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Reliability and validity of the assessment of neurological soft-signs in children with and without attention-deficit–hyperactivity disorder

PEIK GUSTAFSSON¹; CARL GÖRAN SVEDIN²; INGEGERD ERICSSON³;
CHRISTIAN LINDÉN⁴; MAGNUS K KARLSSON⁴; GUNILLA THERNLUND¹

- 1** Department of Child and Adolescent Psychiatry, Department of Clinical Sciences, Lund University, Sweden .
- 2** Department of Child and Adolescent Psychiatry, Department of Clinical and Experimental Medicine, Faculty of Health Sciences, Linköping University, Sweden .
- 3** Department of Sport Sciences, School of Teacher Education, Malmö University, Sweden .
- 4** Department of Orthopaedics, Malmö University Hospital, Lund University, Sweden.

Correspondence to Dr Peik Gustafsson at Department of Child and Adolescent Psychiatry, Malmö University Hospital, SE-205 02 Malmö, Sweden. E-mail: Peik.Gustafsson@med.lu.se

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ABSTRACT

Aim To study the value and reliability of an examination of neurological soft-signs, often used in Sweden, in the assessment of children with attention-deficit–hyperactivity disorder (ADHD), by examining children with and without ADHD, as diagnosed by an experienced clinician using the DSM-III-R.

Method We have examined interrater reliability (26 males, nine females; age range 5y 6mo–11y), internal consistency (94 males, 43 females; age range 5y 6mo–11y), test–retest reliability (12 males, eight females; age range 6–9y), and validity (79 males, 33 females; age range 5y 6mo–9y).

Results The sum of the scores for the items on the examination had good interrater reliability (intraclass correlation [ICC] 0.95) and acceptable internal consistency (Cronbach's alpha 0.76). The test–retest study also showed good reliability (ICC 0.91). There were modest associations between the examination and the assessment of motor function made by the physical education teacher (ICC 0.37) as well as from the parents' description (ICC 0.39). The examination of neurological soft-signs had a sensitivity of 0.80 and a specificity of 0.76 in predicting motor problems as evaluated by the physical education teacher.

Interpretation The reliability and validity of this examination seem to be good and can be recommended for clinical practice and research.

Subtle motor problems, often called neurological soft-signs (e.g. mild dysfunction in muscle tone regulation, choreiform dyskinesia, dysdiadochokinesis, difficulties with balance, fine manipulative disability, and difficulties in coordination between right and left arm or leg) have been considered to reflect brain dysfunction.¹⁻³ The assessment of soft-signs has been met with criticism concerning reliability and validity.⁴ In their classic work, Touwen and Kalverboer have described detailed methods for examining children of different ages.⁵ Uslu et al.⁶ used the Neurological Examination for Subtle Signs to differentiate clinical groups with attention-deficit–hyperactivity disorder (ADHD), specific learning disorders, and ADHD combined with learning disorders, from comparison groups and from each other. The term of developmental coordination disorder (DCD)¹ is applied if the patient has difficulties with motor coordination that interfere significantly with academic achievement or activities of daily living. Different assessment methods for the evaluation of DCD have been developed,^{1,7-11} of which some (like the so-called Motor Development as a Basis for Learning [MUGI] examination used in the present study) have been used by physical education teachers in school settings.¹² In the Nordic countries, the concept of deficits in attention, motor control, and perception¹³ has been used and is defined as a condition in which ADHD and DCD are both present.¹ Hadders-Algra¹⁴ has described two types of minor neurological dysfunction: simple (children with fewer symptoms at an early age, mild hypotonia and choreiform dyskinesia just before puberty, with mild or low level learning and behavioural problems), and complex (children having more symptoms at young age, more pre- and perinatal adversity, coordination problems, fine manipulative disability just before puberty, and a high frequency of learning and behavioural problems). She suggests that children with complex minor neurological dysfunction can also be classified as having deficits in attention, motor control, and perception. Several Swedish studies have shown that about 5/10 of children with ADHD also meet criteria for DCD and that these children have poorer outcomes than those with either ADHD only or DCD only.¹ Leung and Connolly, by contrast, imply that motor functioning is unaffected in patients with ADHD.¹⁵

The reason for the discrepancy in the estimation of the degree of motor dysfunction in patients with ADHD could be the result of examining different populations, using different tools of assessment, and using methods with poorly examined reliability and validity.¹⁶ In Sweden a battery of neurological tests developed by Gillberg et al. for assessing neurological soft-signs¹⁷ have been used clinically and in several studies (e.g. Gillberg et al.¹⁸). In this study, this approach is referred to as the neurological soft-signs examination (NSS examination). In a study by IC Gillberg¹⁹ of 21 items (of which six are included in the NSS examination) the interrater reliability for the different items varied between 0.68 and 1.00 (15 participants), except for choreatic movements in the Prechtl test, where the Pearson's correlation was only 0.20. In another study by Gillberg et al.,²⁰ the mean correlation for the 10 studied items (of which four are part of the NSS examination) was found to be 0.82 (36 participants).

The aim of the present work was to assess the NSS examination for the following factors: (1) interrater reliability; (2) internal consistency of the sum score of individual items; (3) test–retest reliability; (4) validity by comparison with parents' ratings and the physical education teacher's ratings of motor function; as well as (5) examine the clinical importance of assessing neurological soft-signs, by comparing results from the NSS examination with assessment of ADHD and other psychiatric symptoms.

Method

Participants

Two population-based samples in the city of Malmö, Sweden were used for screening ADHD. The first group consisted of children aged 5 years 6 months (62 males, 27 females) screened in connection with a routine health control at the child health care centre. Suspected ADHD was defined by the parents, the nurse, or the preschool teacher who described the child as hyperactive or having attention deficit, or as having motor difficulties in a routine examination performed by the nurse. Nineteen of 62 children with suspected ADHD were found to fulfil the criteria of ADHD (according to the DSM-III-R)²¹ when examined by an experienced clinician (PG). In the comparison group, three children were found to fulfil ADHD criteria. The second group consisted of 23 children aged 7 to 9 years (17 males, six females) who had been screened at a school health care centre. Eight children were identified as possibly having ADHD, of whom six were found to fulfil the criteria for ADHD. In the group of 15 comparison children, none was found to fulfil the ADHD criteria when examined by the same clinician (PG).

In the reliability study, 28 children (22 males, six females) from the groups described above and a third group consisting of seven 8- to 11-year-old children (four males, three females), from a prospective study of children with moderate intrauterine growth retardation, were examined. These 35 children were also assessed with DSM-IV²² criteria for ADHD; 15 were found to fulfil the criteria for ADHD.

The test–retest study was performed with a group of 20 children aged 6 to 9 years (eight females, 12 males). They were examined on two occasions separated by a 4-week interval. One child was participating in a special education programme because of developmental and behavioural problems, and two children had known developmental disorders.

The validity study was performed with children from the first and second group (79 males, 33 females) who underwent the NSS examination and for whom the parents were interviewed about their child's motor function. The children in the second group were also assessed for motor function by the physical education teacher.

All children were examined by two experienced clinicians (one being PG), using a routine paediatric examination and the NSS examination.

The study was approved by the Ethics Committee at the Medical Faculty, Lund University, LU 330-99. All parents of participating children gave their written consent.

Dropout analysis

The dropout frequency of the sample of children examined by the physician and the psychologist was high (44/100; Figs. 1, 2). In the preschool group, the ratings by parents and nurses of symptoms of attention deficit given to children who attended the examination performed by the same two experienced examiners (the physician and the psychologist) and those who did not attend, were compared. There was no significant difference in the answers given to the screening questions on attention deficit for children who were examined and those who were not. For the comparison children (dropout frequency 60%) there was similarly no significant difference between the answers given to the screening questions for

the children who were examined and those who were not. The total motor score, rated by the nurse at the child health care centre, was significantly higher for the index children who were examined by the physician and the psychologist than for those who were not examined (median 5.0, interquartile range [IQR] 3.0–8.0, compared with 3.0, 1.0–5.0; $p=0.001$). For the comparison children, there was no significant difference.

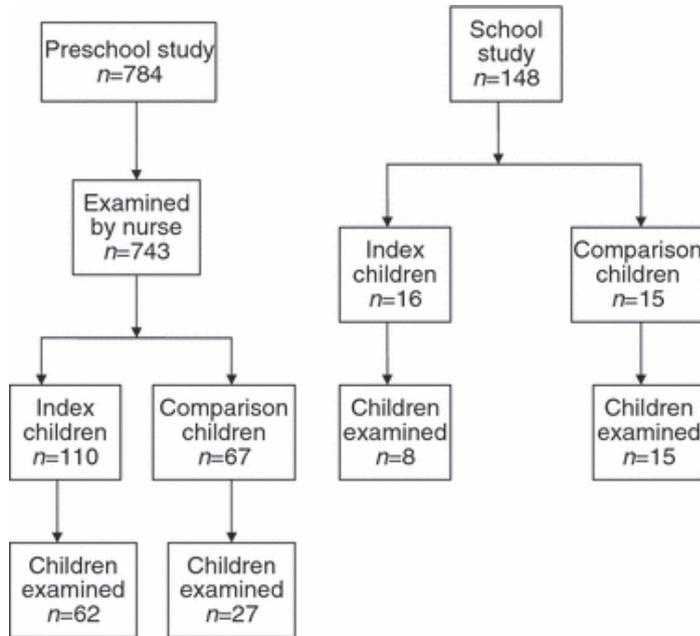


Figure 1: Children in the preschool and school study showing the original populations and the children who were examined.

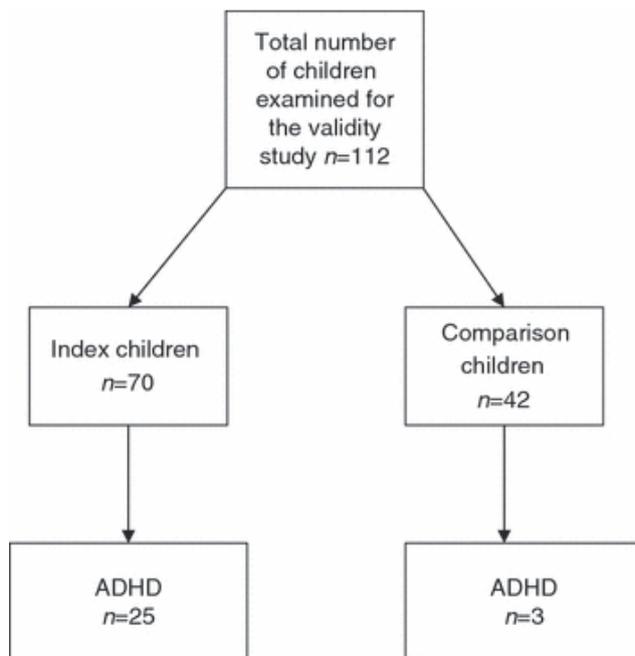


Figure 2: Children examined, except 20 children in the test–retest study and the seven children who were supplemented in the interrater reliability study.

In the school study, there was one dropout in the comparison group. For the index group, we had a dropout frequency of 5/10 (eight children). Comparisons between examined children and dropout children showed no significant difference in the teachers' Conners scores²³ and the MUGI examination,¹² whereas the parents' Conners scores were significantly higher for the examined children (median 15.0, IQR 11.25–19.75, compared with 2.5, 0.0–4.75; $p < 0.001$). The index children who dropped out had very low Conners scores according to the parents but a score greater than 11 according to the teacher. For the Five to Fifteen questionnaire, the children in the 61 dropout families (42/100) had significantly worse motor functioning according to the MUGI examination than those in the 85 families who answered the questionnaire (median 4.0, IQR 2.0–9.5, compared with 3.0, 0.0–6.0; $p = 0.019$). The children in the dropout families did not have significantly different Conners scores compared with those in the families answering the questionnaire.

Interview about motor function

A semi-structured parent interview about motor skills was conducted. The questions concerned difficulties with the following factors: (1) gross-motor function; (2) fine-motor skills; (3) riding a bicycle; (4) skating or roller-skating; (5) skiing; (6) swimming; (7) ball play; (8) drawing; (9) dressing themselves; (10) buttoning their clothes; (11) tying shoelaces; and (12) eating with fork, knife, or spoon. The answers were 'yes' or 'no'. Each item gave one point if fulfilled. A score ranging from 0 to 12 could be obtained for each child.

MUGI examination

The physical education teacher of the children in the school study performed a MUGI examination (Appendix SI, supporting information published online). The MUGI examination has been used in Sweden and normative values have been established.¹² The reliability of the MUGI examination was studied with three independent raters rating each pupil in the same class ($n = 22$, interrater reliability $r_s = 0.75$, test–retest $r_s = 0.78$, $p < 0.05$).¹² Cronbach's alpha for the items of the MUGI examination in this study was 0.80.

NSS examination

The 70 participating index children and the 42 participating comparison children were examined with a method used by Gillberg et al.¹⁹ and IC Gillberg²⁰ based on earlier works by Touwen and Prechtl,²⁴ and used with minor modifications in different parts of Sweden. The sum score of all items was calculated, varying from 0 to 40 (Appendix SII, supporting information published online). The children with an NSS score of more than 1SD above the mean value for the comparison group were defined as having DCD.

Child Behaviour Checklist

All parents of the children examined by a physician and a psychologist were asked to complete the Child Behaviour Checklist (CBCL)²⁵ to assess psychiatric problems and deviant behaviour.

The 'Five to Fifteen' questionnaire

All parents in the school study were asked to complete this questionnaire, which was used to analyse social difficulties among the children in the school part of the study. The 'Five to Fifteen' questionnaire has been developed by a Nordic research group, and has been validated in research and for clinical use.²⁶ The items concerning social functioning consist of questions of social dysfunction of the kind that occurs in children with Asperger syndrome, like the questions in the Asperger Syndrome Questionnaire.²⁷

Procedure

Twenty-eight children from the first two groups and the seven children from the prospective study were videotaped; three experienced clinicians were asked to assess the children from the videotapes. These three clinicians were unaware of the child's status (i.e. index or comparison child), just like the clinician (PG) who performed the examination for this study.

In the analysis of internal consistency of the NSS examination, two children were excluded because of lack of compliance.

In the test–retest study, 20 schoolchildren (eight females, 12 males) were examined by two experienced clinicians (11 by PG, nine by the other clinician) with 4 weeks between the first and the second examination. Each child was examined by the same examiner on both occasions.

In the validity study, the 112 children from the two population-based samples were examined with the NSS examination, and parents were interviewed about motor difficulties. There was a dropout of four individuals because of poor participation of the children in the NSS examination. For 23 schoolchildren, we could compare the result of the NSS examination with results from the MUGI examination.

Statistical analyses

Intraclass correlations²⁸ were used to test for interrater reliability between the four different clinicians rating the NSS examination, for comparisons between results from the NSS examination, parents' description of the child's motor function, and with the examination by the physical education teacher and for the test–retest analysis.

Cohen's kappa was used for pairwise comparisons between different examiners assessing the neurological examination. The Wilcoxon paired *t*-test was used to compare results from the first and second examination in the test–retest study. Cronbach's alpha was used to test internal consistency of the items in the sum of scores of the neurological examination. The Mann–Whitney *U* test was used to compare results from the two examiners in the test–retest study. Multiple linear regression was used when symptoms on the CBCL were compared with ADHD symptom and findings from the neurological examination.

Logistic regression analysis was used when data from the 'Five to Fifteen' questionnaire were used to predict social problems when having ADHD and/or signs of motor dysfunction. Fisher's exact test was used for comparison between ADHD diagnosis and DCD, and for comparison between ADHD diagnosis and total sum score of the NSS examination, parental description of motor functioning, and examination by the physical education teacher.

Results

The NSS examination

Results for the different items on the NSS examination for the different groups of children who were examined are shown in Table I.

Table I: Results for different items in the neurological soft-signs examination

	Index children (<i>n</i> =75)	Children with ADHD (<i>n</i> =26)	Comparison children (<i>n</i> =42)	Test–retest study (<i>n</i> =20)
	Median (range)	Median (range)	Median (range)	Median (range)
Diadochokinesis, right and left	1.5 (0–4)	2 (0–4)	0 (0–4)	0 (0–4)
Hopping on one leg, right and left	1.5 (0–4)	2 (0–4)	0 (0–4)	0 (0–4)
Standing on one leg, right and left	2 (0–4)	2.5 (0–4)	1.5 (0–4)	1 (0–4)
Prechtl choreatic movements, right and left	0 (0–4)	0 (0–4)	0 (0–4)	0 (0–4)
Prechtl athetotic movements, right and left	0 (0–4)	0 (0–2)	0 (0–2)	0 (0–2)
Prechtl tremor, right and left	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Prechtl spooning, right and left	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–1)
Walking on heels	0 (0–2)	0 (0–2)	0 (0–1)	0 (0–2)
Fog test	1 (0–2)	1 (0–2)	0 (0–2)	1 (0–2)
Alternating jumps	2 (0–2)	2 (0–2)	0 (0–2)	0 (0–0)
Alternating jumps, crossed	2 (0–2)	2 (2–2)	2 (0–2)	1 (0–2)
Finger opposition	0 (0–1)	0 (0–2)	0 (0–2)	0 (0–1)
Sum score	10.5 (2–25)	12.5 (5–16)	4.0 (0–20)	5.0 (0–19)

Reliability

Interrater reliability

The interrater reliability between the different examiners was examined by calculating the interrater intraclass correlation coefficient for the different examiners concerning the total sum of the items in the NSS examination.²⁸ The interrater correlation coefficient R_u was calculated to be 0.95 (estimated 95% confidence interval [CI] 0.94–0.98, *n*=35).

Pairwise interrater reliability for the single items in the NSS examination was analysed with Cohen's kappa (Table II). A couple of items, such as the different parts of Prechtl's test, had mostly zero answers and, thus, had insufficient resolution. Cohen's kappa of no more than

0.20 is considered poor, 0.21 to 0.40 fair, 0.41 to 0.60 moderate, 0.61 to 0.80 good, and 0.81 to 1.00 as very good reliability.²⁹ For the items diadochokinesis, standing on one leg, hopping on one leg, alternating jumps, and finger opposition, a fair to good reliability was achieved.

Table II: Cohen's kappa, pairwise comparisons of each child by the four examiners (n=35)

	1 and 2 Kappa^a	1 and 3 Kappa^a	1 and 4 Kappa^a	2 and 3 Kappa^a	2 and 4 Kappa^a	3 and 4 Kappa^a
Diadochokinesis right hand	0.40	0.84	0.24	0.51	0.48	0.33
Diadochokinesis left hand	0.34	0.41	0.20	0.38	ns	0.17
Hopping on right leg	0.52	0.53	0.50	0.43	0.48	0.29
Hopping on left leg	0.53	0.41	0.57	0.44	0.46	0.60
Standing on right leg	0.43	0.42	0.32	0.50	0.57	0.61
Standing on left leg	0.58	0.53	0.57	0.58	0.81	0.66
Choreatic movements of right hand	ns	ns	ns	ns	ns	0.50 (1)
Choreatic movements of left hand	ns	ns	ns	—	ns	0.64 (1)
Athetotic movements of right hand	ns	—	ns	—	0.39 (3)	—
Athetotic movements of left hand	ns	—	0.34 (1)	—	—	—
Tremor of right hand	—	—	—	—	—	—
Tremor of left hand	—	—	—	—	—	—
Spooning of right hand	—	—	0.48 (3)	ns	—	0.66 (1)
Spooning of left hand	ns	ns	0.28 (1)	ns	0.43 (3)	ns
Walking on heels	ns	0.64 (2)	0.47 (1)	0.29	ns	0.39
Fog test	0.20	0.42	0.46	ns	ns	0.31
Alternating jumps	—	—	0.82 (1)	0.47 (1)	—	—
Alternating jumps, crossed	—	—	0.82 (1)	0.47 (1)	—	—
Finger opposition	0.43 (3)	0.49 (3)	0.37 (3)	0.84 (3)	0.63 (3)	0.73 (3)

^aNumber of comparisons with missing data from one examiner. ns, non-significant; —, too few data, so that kappa could not be computed.

Internal consistency

Internal consistency of the items in the NSS examination was analysed with Cronbach's alpha for all individuals. The preschool children were not asked to do the three last items on the examination because these items were expected to be too difficult for them. Thus, the last three items shown in Appendix SII were omitted in order to include more participants (all participants from the four samples, n=137). For the sum of the items, Cronbach's alpha was 0.76 (no difference in internal consistency was found between the different age groups). When all items from the 20 children with data on the last three items were used to calculate internal consistency, Cronbach's alpha was 0.79. For the MUGI items, Cronbach's alpha was 0.80.

Test–retest analysis

Test–retest analysis yielded an intraclass correlation²⁸ between total sum scores on the first and second NSS examination of $R_c=0.91$ (95% CI 0.78–0.96, n=19). Comparison of the difference between the sum scores of the first and the second examination between the two examiners yielded a non-significant result according to the Mann–Whitney *U* test ($p=0.28$). Pairwise Wilcoxon tests showed a non-significant difference between the sum scores of the

first and the second test ($p=0.37$). The correlations for the individual items in the first and second examination varied between 0.14 and 1.00. The items tremor, spooning (hyperextension of metacarpo-phalangeal joints and flexion of wrist), and athetotic movements on the Prechtl test showed a floor-effect, i.e. most individuals scored zero on both examinations (>90%). For other items, the number of individuals scoring zero on both examinations varied between 26/100 (alternating jumps with crossed arm movements) and 79% (walking on heels). For the sum score, 2/10 of the individuals had zero on both the first and the second examination. The item choreatic movements on the Prechtl test did not reach significance for correlations between test and retest. Items with significant and high correlations between the first and second examination were walking on the heels, Fog's test, alternating jumps, diadochokinesis, hopping on one leg, and standing on one leg.

Validity

The intraclass correlation²⁸ between the parents' description and the neurological examination was $R_c=0.39$ (95% CI 0.21–0.54, $n=108$). The correlation between the examination by the physical education teacher (MUGI) and the neurological examination was $R_c=0.37$ (95% CI 0.34–0.48, $n=22$). Children with ratings of more than nine on the MUGI examination were considered to have significant motor problems. Children with five or more on the total score of the NSS examination were considered to have significant soft-sign problems. This cut-off was chosen as it identifies about 1/10 of the children with the highest degree of soft-sign problems from the examined population. With this cut-off value on the neurological examination, the sensitivity for the NSS examination in identifying children with significant motor problems was found to be 0.80 and the specificity 0.76. The sensitivity indicates the proportion of children with high MUGI scores (>9) correctly identified by having a score of five or more on the NSS examination. The specificity indicates the proportion of children with low MUGI scores (≤ 9) correctly identified by having a score of less than five on the NSS examination. Of six children with ADHD from the second sample, four were found to have significant motor problems. Of the 15 children with ADHD according to the DSM-IV, seven were found to have the combined type. The children with the combined type had significantly higher scores on the NSS examination (mean 12.29, SD 2.56, compared with 9.00, 2.51, $p<0.05$). Sex differences were analysed for the NSS examination. Males had higher scores on the NSS examination than females but the difference was not significant, presumably because of the small number of participants (six females, 17 males). If the difference had been significant (as it might be with a larger number of participants) then it would have been necessary to use different cut-off values for males and females. The sum of total scores on the NSS examination, total scores on the MUGI examination, and scores of the interview with the parents were calculated and used to predict ADHD according to the DSM-IV criteria for the children in the school study ($n=22$). When a sum score on all three measures of more than 15 was used to predict ADHD, an exact prediction could be made identifying all six children with ADHD and no child without diagnosis ($p<0.001$ according to Fischer's exact test). When DCD was defined as having a total score more than one SD above the mean on the NSS examination, 5/10 of the children with a diagnosis of ADHD according to the DSM-III-R were found to have DCD compared with 22.6/100 of children without diagnosis ($n=112$, $p<0.001$ according to Fisher's exact test). To analyse the association between high scores on the NSS examination and psychiatric problems, the total scores on CBCL were used. A linear regression analysis with total CBCL-scores as the dependent variable and number of ADHD-criteria according to the DSM-III-R and total score on the NSS examination as the independent variables was performed. The analysis showed a

significant linear association ($R^2=0.48$, $p<0.001$, $F=36.09$, $df_{\text{regression}}=2$, $df_{\text{total}}=76$, $n=77$) with a coefficient for the number of ADHD criteria of 3.04 ($p<0.001$) and a coefficient for scores on the NSS examination of 3.71 ($p<0.05$).

An analysis was also performed for results of the 'Five to Fifteen' questionnaire. The factor social functioning (which contains items describing some of the symptoms of Asperger syndrome) was compared with ADHD diagnosis according to the DSM-IV criteria and results from the MUGI examination. The variable social functioning was dichotomized at 1.5SD above mean for comparisons. This cut-off value was chosen to identify children with significant and not minor problems of social functioning. A logistic regression analysis was performed, with social functioning as a dependent variable. The analysis showed that ADHD had an odds ratio (OR) of 51 (95% CI 3.1–834.2), and motor problems ($>1SD$ according to the MUGI) had an OR of 11 (95% CI 1.1–122.6) with $R^2=0.45$ (Nagelkerke) and $\chi^2=16.702$ ($p<0.001$). An OR of 51 means a 51 times increased risk of having social problems if an individual also has ADHD. The widths of the CIs indicate that the OR cannot be determined with any precision.

Discussion

The ratings performed by different examiners showed good correlations for the total score on the NSS examination. The items diadochokinesis, standing on one leg, hopping on one leg, and finger opposition showed fair to good interrater reliability. The internal consistency was found to be reasonably good. According to Rousson et al.,³⁰ an ICC of the order of 0.80 is sufficient for group comparisons. They describe the Zurich Neuromotor Assessment, which has some items reminiscent of the NSS examination, such as standing on one leg and diadochokinesis. However, there is an important difference between the Zurich neuromotor assessment and the NSS examination in that the items of the Zurich Neuromotor Assessment are analysed quantitatively as time performance or degree and frequency of associated movements, in contrast to the dichotomous and more qualitative assessment of the NSS examination. Time performance in the Zurich Neuromotor Assessment had interrater reliabilities of the order of 0.9 and test–retest of the order of 0.75, and associated movements had interrater reliabilities of the order of 0.7–0.9 and test–retest reliabilities of 0.3–0.5. These results are fairly comparable to our results, although we got somewhat higher results on the test–retest analysis. Another widely used test is the Quick Neurological Screening Test. Parush et al.³¹ have studied reliability and validity aspects of the Quick Neurological Screening Test. In their study, interrater reliability was 0.89 and test–retest reliability was 0.63, and therefore had comparable interrater and lower test–retest reliability than our results for the NSS examination. The Cronbach's alpha of the Quick Neurological Screening Test was found to be 0.85, which is to some extent higher than for the NSS examination in our study.

We have analysed the interrater reliability by making videotapes of the NSS examinations and letting different raters score the results. There might be a weakness in this procedure because the result to a certain degree depends on the quality of the videotapes. Another difference might be that in a direct examination the examiner gives the instruction to the child. Different examiners might do so in different ways, so affecting the result.

The test–retest study showed a good and acceptable correlation between the first and the second examination on the total score of the NSS examination.

The results show that the items originally taken from the Prechtl test³² render lower reliability. In some cases they have such a low frequency that their usefulness in detecting soft-signs must be questioned. The explanation for this might be that those items were mainly developed for examination of children with more severe dysfunction.

The neurological examination yielded results somewhat similar to those from the examination by the physical education teacher and in the description by parents. The correlation with these other measures of motor function was moderate and supports the validity of this kind of examination. The parents' descriptions have some obvious limitations. The questions were of the 'yes' or 'no' type, reminiscent of an unstructured clinical interview. Items 1 and 2 are of a more general kind, whereas items 3 to 12 are more specific. The interview has not been studied for reliability, validity, or population norms.

The NSS examination results were shown to be reliable in identifying ADHD problems. Children with high scores on the NSS examination had higher CBCL scores, and those with a combination of ADHD and high scores on the NSS examination had even higher CBCL scores. This gives support to the work by Gillberg et al.¹ who have shown that children with the combination of ADHD and DCD have more symptoms of psychiatric dysfunction than children with ADHD or DCD only. The results from using the 'Five to Fifteen' questionnaire show that children with DCD have more symptoms of social difficulties of the kind seen in Asperger syndrome.

Conclusion

The reliability and validity of the soft-signs examination studied seem to be good, and the examination seems to be useful in clinical practice and research. Our results indicate that examining only a few of the items in the NSS examination with high reliability or using the MUGI checklist might be sufficient when screening children with attention deficit for mild to moderate motor dysfunction. An evaluation of motor function seems to be appropriate in clinical assessments of ADHD, because children with ADHD and motor dysfunction in combination have a higher frequency of other problems, such as problems with social function, than children with ADHD without motor dysfunction.

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