REGULAR ARTICLE

Infant-Toddler Checklist identifies 18-month-old children with communication difficulties in the Swedish child healthcare setting

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Abstract

Aim: At present, there is no reliable method to screen for communication difficulties at age 18-months in the Swedish child health care. This study examined the psychometric properties of the Communication and Symbolic Behavior Scales Developmental Profile Infant-Toddler Checklist (ITC) when used at the 18-month visit in the child healthcare setting.

Methods: Children aged 16–20 months (*n* = 679) were screened. Children were referred for an assessment if they screened positive screen or if the parent or nurse was concerned about the child's communicative development. Two groups of positive screens were used in the analysis (*n* = 78 children), one based on the ITC result, and one combining the ITC with contradicting information from the nurses' informal clinical assessment.

Results: The AUC ranged from 0.68 to 0.84. The sensitivity was 0.85, and the specificity was 0.59. When the ITC result was combined with the nurses' information, sensitivity increased to 0.88 and specificity to 0.63. The internal consistency was moderate to high, and fit indices were satisfactory.

Conclusion: The results suggest that the ITC can be used to identify children in need of interventions to enhance communication at 18 months of age, especially in combination with the nurse's assessment.

KEYWORDS
communication, early screening, language screening, toddlers

1 | INTRODUCTION

Communication and language difficulties in early childhood may have a profound impact on the child's development, with enhanced risk of behaviour problems, social withdrawal, internalising or externalising behaviours,[1] and a negative impact on the child's quality of life.[2] In addition, communication and language difficulties are often the first sign of a developmental, intellectual or autism spectrum

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disorder.[3] Communication and language disorders are also related to problems in adulthood, such as difficulties in peer-relationships, low academic achievement, poor mental health and unemployment.[4] Language disorders have been described as a public health problem.[5] Given that interventions initiated before a child's third birthday have shown to significantly improve their child's development, communication and language, there is a need for methods to reliably identify children with such difficulties at an early age.[6]

The public-funded Swedish child health services reach 99% of children aged 0–5.[7] The service is staffed by specialist nurses and general practitioners who offer regular child health visits according to a national child health programme. An increasing focus has been placed on establishing evidence-based methods within the child health services to offer high-quality care and assist the personnel in their busy clinical practice.[8] The need for instruments with favourable psychometric properties to accurately identify children with communication and language difficulties has been highlighted. However, few methods have been developed and tested in clinical settings.[9] At present, communication and language abilities at 18-months of age are assessed by asking the parents if the child speaks at least 8–10 words and understands more than 8–10 words, a method with low sensitivity.[10] Many nurses report that they informally observe the child's communication and language use, and add their prior knowledge about the child and the family to their assessment. Nationally, the earliest formal screening to identify communication and language difficulties is performed at the health visit at two-and-a-half to three years of age.[11]

Screening materials provide an opportunity for healthcare professionals to engage with parents who need more support in promoting their child's development or have misconceptions about typical child development.[12] Screening should be repeated at different ages and should be combined with the healthcare provider's prior knowledge about the child and the family.[13] Numerous methods are available to screen for developmental difficulties, some of which are broadband screens, while others are disorder-specific.[14] It has been proposed that broadband screening methods may be easier to implement as they identify a wider spectrum of disorders that warrant interventions.[14]

The Communication and Symbolic Behavior Scales Developmental Profile (CSBS-DP), is a broadband evaluation tool used to identify children with language, communication or developmental disorders. The CSBS-DP has been studied globally and has shown to be widely applicable with minor cultural adaptations.[15,16] The CSBS-DP consists of three parts, the Infant-Toddler Checklist (ITC), a four-page follow-up Caregiver Questionnaire and the Behavior Sample (BS) assessment.[17] The ITC is a parent questionnaire designed for children aged 6–24 months and consists of a 24-item measure in the three composites social, speech, and symbolic and a single question regarding parental concerns.[17] The psychometric properties in North American studies vary with the age of the child, with a sensitivity of 0.89–0.94 and a specificity of 0.59–0.89.[18] A study of 24-month-old children showed moderate sensitivity and good specificity for the Finnish version of the ITC.[19]

Key Notes

- In Swedish child health care, there is no reliable method to screen for communication difficulties at 18 months of age.
- The Infant-Toddler Checklist identified children with communication and language difficulties with good sensitivity, acceptable specificity and adequate internal consistency and factor structure.
- Combining the Infant-Toddler Checklist with nurses' developmental surveillance and prior knowledge of the child and family enhanced the sensitivity and specificity.

Internal consistency is high, with alpha coefficients ranging from 0.86 to 0.92.[18]

The ITC has been described as a valuable improvement in clinical practice.[20] Nurses described that parents' understanding of their child's communication increased after filling out the ITC, and nurses were able to alleviate unfounded or excessive worry through its use.[21]

The BS is a standardised and norm-referenced assessment using a systematic naturalistic sampling procedure to encourage spontaneous social communication.[17] The BS consists of twenty items that are summed to form social, speech and symbolic composites corresponding to the ITC and has good psychometrics and is valid for evaluating communication development.[22]

1.1 | Aims

This study aimed to investigate the psychometric properties, including sensitivity and specificity, internal consistency and factor structure of the ITC when used at the 18-month health visit in the Swedish child health service setting to identify children with communication difficulties.

2 | METHODS

2.1 | Study design

This study applied a consecutive sample design, with quantitative data collected between 2015 and 2017. American norms for the ITC were used to decide which children to refer for further assessment by a speech and language pathologist. To evaluate the psychometric properties of the ITC, Swedish cut-off values were calculated using the lowest 10th percentile in the study population, applying the result of the BS assessment as the reference standard. The criterion used to define communication difficulties was an outcome in the lowest 10th percentile on one composite or the total score based on the North American norms.[17]

2.2 | Setting

The Swedish version of the ITC, translated within the Early Autism Sweden project,[23] was implemented at 10 child health centres in Uppsala and Knivsta municipalities, Sweden which have populations of 215 762 and 17 533, respectively. This version of the ITC has not previously been validated in Sweden. The centres were chosen to represent diverse areas with respect to socio-demographic background as well as the size and urban or rural location of the child health centre.

2.2.1 | Participants

In total, 704 children were screened with the ITC (Figure 1). Age was adjusted for prematurity for children born at or before 36 weeks. Children younger than 16 months or older than 20 months when screened were excluded, leaving 679 children (50.22% boys). Of the 81 children assessed with the BS, three were excluded due to large amounts of missing data, see data analysis for further description, leaving 78 assessed children (55.13% boys) in the analysis (Figure 1).

2.2.2 | Parent demographics

There were 672 mothers with a mean age of 33.51 years (range 20–45) and 614 fathers with a mean age of 35.78 (range 21–66). Most parents were born in Sweden (81.12% of mothers, 82.80% of fathers), while 10.77% of mothers and 9.32% of fathers were born in a country outside of Europe. Most parents were married or living with a partner (94.84% of mothers and 96.62% of fathers). A small

percentage of the mothers (3.54%) and fathers (1.60%) lived in one-parent households. A total of 14 (2.06%) children had parents of the same sex. Approximately 95% of the children lived in household with a stable financial situation (Table 1).

2.3 | Procedure

The ITC was collected at the 18-month child health visit along with a questionnaire regarding social and economic conditions as previously described.[24] The ITC was sent to the families by mail prior to the visit. During the visit, the nurse reviewed the ITC form and scored the screen as positive or negative based on American norms. As described in the official CSBS-DP manual, children who screened positive only on the speech composite were rescreened at the age of 21 months and seen as positive after two consecutive positive screenings.[17] The nurses were instructed to refer children to a speech and language pathologist for further assessment if the screen was positive or if the parent or nurse was concerned about the child's communicative development, regardless of the ITC result. The nurses were instructed to note when their informal assessment contradicted the ITC result or when the referral was based on parental concerns. Two groups of positive screens were used in the analysis, one based on the ITC result, and one combining the ITC with contradicting information from the nurses' informal clinical assessment including parental concerns, in which case the latter was given precedence.

The 44 children who were referred were offered a speech and language pathologist assessment using the BS in the child's home environment. Randomly selected children with a negative screen (n = 34) were assessed in the same way.
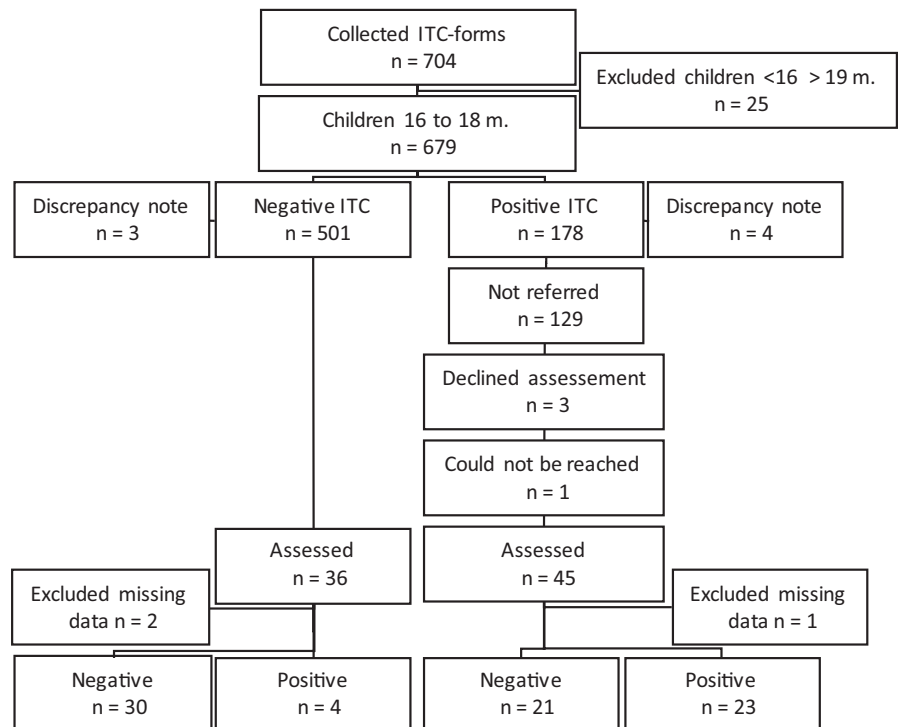

FIGURE 1 Flow chart of data collection and screening outcome in the child health services and number of participants included in the data analysis

TABLE 1 Child and parent demographic factors of participating families

Child	Girl (n = 338)	Boy (n = 341)
Age at ITC in months, mean (sd)	17.40 (0.69)	17.35 (0.79)
Age at BS month, mean (sd)	19.03 (0.89)	19.54 (1.73)
Premature ≤ 36, n	5	6
Parent	Mother	Father
Age, years, mean (sd)	33.51 (4.49)	35.78 (5.94)
Country of birth		
Sweden	81.12%	82.80%
Other Nordic county	2.36%	1.61%
Europe outside Nordic region	4.87%	5.95%
Outside of Europe	10.77%	9.32%
Marital status		
Single	2.80%	0.96%
Couple not cohabiting	0.74%	0.64%
Married or living with partner	94.84%	96.62%
Other	0.29%	0.16%
Able to handle an unforeseen cost		
Yes	95.63%	96.23%
No	4.37%	3.77%
Problems paying regular costs during the last 12 months		
No	94.46%	94.92%
Yes, on one occasion	3.59%	3.11%
Yes, on several occasions	1.95%	1.97%

The BS assessments were scored according to the CSBS-DP manual producing raw and standardised scores for the total score as well as the social, speech and symbolic composites. The North American cut-off values for the BS were used to indicate a positive or negative assessment.[17] Video recordings of 19 of the 78 BS assessments were scored independently by two experienced speech and language pathologists. The inter-rater reliability ranged from 0.721 to 0.928, for the social, speech and symbolic composites, with speech giving the lowest reliability.

2.4 | Data analysis

Data analysis was performed using SPSS version 23 (IBM Corp.) and R version 3.5.2 (R Core Team). Means, ranges, frequencies and proportions were used to describe the sample. Sensitivity, specificity and area under the receiver operating curve (AUC) values were computed to explore concurrent validity.[25] The sensitivity and specificity analyses were performed using both the North American and Swedish cut-off values for the ITC and the North American cut-off values for the BS. The North American cut-off

value was 17 points for the social composite and 10 for the symbolic composite for all three age groups (17, 18 and 19 months). The cut-off value for the speech composite was six for children aged 17 months and seven for 18 and 19-month-olds, For the total score, the cut-off value was 36 for 17-month-olds and 38 for 18 and 19-month-olds. Swedish cut-off values for the ITC were based on the imputed data using the 10th percentiles for two age groups: 16–17 months and 18–19 months. The cut-off points for the social composite differed between the two age groups (18 and 19 points, respectively). For the two other composites and total score, the scores were the same for the two age groups: speech seven points; symbolic 12 points; and total 39 points. The AUC was calculated for each ITC composite and total score as a continuous parameter and for the result of the BS as a dichotomous parameter based on the North American norms.

Among the children with a positive ITC screen, differences between those who were referred for further assessment and those who were not referred were analysed using the t-test for the ITC scores and chi-square for parental demographic factors.

Assessment of internal consistency was based on polychoric alpha, following the recommendations by Gadermann et al,[26] as the items on the ITC were rated on ordinal, Likert-type scales. A confirmatory factor analysis was conducted to assess the fit of the theoretical model of subscales on the ITC. Since data were ordinal, traditional Pearson correlation matrices could not be used to estimate the fit measures. Instead, polychoric correlation matrices were calculated to estimate model parameters. Comparative fit index, Tucker–Lewis Index, and root mean square error of approximation, were used to assess the model fit. In following with recommendations by Hu and Bentler,[27] root mean square error of approximation values less than 0.06 in combination with Comparative fit index or Tucker–Lewis Index above 0.90 were considered as indicators of acceptable fit.

Inter-rater reliability of the BS was calculated using generalisability coefficients.[15] The g coefficient can range between zero and one, where higher values indicate stronger reliability.

2.5 | Missing data

The ITC data were missing for 20 of 24 variables, 0.10 of the cases and 0.56 of the values. The variables with most missing data were those regarding how many blocks the child stacks and if the child puts two words together, with 0.02 missing data in both cases. Multiple imputations were performed, after which the three composite scores and the total score were calculated.

BS data were missing for 0.37 of the variables, 0.46 of the cases and 0.01 of the values. Missing data were primarily missing for response to the two joint attention bids (0.31 and 0.24 missing, respectively). Multiple imputation was used to address missing data.

When possible, variables that were missing from the video recordings were retrieved from the worksheet completed during the visit. If data for a large number of variables were missing from both

the video recordings and the worksheet, the child was excluded from the analysis (*n* = 3).

In total, 40 iterations were run in the multiple imputation.

3 | RESULTS

A total of 679 (50.22% boys) children with the mean age of 17.4 months (range 16–19 months) comprised the final sample. The descriptive data for the ITC are presented in Table 2. It was expected that approximately 68 children would be identified by the screening using the 10th percentile cut-off score to indicate possible communication difficulties. In our sample, 178 children (26.21%, 109 boys and 69 girls) scored at the level of concern for social, symbolic, speech (two consecutive positive screenings) or total score (Table 3) based on Swedish cut-off values. Most of these children screened positive for one composite, most often symbolic (*n* = 124, 18.26%). Only 25 children (3.68%) scored at the level of concern for all three composites and total score (Table 3).

Of the positive screened children, 129 were not referred, three declined assessment and one family could not be reached. There were no differences between the 48 children who were referred, and the 129 children who were not referred regarding parental demographic factors (*p* = >0.05). There were significant differences between the groups with respect to the ITC scores (*p*-value ranging from 0.005 to ≤0.000). The referred children scored lower than the non-referred children on all composites and total score.

When combining the ITC with contradicting information from the nurses' informal assessment or parental concerns, four of the children with a positive ITC were considered to be negative and three of the children with a negative ITC result were considered to be positive. This resulted in 177 children (26.06%, 110 boys and 67 girls) who had a positive screen.

3.1 | Behaviour sample

In total, 78, children were assessed between 17 and 23 months of age (mean age 19,16). Of these, 44 children (32 boys and 12 girls) had a positive ITC screen and 34 had a negative screen (11 boys and 23 girls). When the nurses' contradicting information was taken into account, 42 children (32 boys and 10 girls) with a positive screen and 36 children (11 boys and 25 girls) with a negative screen were assessed.

TABLE 2 Descriptive statistics of the ITC result

Composite	Social	Speech	Symbolic	Total
Minimum	9	2	1	20
Maximum	26	20	17	57
Mean	22.05	45.88	14.18	45.88
Std. Deviation	2.83	2.13	2.18	5.70

Of the assessed children, 27 (21 boys, six girls) had communication difficulties based on the BS assessment. The AUC ranged between 0.68 and 0.84 (Table 4.)

The results indicate a sensitivity of 0.85 and a specificity of 0.59 for the ITC alone based on the Swedish cut-off levels. When combining the ITC with contradicting information from the nurses' informal clinical assessment, sensitivity increased to 0.88 and specificity to 0.63. Using the North American norms yielded a lower sensitivity (0.79) but a higher specificity (0.72) (Table 5).

3.1.1 | Internal consistency and factor structure

Analyses of all three subscales and total scores indicated that internal consistency was good for social (α = 0.84) and total (α = 0.87), and somewhat lower for speech (α = 0.66) and symbolic (α = 0.70). All fit indices for the three-factor model were satisfactory, suggesting acceptable fit (Comparative fit index = 0.93; Tucker–Lewis Index = 0.92; Root mean square error of approximatio *n* = 0.04).

4 | DISCUSSION

The study aimed to investigate the psychometric properties of the ITC when applied in the Swedish child health services for children aged 18 months to identify children with communication difficulties. Although the sensitivity of the instrument alone was relatively high (0.85) for those children who were referred for speech and language pathologist assessment, the specificity was moderate (0.59). The sensitivity was somewhat lower than previous studies,[18] although a Finnish study with two-year-old children reported a lower sensitivity.[19] This difference in sensitivity might be explained by differences in the age of the children screened and the instrument used to assess the children. Concurrent validity in the present study was based on comparison to the result of the BS, which assessed the same behaviours as those screened for in the ITC, while the Finnish study used The Reynell Developmental Language Scales III, which measures slightly different skills.[19]

The AUC values of 0.68–0.84 indicate that accuracy was good for the social and symbolic composites and total score but poor for the speech composite, as AUC values below 0.7 are often considered as poor discrimination and AUC values over 0.8 as good discrimination.[28] Both accuracy and inter-reliability were low for speech, which was in line with previous research.[16]

One reason for this finding may be that it is often difficult to assess speech in children with communication difficulties. In the speech domain of the BS assessment, a vocalisation or word should be used as a communicative act and should be transcriabeable. The vocalisation should include a vowel and a consonant, and a word should consist of a constant sound pattern.[17] This can be difficult to assess when a child has difficulties with spoken language and when video recordings are used for the assessment. Sound may be distorted on video recordings and nuances of communication may

Composite	Symbolic	Social	Speech primary screening	Total score	Two consecutive assessments
Per cent of children (n = 679)	18.22%	12.92%	15.35%	11.63%	1.18%
Number of concerns on the Infant-Toddler Checklist.					
Number of concerns	0	1	2	3	4
Per cent (n = 679)	67.39%	19.51%	4.39%	5.01%	3.70%

TABLE 3 Per cent of children with positive screening result on three composite, total score and second assessment after a primary positive speech screening result

Note: Number of concerns based on the Infant-Toddler Checklist Swedish cut-off-values (including positive speech screen).

TABLE 4 Area under the receiver operating curve, standard error and bounds of a 95% confidence interval calculated on each composite and total score as a continuous parameter and for the result of the BS as a dichotomous parameter

			95% Confidence Interval	
	Area	SE	Lower Bound	Upper Bound
Social composite	0.80	0.06	0.67	0.92
Speech composite	0.68	0.06	0.56	0.80
Symbolic composite	0.84	0.04	0.76	0.93
Total score	0.83	0.05	0.73	0.94

not be captured. Another reason for the low inter-reliability for the speech domain is that the analysis is multi-layered in that several components of the speech act are evaluated simultaneously.

The Swedish child health services have the ability to combine screening with developmental surveillance, including observation of the child and parent as well as knowledge regarding the child's medical and developmental history and the family's psychosocial situation, strengths and vulnerabilities. This approach is in line with previous recommendations.[13]

Some of the children who were false-negative on the ITC alone were referred due to concerns mentioned by the parents or that arose during the nurse's assessment. When this contradicting information was given precedence regarding discrepancies between the ITC results and the nurses' informal assessment in the clinical encounter, sensitivity and specificity increased to 0.88 and 0.63, respectively.

The sensitivity of the ITC is substantially higher than the method used at the 18-month health visit nationally, which has a sensitivity of 0.32.[10] The specificity of the ITC was lower than current standard practice, where the nurse asks the parents if the child speaks at least 8–10 words and understands more than 8–10 words (0.91), even though the ITC includes questions regarding the child's spoken words and language comprehension. The high specificity of the standard practice today is a result of the low level of positive screens. The AUC values for the speech composite in the ITC (0.78) and for standard practice (0.68), are equally poor. The methodology differs

between the two methods as the standard method is two yes or no questions asked by the nurse in comparison with 25 questions in a questionnaire, with five questions focusing on speech and two focusing on language comprehension. The questionnaire may capture parental concerns to a greater extent, even unfounded or excessive worries.

Screening of 679 children during the child health visit identified 27 children (3.98%) with communication difficulties. These 27 children were offered to take part in a randomised controlled trial of an early communication intervention. Parents who declined participation were treated in standard care with further assessments and contingent interventions.[24]

Out of 178 children with a positive screen, 133 children were not further assessed, most of whom had scores near the cut-off values. Children who were referred had significantly lower scores than the children who were not referred. This indicates that use of the ITC alone gives a higher rate of false positives than when the method is combined with the nurses' clinical assessment, as nurses tended not to refer children with borderline scores. However, the reasons for this failure to refer are not known and must be further evaluated. Similar low referral rates were seen in previous research,[20] where 73% of the one-year-old children who screened positive for autism spectrum disorder were not referred. There were no differences in parental demographic factors between the referred positive children and the positive children who were not referred.

The results indicated adequate internal consistency of the ITC total score and subscales, and our factor analysis confirmed the original factor structure. One previous study reported having conducted a confirmatory factor analysis of the three ITC subscales.[16] The sample consisted of 12-month-old children, and some items concerning verbal abilities were omitted from their analysis. As chi-square was the only fit measure reported in that study, we could not compare their results to our own. This measure is problematic, as it provides a dichotomous answer and a large sample size increases the risk of type I errors.[29] The measures used to assess the model fit in the current study yield a better estimation of fit.

A larger proportion of boys had a positive screen compared to girls. Although tendencies towards gender differences have been shown in previous studies of the ITC, these findings warrant further investigation.[15]

TABLE 5 Sensitivity and specificity of the Infant-Toddler Checklist (ITC) in per cent based on Swedish norms, Swedish norms combined with discrepancy information and North American norms

	Sensitivity	Specificity
ITC based on Swedish norms	0.85	0.59
ITC based on Swedish norms and discrepancy information	0.88	0.63
ITC based on North American norms	0.79	0.72

4.1 | Strengths and limitations

This is the first study to explore the psychometric properties of the ITC in the Swedish child health service and adds to the knowledge base regarding early identification of children with communication difficulties. Missing data for the ITC and the BS were handled with multiple imputation, which is superior to many other imputation techniques. Not all children with a positive screen were referred and were therefore not assessed. It was therefore not possible to investigate the predictive capacities of the method. The concurrent validity was based on the result of the BS. Further knowledge about concurrent validity and predictive capacities could be gained from analysis of results from the language screen performed at two-and-a-half to three years of age and further visits to a SLP or psychologist. In future research, it would be of importance to investigate the gender differences seen in the present analysis, as more boys than girls had a positive screening result. A difference between socio-economic groups in identification has been shown in previous studies.[30] An analysis of socio-economic differences in the concurrent validity of the ITC would therefore be of importance in future research.

5 | CONCLUSIONS

The ITC identified children with communication and language difficulties with good sensitivity and acceptable specificity, especially when the ITC was combined with the nurses' developmental surveillance and prior knowledge of the child and family. This suggests that the ITC can be used to identify children in need of communication interventions at 18 months of age. The ITC appeared to yield reliable results with adequate internal consistency and factor structure in the Swedish setting.

CONFLICT OF INTEREST
The authors declare no conflict of interest.

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