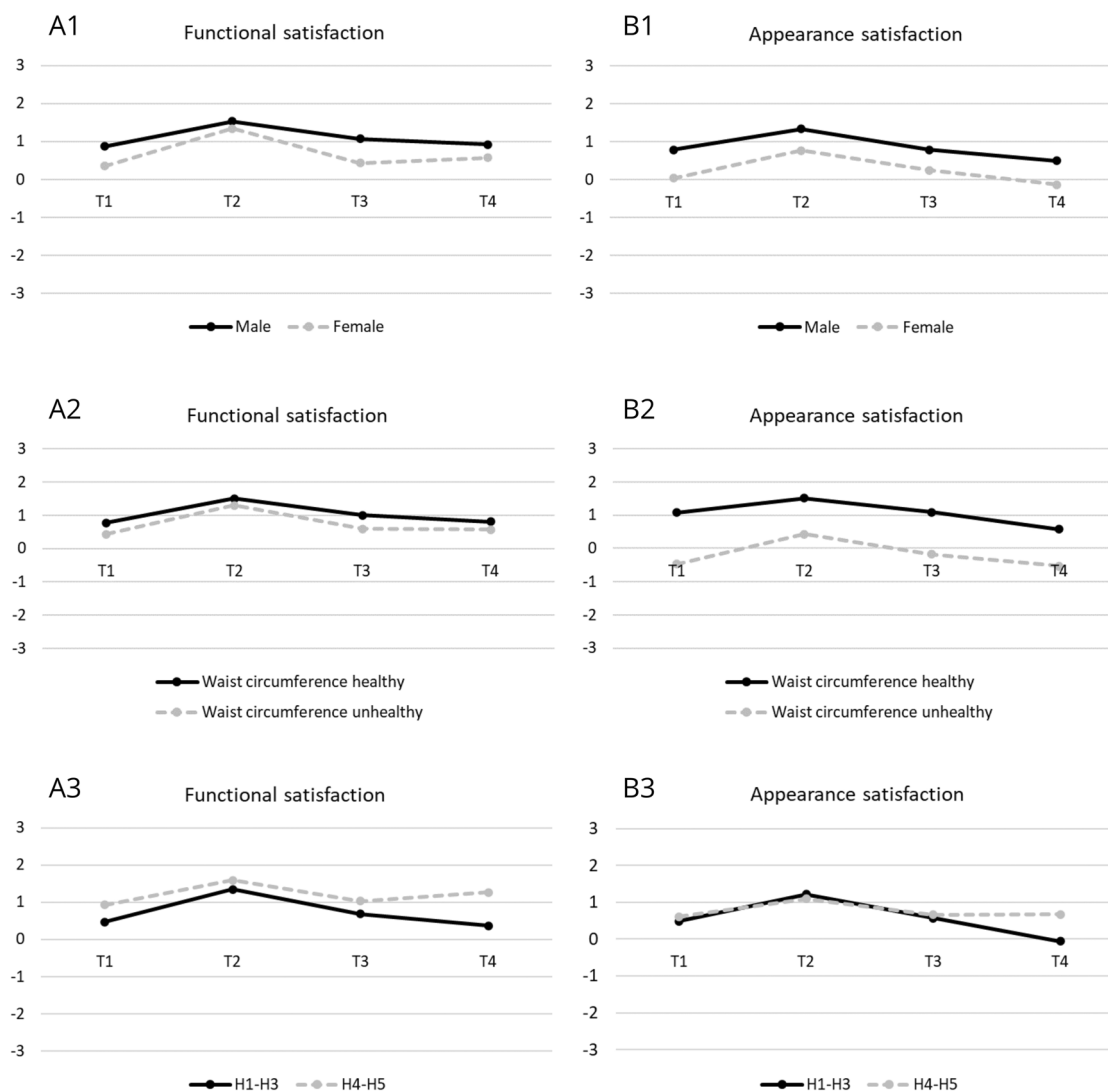


Figure 2. Longitudinal trajectory of functional satisfaction (A) and appearance satisfaction (B) for different Subgroups. A1, B1 = sex: M/F. A2, B2 = waist circumference at T1: healthy (men ≤ 102 cm, women ≤ 88 cm) and unhealthy (men > 102 cm, women > 88 cm). A3, B3 = handcycling classification as a proxy for severity of the impairment: H1-H3 (most impaired)/H4-H5 (least impaired). T1 = start of the training period. T2 = after the training period, prior to the HandbikeBattle event. T3 = follow-up measurement, four months after the event. T4 = follow-up measurement, one year after the event.

Table 5. Longitudinal and cross-sectional associations between physical capacity or body composition and body satisfaction during the training period (T1–T2).

	Functional satisfaction			Confounders	Appearance satisfaction			Confounders
	Regression coefficient	SE	<i>p</i> value		Regression coefficient	SE	<i>p</i> value	
POpeak (W)								
Constant	0.621	0.330			0.527	0.535		
Between-subject	0.004	0.003	0.18	◆§†	0.005	0.004	0.21	◆§
Within-subject	0.025	0.004	<0.01*		0.018	0.005	<0.01*	
Waist circumference (cm)								
Constant	2.251	0.680			6.590	0.975		
Between-subject	−0.010	0.007	0.15	◆§	−0.058	0.010	<0.01*	§
Within-subject	−0.071	0.020	<0.01*		−0.071	0.021	<0.01*	

POpeak: peak power output; Possible confounders: sex §, musculoskeletal pain; ◆: handcycling classification †. A variable was included as confounder if the regression coefficient(s) of POpeak or waist circumference changed with more than 10% when adding the potential confounder. * Significance with $p < 0.05$.

body mass and waist circumference, a decrease in endorphins and less peer support. Based on the descriptive hours of sports participation (Table 2) a decrease in exercise might indeed play a role. However, based on previous findings, it is expected that at least part of the group remains physically active with a stable physical capacity level during follow-up [33]. In addition, it is unknown

whether participants were adhering to a healthy diet during the training period and whether they kept adhering to this diet during follow-up. Another aspect that might play a role is body nostalgia. Especially after one year of follow-up participants might have nostalgic thoughts about their function and appearance at T2, glorifying their body at the end of the training period [7].

Previous studies demonstrated that men with SCI showed higher appearance satisfaction than women with SCI [14,15]. The present study additionally demonstrates that both men and women showed an increase in functional and appearance satisfaction during the training period and showed a similar decline during follow-up (Figure 2(A1, B1)). Previous qualitative research showed that men were mostly satisfied with the increased upper-body muscle mass, as a means to express their masculinity in a socially normative way, whereas women were not satisfied with the appearance of increased upper-body muscle mass but focused on the positive effects of improved upper-body strength on functional independence [7,20].

In addition, in contrast to our hypothesis, waist circumference, and impairment severity did not show interaction effects with body satisfaction during the training period. However, individuals with a more severe impairment showed a clear decline in body satisfaction at one year of follow-up in contrast to individuals with a less severe impairment. Therefore, it is, especially for this group, important to keep them engaged in (group) physical activity and exercise.

Implications

The results of the present study provide important leads to improve body satisfaction in individuals with a physical impairment, especially for individuals who are dissatisfied with their bodies. However, body satisfaction immediately decreased during the first three months of follow-up. Therefore, additional efforts might be necessary to keep individuals engaged in physical activity and exercise, such as social support and new tangible training goals.

Study limitations

Unfortunately, physical capacity and body composition were not measured during follow-up. Therefore, it was not possible to study longitudinal associations with body satisfaction during follow-up. In addition, musculoskeletal pain was the only secondary health condition that was registered, while other secondary health conditions might also influence body satisfaction and physical capacity. Lastly, it is unknown whether the (subjective) experience of participants during the HandbikeBattle event was better than expected or disappointing and whether this feeling has consequences for their body satisfaction during follow-up.

Conclusions

Body satisfaction significantly increased during five months of handcycle training, but significantly decreased to pre-training levels during follow-up. The improvements in body satisfaction during the training period were longitudinally associated with improvements in POpeak and waist circumference. Furthermore, participants with more severe impairments showed a significant decrease in functional and appearance satisfaction during follow-up compared to participants with less severe impairments. Additional efforts might be necessary to keep individuals engaged in physical activity and exercise, such as social support and new tangible training goals.

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ORCID

Ingrid Kouwijzer  <http://orcid.org/0000-0003-1012-3509>
 Sonja de Groot  <http://orcid.org/0000-0001-8463-2563>
 Linda J. M. Valent  <http://orcid.org/0000-0002-3939-8648>
 Janneke M. Stolwijk-Swüste  <http://orcid.org/0000-0001-6793-691X>
 Lucas H. V. van der Woude  <http://orcid.org/0000-0002-8472-334X>
 Marcel W. M. Post  <http://orcid.org/0000-0002-2205-9404>

Data availability statement

The data that support the findings of this study are available from the corresponding author, IK, upon reasonable request.

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