

Bimanual Hand-use in Children with Unilateral Hand Dysfunction – Differences Related to Diagnosis Investigated by the Children’s Hand-use Experience Questionnaire

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Abstract

Introduction: Everyday activities assume the use of two hands; hence, unilateral hand dysfunction is commonly targeted for interventions.

Purpose: To explore how the use of the affected hand is experienced in bimanual activities, and the influence of diagnosis on use and experience.

Methods: The Children’s Hand-use Experience Questionnaire (CHEQ) was completed for 110 individuals aged 6-18 years diagnosed with unilateral cerebral palsy (CP), obstetric brachial plexus palsy (OBPP), or upper limb reduction deficiency (ULRD) in a cross-sectional study.

Results: The children experienced problems when performing the activities, with mean CHEQ experience scores (0-100) of: *Time taken* 66.9, *Grasp efficacy* 68.7, and *Feeling bothered* 68.7. Participants with unilateral CP had significantly lower scores on all scales. The ULRD group performed most activities and used both hands more than the unilateral CP or OBPP groups.

Conclusion: Unilateral dysfunction has differential impact on use and experience of the hand depending on diagnosis.

Keywords: Unilateral cerebral palsy; Obstetric brachial plexus palsy; Upper limb reduction deficiency; Assessment; Hand skills

Abbreviations: CHEQ: Children’s Hand-use Experience Questionnaire; ULRD: Upper Limb Reduction Deficiency; OBPP: Obstetric Brachial Plexus Palsy; CP: Cerebral Palsy; ANOVA: Analysis of Variance

Introduction

A number of activities in everyday life assume the use of two hands. For children and adolescents with reduced function in one hand, the performance of such activities can be difficult [1-3]. Thus, these children are often referred for occupational therapy. The treatment is usually targeted towards improving hand function, commonly focusing on grasping ability. However, little is known about how these children experience the use of the affected hand in the performance of daily tasks. If the treatment should have an impact on the child’s daily life it is probably important to recognize the child’s experience of using the affected hand whilst performing different activities that require the use of two hands. A newly developed test, the Children’s Hand-use Experience Questionnaire (CHEQ) [4], is an instrument that covers these aspects of hand function. According to the International Classification of Functioning, Disability and Health [5], the CHEQ covers the level of activity and participation. Hence, this is the level of hand function that this study attempted to compare.

The three most common pediatric diagnosis groups involving reduced function in one hand are: upper limb reduction deficiency (ULRD), in which part of the limb is missing; obstetric brachial plexus palsy (OBPP), which is a peripheral nerve injury due to traction of the head during delivery; and unilateral cerebral palsy (CP), which is caused by a brain lesion. The impairments differ greatly between these groups although, from an activity perspective, the individuals involved may be treated as having the same problem by, for example, using adapted

tools to enable performance of the task. An important question, then, is whether there is also a variation between the groups in experiencing problems related to the performance of bimanual activities in everyday life. This is valuable information for the therapist in order to provide individualized treatment. If the intervention is targeted towards the area where the child experiences problems, there is a higher chance that the child will also feel better.

Self-rated or proxy-rated experience of activity performance for children or adolescents with reduced function in one hand should be focused on bimanual activities, because the problems are often restricted to this area. Several methods measuring activity performance or quality of life have been used for these three diagnoses, but no questionnaire specifically focusing on the child’s experience of feeling bothered by impaired hand function in bimanual activities by using a separate scale for this has previously been available [6-8]. Recently, however, the CHEQ was developed. This is a new questionnaire with demonstrated validity for use in children and adolescents aged 6-18 years with unilateral CP, OBPP, or ULRD [4]. The CHEQ is based on activities that have previously been shown to be typically bimanual and

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Received August 08, 2013; **Accepted** September 22, 2013; **Published** September 26, 2013

Citation: Hermansson LN, Sköld A, Eliasson AC (2013) Bimanual Hand-use in Children with Unilateral Hand Dysfunction–Differences Related to Diagnosis Investigated by the Children’s Hand-use Experience Questionnaire. *Pediat Therapeut* 3: 169. doi:[10.4172/2161-0665.1000169](https://doi.org/10.4172/2161-0665.1000169)

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performed by individuals in the targeted age group [4]. One advantage of CHEQ is that it measures both how the hand is used when the activity is performed and the experience of the performance in terms of efficiency of the grasp, need for extra time to perform the activities, and the sense of feeling bothered by the hand function during the activities.

The aims of this study were to use the CHEQ to explore how children and adolescents with reduced function in one hand use their affected hand in typical bimanual activities, how they experience the hand use when performing bimanual activities, and to examine how experiences vary based on the specific diagnosis.

Method

Participants and procedure

The inclusion criteria for the study were: diagnosis of unilateral CP, OBPP, or ULRD (not using a prosthesis) and being aged between 6 and 18 years. An informational letter was used to recruit a convenience sample of 110 families via occupational therapists in pediatric rehabilitation settings. The demographics of the participants are presented in Table 1. A one-way analysis of variance (ANOVA) for differences in age and a Kruskal-Wallis test for difference in gender across the groups showed no differences among the diagnostic groups (Table 1). According to the questionnaire instructions [4], the families could choose whether the child or a parent should be the respondent, but it was recommended that children below the age of 13 should be assisted. Hence, in 40 families the ratings were made by the child alone, in 15 families the ratings were made by the child and parent (or parents) together, and in the remaining 55 families the ratings were made by a parent. Before initiation of the study, ethical approval was obtained from the regional Ethics Research Committee. All participants gave informed consent to the research and to publication of the results.

Instrumentation

The Children’s Hand-use Experience Questionnaire (CHEQ) is a newly developed and validated instrument [4] for describing and measuring how children and adolescents with unilateral hand dysfunction experience the use of the affected hand during the performance of ordinary daily tasks (see www.CHEQ.se). The questionnaire is based on 29 tasks that children commonly perform in daily life and that require the use of two hands to a high degree, such as tying shoelaces or opening a bag. For each task, the respondent first indicates whether he or she usually carries out the task independently (*Doing by oneself*). If this is the case, the respondent states whether one hand or both hands together are used in completion of the task (*Using the affected hand*) and, if so, how the affected hand is involved, namely, supporting without holding the object or by holding the object (*Holding objects*). There are also three sub questions in which the respondent rates his or her experience of using the affected hand for that particular task, using three separate four-point rating scales: (a) *Grasp efficacy* (how effective the grasp is); (b) *Time taken* (the time it takes to perform the activity compared to peers); and (c) *Feeling bothered* (whether the

hand function is bothersome). On completion of all 29 items a tabular report is created, listing which activities are performed by the person independently, to what extent the affected hand is used for completion of the task and how this is experienced.

Statistics

The ratings of how the affected hand was used were analyzed using descriptive statistics. For each of the CHEQ hand-use variables *Doing by oneself*, *Using the affected hand*, and *Holding objects*, a percentage value was calculated for each participant. In each of these three variables, a higher percentage value indicates more independence or more use of the affected hand.

The ratings on the three CHEQ scales representing the experience of using the affected hand, namely, *Grasp efficacy*, *Time taken*, and *Feeling bothered*, were analyzed through Rasch rating-scale analysis [9] with the items and rating scale anchored on the original values [4]. A measure for each person on each scale was calculated using version 3.65.0 of the Winsteps software package [10]. The resulting logit measures were then transformed to a 0-100 scale where higher scores are positive, indicating higher efficiency, less time taken, and less concern about the hand.

Shapiro-Wilks test of normality revealed significant differences in data, hence Kruskal-Wallis tests were performed to detect any possible effects of diagnosis and Mann-Whitney *U*-tests were performed to test for gender effects on the CHEQ hand-use variables and experience scales. Spearman’s correlation analyses were calculated to measure the strength of the linear dependence between age and the CHEQ experience scales. Alpha was set to $p < 0.05$. The analyses were performed with version 17.0 of the SPSS software package.

Results

Use of the affected hand in bimanual activities

Across the three diagnostic groups, the mean percentage scores were high for the variable *Doing by oneself* (85%, SD 18). This means that the participants could perform most of the bimanual activities independently (range, 7-29 items). Generally, there were also high scores for the variable *Using the affected hand* when performing the activities (mean 86%, SD 20), indicating that the activities were mostly performed bimanually. For the variable *Holding objects*, the participants used the affected hand for holding objects in 54% (SD 39) of the activities, and thus performed the remaining 46% of the activities with the affected hand used only as a support (Table 2).

There was a significant difference in *Doing by oneself* between the diagnostic groups ($p < 0.001$). Participants with unilateral CP performed fewer activities by themselves (median 80%) than participants with ULRD (95%) and participants with OBPP (97%). *Using the affected hand* and *Holding objects* also differed in medians between the diagnostic groups ($p = 0.001$; $p = 0.020$). Participants with ULRD used the affected hand most (100%), compared to participants with unilateral CP (88%) and OBPP (96%). The ability to use the affected hand for holding objects, as indicated by the variable *Holding objects*, had the lowest median in participants with unilateral CP (37%), compared to the ULRD (75%) and the OBPP (79%) groups.

Experience of using the affected hand in bimanual activities

For those activities that the participants were performing independently, as indicated by the variable *Doing by oneself*, participants in all three diagnosis groups generally reported problems

	Unilateral CP n=39	OBPP n=34	ULRD n=37	Total n=110	p
Mean age: years (SD)	11.1 (3.6)	12.1 (4.1)	10.5 (3.2)	11.2 (3.7)	0.183 ^a
Sex: boy/girl (n)	19/2	17/17	19/18	55/55	0.974 ^b

Unilateral CP=Unilateral Cerebral Palsy; OBPP= Obstetric Brachial Plexus Palsy; ULRD=Upper Limb Reduction Deficiency

^aOne-way ANOVA between-group comparisons

^bKruskal-Wallis test for between-group comparisons

Table 1: Demographic data for the respondents.

	Unilateral CP n=39	OBPP n=34	ULRD n=37	Total n=110	p ^a
Doing by oneself (%)	77 (25-100)	87 (27.59-100)	93 (65.52-100)	85 (25-100)	<0.001
Using the affected hand (%)	79 (25-100)	84 (0-100)	96 (61-100)	86 (0-100)	0.001
Holding objects (%)	40 (0-100)	64 (0-100)	59 (0-100)	54 (0-100)	0.020
Grasp efficacy ^b	52.4 (33.62-91.62)	74.1 (27.33-99.96)	74.2 (44.19-99.96)	66.3 (27.33-99.96)	<0.001
Time taken ^b	50.3 (34.90-88.99)	75.7 (36.55-99.97)	72.5 (42.09-99.97)	65.6 (34.90-99.97)	<0.001
Feeling bothered ^b	53.3 (38.85-88.14)	77.4 (10.40-99.96)	75.1 (46.50-99.96)	68.1 (10.40-99.96)	<0.001

^aKruskal-Wallis test for between-group comparisons

^bCHEQ mean logits transformed to a 0-100-scale

Higher scores are positive

Table 2: Children’s Hand-use Experience Questionnaire scores for children and adolescents with unilateral cerebral palsy (unilateral CP), obstetric brachial plexus palsy (OBPP), and upper limb reduction deficiency (ULRD); mean (range).

on the three CHEQ experience scales *Grasp efficacy*, *Time taken*, and *Feeling bothered* (mean score 66.3, 65.6, and 68.1, respectively; Table 2). There was a significant difference between the diagnostic groups ($p < 0.001$). Participants with unilateral CP were significantly lower on all experience scales while there were no significant differences between the ULRD and OBPP groups. The median scores for *Grasp efficacy* were on average higher in both the ULRD group and in the OBPP group (73.7/77.0) compared to the unilateral CP group (50.5). Lower median scores (52.4) was also found for the unilateral CP group when compared to the OBPP group (77.7) and the ULRD group (72.1) on *Time taken*. The same result was found for scores on *Feeling bothered*. The group of participants with unilateral CP had lower median scores (53.7, corresponding to individuals being more bothered) compared to both the OBPP group (81.0) and ULRD group (74.5).

For age, there was a low correlation to *Time taken* for the whole group ($r_s = 0.270$, $p = 0.004$), somewhat higher for the OBPP group ($r_s = 0.409$, $p = 0.016$). *Grasp efficacy* was not correlated with age either for the whole group ($r_s = 0.161$, $p = 0.096$), or for any specific diagnostic group. *Feeling bothered* had a low correlation with age both for the whole group ($r_s = 0.223$, $p = 0.019$) and for the unilateral CP group ($r_s = 0.354$, $p = 0.027$). Sex appeared to have no effect on any of the three CHEQ experience scales *Grasp efficacy* ($p = 0.342$), *Time taken* ($p = 0.420$), or *Feeling bothered* ($p = 0.762$).

Because the results on the three CHEQ experience scales were similar both in total, but also between diagnosis groups, we wanted to explore the relationship between these three scales. We therefore performed regression analysis with *Feeling bothered* as the independent variable. When *Feeling bothered* was correlated with the other experience scales, the correlation coefficient was high. With *Time taken* it was $r_s = 0.910$ ($p < 0.001$) and with *Grasp efficacy* it was $r_s = 0.876$ ($p < 0.001$).

Discussion

Participants in all three diagnostic groups showed suboptimal scores for all CHEQ experience scales, indicating problems when performing typical bimanual activities. However, despite the commonality in living with a unilateral hand dysfunction, there is a difference among the diagnostic groups in how the consequences of the dysfunction are experienced. Participants with unilateral CP showed significantly lower scores than participants in the other two groups on all three CHEQ scales of experience. Although all groups performed the bimanual activities to a high degree, participants with ULRD performed the most activities and used the affected hand most in these activities.

Children and adolescents with unilateral CP differed from those with the other diagnoses in all of the aspects investigated. From the CHEQ experience scales we could see that they reported significantly lower grasp efficacy, more time taken, and more bother when using the affected hand than the participants with OBPP or ULRD did. They also reported more dependence, less use of the affected hand and, when they did use both hands, they most commonly used the affected hand for support instead of for holding objects. The reason why participants with unilateral CP differed from the others might be related to the different origin of their diagnosis. Brain lesions are known to have an impact on the individual’s overall functioning, and factors such as motor planning and other aspects of cognition might also influence the ability of people with unilateral CP to perform bimanual activities [11-13].

The OBPP and the ULRD groups showed almost identical scores on the CHEQ experience scales. The only statistically significant difference between the OBPP and the ULRD groups was on the variable *Using the affected hand*. Participants with ULRD used their affected limb more than the other participants did. This is probably also due to the origin of the deficiency—in ULRD there is no neurological deficiency. Hence, proximal mobility and sensitivity is unaffected. The major limitation for the ULRD group is in the distal structures of the limb and in the hand. This is shown by the relatively lower frequency on the variable *Holding objects* and is not surprising, given that most of these individuals have short fingers or none at all.

Because of the common view that activity performance is influenced by personal factors, it could be assumed that the CHEQ experience variables might be influenced by age and gender. However, there was no influence of gender on any of the variables. For age, *Time taken* and *Feeling bothered* demonstrated a significant but low correlation with age in the whole group. It is well known that children typically get faster with age but a low correlation between affected hand use and age has been described earlier in children with unilateral CP [14]. Our result indicates that this may also be the case in children with unilateral hand dysfunction from other causes.

Many participants performed most of the bimanual activities included in CHEQ. This was expected, since the selection of activities in the CHEQ was based on the premise that all children within the eligible age range should be able to perform them, in order to have a basis to explore their experience of doing them. Interestingly, although the activities in CHEQ specifically demand the use of two hands to a great extent, some participants preferred to perform them by using just one

hand, a phenomenon also reported in other studies [2-3]. This confirms that individuals with unilateral hand dysfunction to a great extent use compensatory strategies to accomplish these tasks. Furthermore, not all participants could use the affected hand for holding, but instead used it for support. To our knowledge, this is the first time it has been shown that the use of the affected hand in children and adolescents with unilateral hand dysfunction varies among diagnosis groups, namely, that individuals with unilateral CP use the hand to a greater extent as support compared to people with OBPP or ULRD.

The ratings for younger children were mostly done by the parents as proxy raters, whereas the adolescents mostly completed the questionnaires themselves. That might be a limitation but it has earlier been recommended to use proxy raters for younger children because it is too difficult for them to rate themselves [15,16]. Ylimäinen et al. [17] have, on the other hand, shown that parents tend to overestimate the problems for their child, judging by the fact that children themselves typically give higher ratings than the parent's proxy rating. This is something that needs to be studied further in CHEQ and, hence, is the subject of an ongoing study that we are conducting.

One limitation of this study was the sample size; since we had three different diagnostic groups the size of each group was relatively small. Although there was a spread in the range and distribution of age and independent performance (*Doing by oneself*) of CHEQ activities in each diagnostic group, the normal distribution of the groups could not be verified by this. The results are, however, interesting and further studies are warranted to confirm the findings from this research.

The study reported here shows that, independent of diagnosis, children and adolescents with unilateral hand dysfunction commonly used the affected hand in most of the CHEQ activities but experienced suboptimal efficacy and some sense of being bothered by the affected hand use. This aspect of hand function is commonly not recognized. For clinical purposes, it is important to look at the individual reports in how the children experience their performance on *Time taken*, *Grasp efficacy* and *Feeling bothered*. Nonetheless, on a group level, the diagnosis had a differential impact on the use of the affected hand and how this hand use is experienced, such that participants with unilateral CP showed the lowest performance and the least positive experience. Based on these findings, the assessment data from these three groups is not recommended to be pooled together for analysis.

Acknowledgement

We wish to acknowledge Anders Magnusson, statistician at the Clinical Epidemiology and Biostatistic Unit, University Hospital, Örebro, for advice on the manuscript. We thank Lena Krumlinde-Sundholm, associate professor, registered occupational therapist, at Karolinska Institutet, Stockholm, for contributing to the data collection. We also thank Karin Eriksson, registered occupational therapist, at University Hospital, Örebro, for help with data collection.

This study was supported by grants from the Swedish Research Council, Norrbacka-Eugeniastiftelsen, Stiftelsen Sunnerdahl Handikappfond, Groschinsky Memorial Fund, the Centre for Health Care Science at Karolinska Institutet, and the Research Committee of Örebro County Council, Sweden.

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Citation: Hermansson LN, Sköld A, Eliasson AC (2013) Bimanual Hand-use in Children with Unilateral Hand Dysfunction—Differences Related to Diagnosis Investigated by the Children's Hand-use Experience Questionnaire. *Pediat Therapeut* 3: 169. doi:[10.4172/2161-0665.1000169](https://doi.org/10.4172/2161-0665.1000169)

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