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Acquiring a tailor-made tricycle: Implications for people with disabilities

Berit Gjessing[a,b,*], Astrid Nyquist[a] and Reidun Jahnsen[a,b,c]
[a]*Beitostolen Healthsports Centre, Norway*
[b]*Faculty of Medicine, University of Oslo, Norway*
[c]*Department of Neurosciences for Children, Rikshospitalet, Oslo University Hospital, Norway*

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Abstract.
BACKGROUND: People with physical disabilities are far less active than recommended, but many are motivated for cycling on a tailor-made tricycle.
OBJECTIVE: Does the acquisition of an adapted tricycle lead to better cycling outcomes, and are there differences associated with the application procedure?
METHODS: An observational study was conducted with cohorts of participants applying for an adapted leg-driven tricycle via rehabilitation centres or local therapists. Questionnaires were answered electronically before applying and after having had the opportunity to use the new tricycle for at least 3 weeks. Non-parametric analyses were conducted in SPSS.
RESULTS: Fifty participants (54% women) aged 5–79 years (M = 31.5) with diverse disabilities responded. Forty-seven participants (94%) used their tricycle. Results showed a significant positive change in cycling frequency, cycling performance and satisfaction with cycling ($p < 0.01$). The group of participants who applied at a Healthsports Centre reported higher performance and satisfaction with cycling both after testing them (pre-test) and after having used their new tricycles for some weeks (post-test).
CONCLUSIONS: Acquisition of an adapted tricycle led to a higher amount of cycling, better cycling performance and higher satisfaction with cycling. The highest scores were seen among those who apply via a Healthsports Centre.

Keywords: Rehabilitation, adapted tricycle, participation, adapted physical activity, adapted equipment, assistive technology

1. Introduction

People with physical disabilities are far less active compared with people without disabilities [1,2]. To meet physical activity recommendations, it is important for people to find an activity they can master and enjoy [3,4]. Intrinsic motivation is found to be one of the most influential factors for physically active behaviour among people with disabilities [5].

Cycling is a common and useful activity, and it is expected that almost everyone can participate in this activity. Larger cities have built cycling pathways to facilitate cycling activity. Still, it is most common to ride on ordinary pathways for both cyclists and pedestrians. In more rural areas with less traffic, people cycle on ordinary roads.

Although many people with physical disabilities find cycling with normal equipment difficult, they can benefit greatly from adapted activity equipment, such as special bikes [1,6]. Tricycles are the most commonly adapted equipment for physical activity among people with disabilities in Norway [7]. In addition to the possibility to participate in ordinary cycling activity, cycling can compensate for reduced walking function among people with physical disabilities. In particular, cycling is a popular activity among children with disabilities [8].

*Corresponding author: Berit Gjessing, Beitostolen Healthsports Centre, Sentervegen 4, 2953 Beitostolen, Norway. Tel.: +47 9597 4111; E-mail: berit.gjessing@bhss.no.

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Multiple possibilities exist for cycle adaptation, such as two- and three-wheeled bikes that can be leg-driven, arm-driven or both. Moreover, tailor-made cycles can be adapted with different seats, adjustment of seat-angle, upper-body support and different pedals. Despite the wide range of possibilities such equipment offers, many people with disabilities do not have a well-adapted cycle, which reduces the possibility of participating in cycling activity [7].

To access adapted equipment in Norway, individuals contact a physical or occupational therapist who can apply to the Norwegian Labour and Welfare Administration. This can either be done within the municipality where people live or at a regional or national rehabilitation centre within the specialist healthcare system. Therapists in municipalities have reported a need for more knowledge about the range of available adaptive equipment and how to adapt this equipment [9]. Healthsports Centres in Norway offer secondary rehabilitation to persons with disabilities [10]. Their programme is based on the theoretical framework of adapted physical activity [11, p. 85]. Adaptation of an activity includes individual instruction, the adaptation of environmental factors and, when relevant, the use of assistive devices. The multi-professional personnel at these centres have experience in the field of adapted equipment, including special bikes.

The use of adapted equipment for physical activity is unfamiliar to many people and a lack of self-efficacy when trying something new might lead to a failed attempt and low feelings of mastery [12]. Factors associated with optimising participation in physical activity include being able to choose the activity, having enough time in a safe environment to learn activities, support from family and friends, having fun when learning and guidance from professionals [13]. In this article, we are particularly concerned about the *involvement* in activity participation – the subjective experience of participation that might include engagement, persistence, motivation and social connection [4].

Research has shown the benefits of using assistive equipment in general [14–18]. However, little research has been conducted in the field of adapted equipment for physical activity [9,19–21], and no research is found in the specific field of adapted tricycles.

This study aimed to investigate the following research questions:

1) Does the acquisition of an adapted tricycle lead to better outcome parameters related to cycling?
   a. Does the amount of cycling increase?
   b. Do people like cycling better?
   c. Does cycling get more important?
   d. Does cycling performance increase?
   e. Does satisfaction with cycling increase?
   f. Do people cycle more with friends?
2) Are there differences in outcome parameters related to cycling between those who apply for tricycle at a Healthsports Centre and those who apply via a local therapist?

2. Materials and methods

2.1. Design

The present study applied an observational cohort design.

2.2. Participants and inclusion procedures

Participants with disabilities who applied for an adapted tricycle were recruited from Beitostølen and Valnesfjord Healthsports Centres and the Norwegian Labour and Welfare Administration (NAV). Inclusion criteria included sufficient language skills in Norwegian or English and being 5 years of age or older with any kind of disability, applying for a three-wheeled, leg-driven cycle. Participants were recruited by professionals working at the Healthsports Centres, NAV and in the municipalities. The participants themselves or their medical record were sources for diagnosis and demographic data, such as age, sex and place of residence.

2.3. Outcome measures

The participants answered a questionnaire with nine questions based on two well-established measures:

1. The Children's Assessment of Participation and Enjoyment (CAPE)

CAPE was originally a 55-item measure of five dimensions of participation: diversity, intensity, with whom, where and degree of enjoyment [22]. It is suited for people with and without disabilities from 6 years of age. CAPE reflects actual performance by each individual in the context of the normal environment, and construct validity was reported to be good [23]. The Norwegian version of CAPE has demonstrated sufficient internal consistency and test-retest reliability [24]. The instrument has been used to describe participation profiles in Norwegian children [8] as well as sustained activity participation 1 year after a rehabilitation program [25].

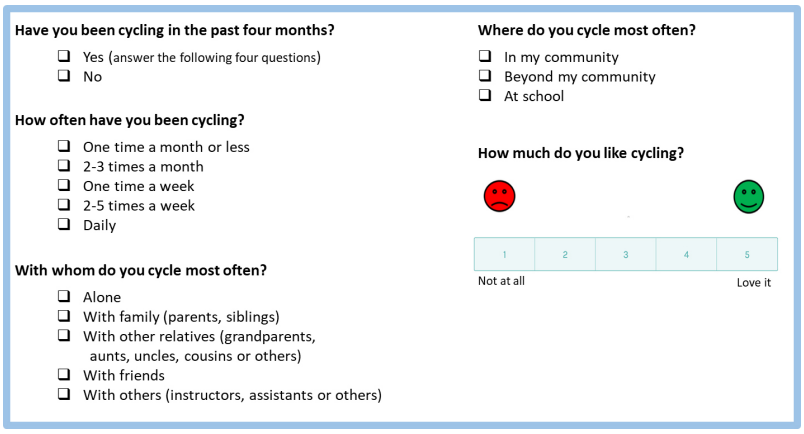

Fig. 1. Questions from the adapted CAPE.

Since the aim of this study was limited to one specific activity, cycling was chosen as the only activity where dimensions of participation should be evaluated. Therefore, 55 items were reduced to one (see Fig. 1). Following critiques of the original CAPE, the *intensity scale* was reduced from seven to five response alternatives [26]: '1 time in the past 4 months', '2 times the in the past 4 months' and '1 time a month' were merged into '1 time a month or less'. '2–3 times a week' was changed to '2–5 times a week' to provide an alternative for those who cycled more than three times a week but less than daily. Also, the *where scale* was reduced from six to three response alternatives: 'At home', 'At a relative's home', 'In your neighbourhood' and 'In your community' were all were merged into 'In my community'.

2. Canadian Occupational Performance Measure (COPM)

COPM was originally a person-centred measure, focusing on activities that each individual is motivated to participate in [27]. It can be used with a wide range of people, both in clinical and research settings. It was found to be valid and reliable [28] and showed good clinical utility in a sub-acute setting [29]. COPM was reported to be sensitive to change over time [30]. In this study, the activity referred to the physical leisure activity of cycling. Participants were asked about the importance of the activity, their perception of their performance and satisfaction with their performance (see Fig. 2). They answered using a modified 5-point scale, which has been used in former research [31, p. 136]. The reduction from a 10-point to a 5-point scale was chosen because a simplified scale would increase the chance that more children could be able to answer the questionnaire without assistance.

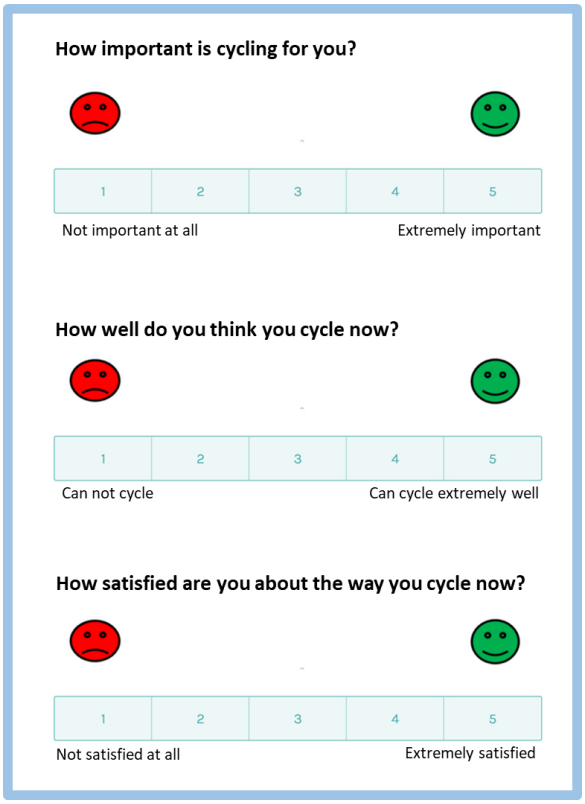

Fig. 2. Questions from COPM – cycling.

2.4. Data collection

Data were collected between May 2019 and November 2020. The questionnaire was created on Typeform [32], and a link was sent to the participants or their parents via e-mail. All participants were asked to answer the questionnaire before they received their first or a new adapted tricycle and again after they had

Fig. 3. Examples of typical tricycles applied for.

had the opportunity to use their new tricycle for at least 3 weeks.

2.5. Statistical analyses

Descriptive analyses were conducted to reveal sample characteristics. Scores for each domain/question gave separate data points. Skewness was found in the data. Logarithmic transformation did not give normally distributed data, but rather a skewness to the opposite side. Therefore, non-parametric analyses were conducted. When searching for change in scores from pre- to post-test in the whole sample, the Wilcoxon signed-rank test was used. The Mann-Whitney U test was used to reveal differences between groups based on where they applied for their adapted tricycle. A Spearman non-parametric correlation test was performed to determine the amount and significance of correlations between the different factors. A correlation of 0.5 or higher was considered moderate, while 0.7 or higher was considered high. For all analyses, the level of significance was set to a p-value of 0.05 or lower. SPSS version 25 was used to record and analyse the findings.

3. Results

3.1. Participants

Seventy people applying for an adapted tricycle consented to participate in the study. Two individuals obtained a tandem bike instead of a tricycle and were, therefore, excluded from the study. Seven did not respond to the first questionnaire, even after a reminder e-mail and/or SMS. Another eight participants did not answer the second questionnaire because they did not get their tricycles before the cycling season ended that year. Some participants waited more than 1 year for their tricycle. Three participants did not answer the second questionnaire after they got their tricycles. Consequently, 50 participants answered both questionnaires, and their answers were the basis for the analyses. Dropout analysis showed that the group of 20 who were not included were quite similar to the group of included participants, except for more women in the dropout group (Table 1).

Table 1
Sample characteristics

Category	Included ($n = 50$)		Excluded ($n = 20$)	
	n	%	n	%
Age				
5–10	12	24	3	15
11–18	10	20	3	15
19–30	8	16	2	10
31–50	8	16	6	30
51–80	12	24	6	30
Gender				
Female	27	54	14	70
Male	23	46	6	30
Place of residence				
City	23	46	11	55
Rural	27	54	9	45
Diagnosis				
Neuromuscular diseases	19	38	8	40
Cerebral palsy	13	26	3	15
Intellectual disability	9	18	2	10
Others	9	18	7	35
Application				
Healthsports Centres	30	60	11	55
Local therapists	20	40	9	45

The included participants ranged in age from 5 to 79 years ($M = 31.5$, $SD = 23$). All participants were either under 30 years of age or over 42 years of age. The gender distribution was approximately equal, and so was urban or rural place of residence. The participants presented a large variety of complex disabilities – mostly neurological and neuromuscular diseases but also Down syndrome and rare congenital syndromes (Table 1).

The participants applied for a total of nine different tricycles. Some had ordinary high seat and ordinary handlebars, while others were recumbent tricycles with lower seat with backrest and alternative handlebars beside the thighs. See Fig. 3 for examples of the different tricycles.

Table 2
Descriptive statistics of outcome parameters

Test	n	Median	Range
How often pre-test	50	0	0–4
How often post-test	49	2	0–4
Importance pre-test	50	4	1–5
Importance post-test	50	4.5	2–5
Like cycling? pre-test	50	5	1–5
Like cycling? post-test	50	5	2–5
Performance pre-test	50	3	1–5
Performance post-test	50	4	2–5
Satisfaction pre-test	50	3	1–5
Satisfaction post-test	50	4	2–5

Table 3
Results from Wilcoxon signed-rank test

Test	Ranks	n	Mean rank	p
How often post-test –	Positive ranks	27	18.06	0.000
How often pre-test	Negative ranks	5	8.10	
	Ties	17		
	Total	49		
Like cycling? post-test –	Positive ranks	10	8.25	0.157
Like cycling? pre-test	Negative ranks	5	7.50	
	Ties	35		
	Total	50		
Importance post-test –	Positive ranks	10	11.50	0.691
Importance pre-test	Negative ranks	10	9.50	
	Ties	30		
	Total	50		
Performance post-test –	Positive ranks	32	18.84	0.000
Performance pre-test	Negative ranks	3	9.00	
	Ties	15		
	Total	50		
Satisfaction post-test –	Positive ranks	33	19.55	0.000
Satisfaction pre-test	Negative ranks	3	7.00	
	Ties	14		
	Total	50		

3.2. Outcomes

Out of the 50 participants, 47 used their tricycle. Among them, 19 (40%) cycled mostly alone, 21 (45%) with their family, and two participants cycled mostly with friends. Of those under 18 years of age, 16 of 19 who used their tricycle (84%) cycled mostly with their family. Most participants liked cycling very well (median of 5 on a 5-point scale), both at pre- and post-test. They also felt that cycling was at least as important at post-test as it was at the time of application (median from 4 to 4.5 on a 5-point scale). The results showed significant positive changes in participants' assessment of cycling frequency (median from 0 = 'once a month or less' to 2 = 'once a week'), cycling performance (median from 3 to 4 on a 5-point scale) and satisfaction with cycling (median from 3 to 4 on a 5-point scale) ($p < 0.01$) (Tables 2 and 3).

Table 4
Significant results from Mann-Whitney U test

Test	Ranks	n	Mean rank	p
Performance pre-test	Healthsports Centres	30	31.60	0.000
	Local therapists	20	16.35	
Performance post-test	Healthsports Centres	30	29.08	0.024
	Local therapists	20	20.13	
Satisfaction pre-test	Healthsports Centres	30	31.20	0.000
	Local therapists	20	16.95	
Satisfaction post-test	Healthsports Centres	30	29.48	0.012
	Local therapists	20	19.53	

Results showed a moderate correlation between how much the participants liked cycling and how often they cycled ($r_s = 0.57$, $p < 0.01$). A high correlation was found between how much participants liked cycling and how important they found cycling ($r_s = 0.69$, $p < 0.01$) and between assessment of own cycling performance and satisfaction with the cycling activity ($r_s = 0.78$, $p < 0.01$) (See Table 5).

Does it matter how and where you apply?

After analysing the results for the sample, the participants were divided into two groups: those who applied during their rehabilitation stay at a Healthsports Centre and those who applied via a local therapist. The group of participants who applied at a Healthsports Centre reported higher performance and satisfaction with cycling both after testing their adapted tricycles (pre-test) and after having used them for some weeks (post-test) (Table 4 and Figs 3a and b, 4a and b).

Those applying via local therapists had a larger positive change in performance (Fig. 3) and satisfaction (Fig. 4). However, as seen in Table 4 and Figs 3b and 4b, they did not reach the same post-test scores as those applying during a rehabilitation stay.

Results did not show significant differences between the groups regarding how often the tricycles were used at post-test, how well they liked cycling, or how important they found cycling.

4. Discussion

4.1. Results discussion

Those who applied for an adapted tricycle found cycling to be an important activity, both when applying for and after they received their tricycle. Out of the 50 included participants, 47 used their tricycle. Thus, the question about whether the acquisition of a tailor-made tricycle leads to more cycling is, not surprisingly, an-

Table 5
Spearman's correlation values

Correlations							
			How often post-test	Like cycling post-test	Importance post-test	Performance post-test	Satisfaction post-test
Spearman's rho	How often post-test	Correlation Coefficient	1,000	,566**	,448**	,196	,309*
		Sig. (2-tailed)	.	,000	,002	,192	,036
		N	46	46	46	46	46
	Like cycling post-test	Correlation Coefficient	,566**	1,000	,693**	,232	,472**
		Sig. (2-tailed)	,000	.	,000	,105	,001
		N	46	50	50	50	50
	Importance post-test	Correlation Coefficient	,448**	,693**	1,000	,289*	,458**
		Sig. (2-tailed)	,002	,000	.	,042	,001
		N	46	50	50	50	50
	Performance post-test	Correlation Coefficient	,196	,232	,289*	1,000	,780**
		Sig. (2-tailed)	,192	,105	,042	.	,000
		N	46	50	50	50	50
	Satisfaction post-test	Correlation Coefficient	,309*	,472**	,458**	,780**	1,000
		Sig. (2-tailed)	,036	,001	,001	,000	.
		N	46	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

swered with 'yes'. The result might suggest that few people apply for a tricycle without a genuine wish to participate in cycling and a thorough assessment of whether cycling is a relevant activity in their local environment. An application for an adapted tricycle is often completed because of the person's motivation for cycling. This practice is supported by findings that intrinsic motivation is found to be one of the most important factors related to physically active behaviour [5].

The reason for applying for an adapted tricycle is that attempts to adapt and cycle on regular two-wheeled cycles have not been successful. Such negative activity experience often leads to uncertainty of whether one can master that specific activity [12]. Many are not informed about the large variety of adapted cycles and might have low expectations of managing the activity, even with a tricycle [9]. It is, therefore, not given that those who test a tricycle for the first time have great self-efficacy when it comes to cycling, which in turn can affect the outcome of the testing sequence. Still, as the results suggest, many participants master cycling well after testing an adapted tricycle and even better after having cycled in their local environment. Most participants reported to like cycling very much, which is a crucial factor to maintain the activity.

The scoring improvement from pre- to post-test for performance (1.1 on a 5-point scale) and satisfaction (1.2 on a 5-point scale) is considered clinically relevant [27,31, p. 140]. Thereby, the results seem to have an impact on the participants' lives, meaning they experienced a noticeable change in cycling performance after getting the tricycle. This increased satisfaction with cycling activity is assumed to be related to their performance. Both activity competence and sense of self are closely related to participation and are factors that are likely to facilitate involvement in cycling activity [4].

Although many people want the opportunity to be active with others [6,33], 40% of our sample reported that they cycled mostly alone. Still, in other studies, individuals pointed out the importance of having the opportunity to be independent when performing an activity and being able to choose to be active on their own or with others [20]. In our study, almost all children cycled with their family; however, other studies have found children often have a desire to spend more time with friends, often at the expense of immediate family [6,34]. We did not examine whether the participants were satisfied with whom they cycled with or if they were satisfied with cycling alone. Further studies might investigate the reasons why people cycle with certain people and whether they feel they can choose to be active alone, with family, friends or others.

Although participants from both groups scored better after using their tricycles, those who applied during a rehabilitation stay reported higher performance and satisfaction with their performance when using their tricycles. This study did not investigate what factors caused these differences. However, notable differences exist concerning the two ways of applying for a tricycle.

First, those applying during a rehabilitation stay had the opportunity to test different tricycles over 1 to 3 weeks. Those applying via local therapists usually had one session of testing before an application was written. This time-factor might be crucial to find the most appropriately adapted cycle [33]. Enough time to test different tricycles and different adjustment variations

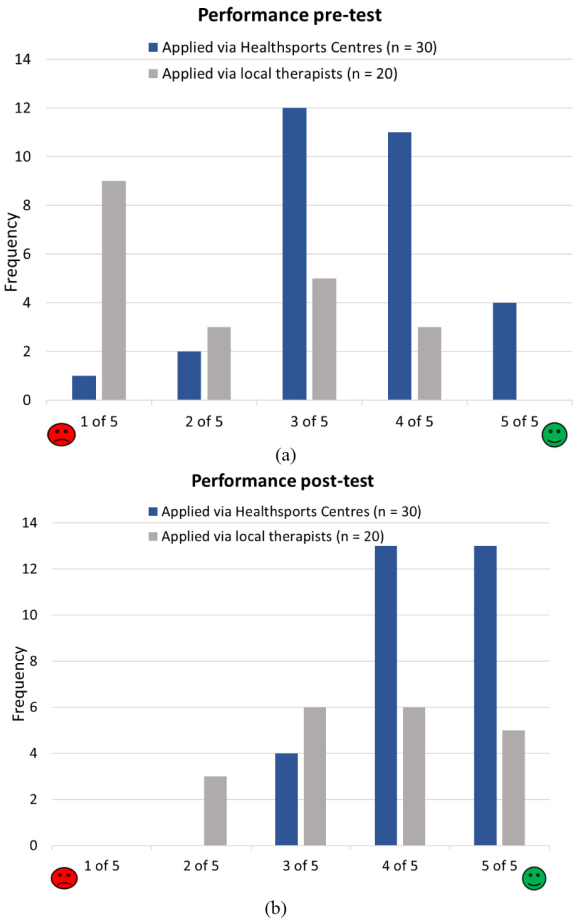

Fig. 4. a. Assessment of cycling performance on a 5-point scale at pre-test. b. Assessment of cycling performance on a 5-point scale at post-test.

might increase the chance of finding the one that is best suited. The feeling of having enough time for testing in one's tempo to feel safe and secure was also found to be important when learning new skills [33].

Second, many local therapists report a lack of sufficient knowledge about the large selection of tricycles and the possibilities of adjustment/adaptation for each individual [9]. The two centres where the participants completed their rehabilitation stays have employees with experience working with selecting and adapting sports equipment, including tricycles to people with disabilities.

Third, a rehabilitation stay in a group setting, over some time, provides an opportunity to watch others master or struggle to learn the same activity [33,35]. Learning from role models has been found to enhance self-efficacy and belief in one's ability to master a task or activity [12].

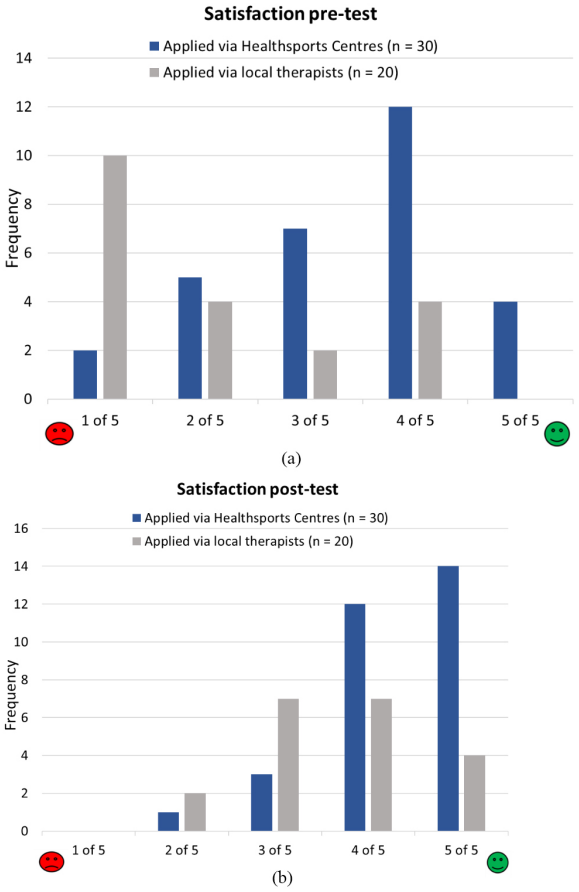

Fig. 5. a. Assessment of satisfaction when cycling on a 5-point scale at pre-test. b. Assessment of satisfaction when cycling on a 5-point scale at post-test.

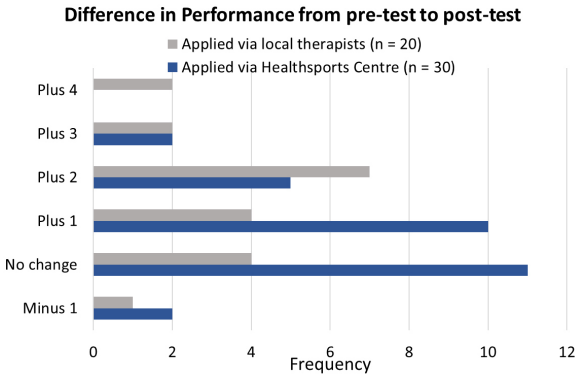

Fig. 6. Change in assessment of cycling performance from pre- to post-test.

It is positive that participants experience good performance and satisfaction when cycling and that they use their tricycles in their local environment. As mentioned in the introduction, many people with disabilities do

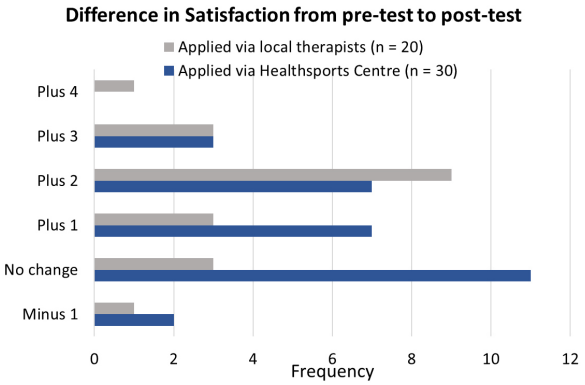

Fig. 7. Change in satisfaction of own cycling from pre- to post-test.

not meet physical activity recommendations [1,36]. Obtaining a tricycle might help individuals develop a habit of more regular activity in their daily lives. However, many participants had to wait more than one cycling season before they received their adapted tricycle. An evaluation of the procurement process of activity devices might be useful to give people with disabilities increased possibilities for activity and participation in their daily life. This evaluation should contain both how long a tricycle testing period should be, what it should contain, how to increase knowledge among therapists, and how to streamline the process from application to receiving the tricycle.

4.2. Strengths and limitations

All results in this study are based on self-reported data. Misunderstandings when answering the questionnaire might cause bias. However, we received no feedback that the questionnaire was difficult to understand. Questions were asked with as little text as possible and with smiley-faces supporting number scales to make scoring more visual. In several studies regarding children, their parents do the scoring [37,38]. A previous study has shown that parents' scoring of satisfaction on behalf of their children is difficult [37], suggesting methods should be employed that enable children to respond on their behalf. Accordingly, we designed our instruments so children could answer themselves. However, despite a small number of questions and little text, a few children needed help from their parents to answer the form.

Bias was found regarding pre-test scores for the question 'How often have you been cycling the last 4 months?' for those who had a rehabilitation stay. Some participants scored based on how they had cycled (or not cycled) at home before the stay, while others included the sessions they had cycled during their stay at the centre. Thus, the pre-scores were artificially high for some. These scores are not comparable with pre-test scores from those who applied via local therapists and all post-test scores, which are scored based on what they do at home. Therefore, these results have not been emphasised in the results and discussion section.

CAPE, and thus also this study, includes a question regarding where the participants have been cycling. Since it is difficult to evaluate the best environment for cycling for each individual, more emphasis has been placed on the participants' satisfaction. The important message is that each individual has the opportunity to be active where he or she prefer.

Almost half of the data collection was carried out during the COVID-19 pandemic. Follow-up of some tricycle applications and adaptation of tricycles upon delivery may have been somewhat deficient because professionals were unable to perform their normal work tasks after March 2020. This may have affected the results of this study. However, there were no outdoor movement restrictions in Norway during this period of time. Thereby, the participants were not prevented from cycling due to such restrictions.

5. Conclusions

Participants reported their amount of cycling, cycling performance and satisfaction when cycling increased after receiving a tailor-made tricycle. Thereby, the answer to research questions 1a, 1d and 1e is 'yes'. An increase in scores of how well participants liked cycling was not seen, since a ceiling-effect was seen already at pre-test. Thus, we do not have a basis to answer 'yes' for research question 1b. Cycling was somewhat more important at post-test than at pre-test, but this change was not statistically significant and we cannot definitively answer 'yes' to research question 1c. Participants did not cycle much with friends, which means the answer to research question 1f is 'no'.

The group of participants who applied at a Healthsports Centre reported higher performance and satisfaction with cycling both after testing them and after having used their new tricycles for 3 weeks. Therefore, our answer to the second research question is 'yes'.

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Author contributions

CONCEPTION: Berit Gjessing, Astrid Nyquist and Reidun Jahnsen
PERFORMANCE OF WORK: Berit Gjessing
INTERPRETATION OR ANALYSIS OF DATA: Berit Gjessing, Astrid Nyquist and Reidun Jahnsen
PREPARATION OF THE MANUSCRIPT: Berit Gjessing
REVISION FOR IMPORTANT INTELLECTUAL CONTENT: Berit Gjessing, Astrid Nyquist and Reidun Jahnsen
SUPERVISION: Astrid Nyquist and Reidun Jahnsen

Ethical considerations

The Regional Committee for Medical and Health Research Ethics in Norway considered the study fell outside the Health Research Act (ref.: 2018/1349). The study was approved by the Norwegian Centre for Research Data 06.12.2018 (ref.: 549301). Written informed consent was collected from participants 16 years of age and older, while parents signed for participants below 16 years. Participants are anonymised in this article.

Conflict of interest

The authors have no conflicts of interest to report.

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