Children with DLD have lower quality of life than children with typical development and children with cochlear implants

There is ample evidence that children with developmental language disorder (DLD) often have difficulties that extend beyond the core symptoms relating to language skills (Bishop et al., 2016; Bishop et al., 2017). This is also reflected in the change in diagnostic terminology from specific language impairment (SLI) to DLD (Bishop et al., 2016; Bishop et al., 2017). Secondary difficulties in children with DLD are commonly reported, and they may involve peer relationship problems, fewer or poorer quality friendships, and emotional- and behavioral problems (Durkin & Conti-Ramsden, 2010; Lloyd-Esenkaya et al., 2020). These difficulties put children with DLD at risk for reduced overall wellbeing, or what is often referred to as Quality of Life (QOL) in the research literature. QOL is a complex notion, encompassing the individual's subjective perception of wellbeing in areas such as physical health, emotional- and social functioning (Saxena & Orley, 1997). Due to QOL's multidimensionality, it can contribute to increasing our knowledge about clinical groups whose functioning is affected across several areas of life.

Despite the apparent problems experienced by many children with DLD, relatively few studies have examined QOL in this population. Further, the studies that have investigated QOL, or a related concept, are not conclusive. A majority of studies find either reduced overall scores or poorer scores on one or more domains of QOL in children with DLD compared to peers with typical development (TD) (Coales et al., 2019; Eadie et al., 2018; Hubert-Dibon et al., 2016; Nicola & Watter, 2015, 2018; Van Agt et al., 2010). However, other studies find no or very few differences (Arkkila et al., 2009, 2011). These discrepancies between studies may stem from a number of different causes such as how QOL is operationalized, differences in sample characteristics (clinically referred vs. population-

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based), self- or proxy-report, and the age of participants. All these factors appear to matter for the level of QOL.

Regarding clinical vs. population-based samples, DLD is massively underdiagnosed (Bishop & Hayiou-Thomas, 2008; Tomblin et al., 1997), and thus most children who are identified with language difficulties in population-based studies have not been clinically referred. Children who are referred may differ from children with low language scores who are not referred on a number of measures such as severity of language problems, gender (boys are more likely to be referred), and presence of speech sound difficulties (Bishop & Hayiou-Thomas, 2008). In the same vein, self-report versus parental report may be important, as parents of typically developing children tend to overestimate their children's QOL, while parents of children with chronic health conditions seem underestimate their children's QOL (Eiser & Jenney, 2007). Finally, QOL has been found to decline from childhood to adolescence, especially in girls (Michel et al., 2009).

Another important difference between previous studies concerns matching of children with DLD to the comparison TD groups. Some studies have compared QOL in children with DLD to test norms, and thus do not have the possibility to control for other characteristics than those reported for the norming sample. Other studies have used a control group recruited for the study, but have not matched the groups on gender, age or nonverbal ability. As language (Ching et al., 2021; Eadie et al., 2018; Haukedal et al., 2020; Haukedal et al., 2018), age (Costello et al., 2011) and gender (Boyd et al., 2015; Zahn-Waxler et al., 2008) are all associated with differences in QOL or in disorders that relate to QOL, it is imperative that samples are matched on these characteristics to determine whether differences are due to DLD status rather than other variables.

While there are a number of studies comparing QOL in children with TD and DLD, there is to our knowledge no studies that have compared to QOL in children with DLD to

other groups of children with low language skills due to different etiologies. Thus, we do not know whether the reduced QOL which has been found in several studies of children with DLD is due to language difficulties in general or to other aspects related to the diagnosis.

Children with cochlear implants (CIs) comprise a particularly interesting comparison group because, similar to children DLD, children with CIs have a difference in language functioning from children with TD, but at the same time a clearly distinct etiology for their language difficulties. Children using CIs are at risk for language delay, and as a group, tend to have substantially lower scores on language tests than peers with normal hearing, though individual variability is large (Cupples et al., 2018; Lund, 2015). For children with CIs, hearing loss is likely an important contributing factor to language problems. For children with DLD, hearing problems is an exclusion criterion for the diagnosis (Bishop et al., 2017). Thus, etiology differentiates children with CIs from other groups of children with language difficulties, such as children with DLD and children with intellectual disability.

There are several differences between children with DLD and children with CI beyond language, which may possibly influence QOL. Children with hearing loss receive a diagnosis and treatment at much higher rates than children with DLD. Deafness is often diagnosed early, especially after the introduction of newborn hearing screening (Joint Committee on Infant Hearing, 2019). DLD is rarely diagnosed before age 5, and in many countries, typically several years later (Bishop et al., 2016). Thus, parents of children with CI tend to get regular follow-up, both medically, emotionally and specifically related to spoken language from the time of implantation, which may be as early as during their first year of life. The support provided to families of children with DLD is likely much less institutionalized, though little is known on the topic. Few studies have examined how different neurodevelopmental disorders affect families (Dykens, 2015). DLD is a less known diagnosis and often mislabeled early on as a mere language delay that will resolve itself (Bishop et al., 2016). While the hearing

technology is visible, DLD tends to be a hidden disorder. Furthermore, as opposed to deafness, DLD by definition does not have a known cause, and DLD, though common, is not a well-known disorder. The difference in QOL between children with DLD and CIs may thus be amplified by these factors. Specifically, the environment may be more attentive towards the needs of children with CIs, while children with DLD and their families might not experience the same understanding and support. A comparison of QOL in children with DLD and children with CI can therefore contribute to illuminating the association between language difficulties specifically (which is common to children with DLD and many children with CI) and QOL, as opposed to the association with other factors related to the diagnoses.

Associations between background factors, QOL, and language

Different background factors that characterize the children themselves (e.g. IQ) or their environment (e.g. parental education) may be associated with QOL or related concepts. Few studies have actually examined the association between background factors and QOL in children with DLD. A notable exception is Arkkila et al. (2011) who found that verbal IQ, was significantly associated with the subdomain 'feelings of distress' in children with DLD, although not related to QOL in general. Edie et al. (2018) found language scores at age 7 to be positively associated with overall HR-QOL scores. The association between QOL and language skills within the DLD population may be an especially important aspect to examine, as the variability in language skills within this group is enormous, possibly larger than the variability in the typical population. Associations between language skills and higher scores on measures of QOL have already been documented in children with hearing loss using CIs (Ching et al., 2021; Haukedal et al., 2020; Haukedal et al., 2018), and there is thus a possibility that a similar association exists in children with DLD.

As language skills seem to be associated with QOL, it is important to consider possible background variables that might affect language skills. Two of the most well-studied

factors known to be associated with language abilities are nonverbal IQ and parental education. Higher educational attainment in parents is associated with better language outcomes both in children with hearing loss (Ching et al., 2013; Cupples et al., 2018; Wie et al., 2020) and in children with typical hearing (Hoff, 2003; Pace et al., 2017). Similarly, a higher nonverbal IQ in children has been found to be associated with better language outcomes in children with hearing loss (Cupples et al., 2018) and in children with typical hearing (Torkildsen et al., 2022). Considering this knowledge, it is important to study groups that are comparable with regards to these background variables.

Novel aspects of the current study

In the current study, we compare QOL in a clinical sample of children with DLD to three comparison groups of peers who are matched statistically on age, gender, IQ and parental education: children with TD, children with CIs, and children with CIs who are also matched to the DLD group on language skills. Secondly, we examine the association between language skills and QOL within the DLD group.

The main novel aspect of the current study is that it examines QOL and language skills across two different clinical groups who struggle with language for different reasons. The study may thus shed light on how language ability and QOL are associated, and to what extent reduced QOL (compared to TD children) is related to low language skills in general and to what extent it is related to diagnosis-specific factors.

Our examination is carried out in three steps. In the first step, we compare QOL in children with DLD to that of children with CIs and TD who are matched to the DLD group through a propensity score matching procedure on the background variables age, gender, nonverbal IQ and parental education level (see methods section for an explanation of the matching procedure). We chose to match the group on nonverbal IQ and parental educational

level as previous studies have found associations between these factors on the one hand, and language and QOL outcomes on the other.

In the second step, we extract a comparison group consisting of children with CIs who are matched on language in addition to the above-mentioned background variables, to further assess how differences in QOL between children with DLD and CIs relate to language skills. The CI group matched on language was from the same pool of children with CIs, leading to some overlap between the two matched groups of children with CIs.

In the third step, we examine the relation between QOL and language skills within the group of children with DLD. The association between language skills and QOL has already been documented for children with CIs in several studies, and the present study will thus examine the association between QOL and language skills within the group of children with DLD only. This association can shed light on degree to which QOL is associated with the severity of the language impairments even within the DLD population.

In sum, the novelty in the current study lies in the comparison of children with DLD to both a clinical and a TD control group, the fact that the groups are well-described on a number of background measures known to be associated with QOL, and in the matching procedure used to extract comparable groups.

Research questions

1) Are there differences in QOL between children with DLD, and age, gender, maternal education and nonverbal IQ-matched comparison groups of children with CI and TD?
2) Are possible differences in QOL between children with DLD and CI attributable to differences in language ability? For robustness reasons this question will be investigated by two sub questions:

147 a. Do possible differences between children with DLD and children with CI
148 disappear when we statistically control for language skills in in the sample
149 from research question 1?
150 b. Are there differences in QOL between the children with DLD and a new
151 sample of children with CI who are matched on language as well as age,
152 gender, maternal education, and nonverbal IQ?
153 3) To what degree are language skills associated with QOL within the group of children
154 with DLD?
155

156 **Method**

157 The present study was a part of a larger national cross-sectional research project,
158 *Speech Perception, Language, and QOL in People Who Received CI as Children in Norway*.
159 The study was approved by the Regional Committees for Medical and Health Research Ethics
160 in Norway and the Data Protection Official at Oslo University Hospital. Although originally
161 focusing on children with CIs, children with DLD as well as a control group of 90 children
162 with typical hearing, were later included. The focus of the present study is children with DLD.

163 **Participants**

164 Twenty-nine children with DLD (11 girls, 18 boys), ranging in age between 5 ½ and
165 12 ½ years participated in the study. For the purposes of research question 1, two subsamples
166 of children with CIs and TD were selected (through propensity score matching) to match the
167 group of children with DLD on age, gender, nonverbal ability and maternal education,
168 resulting in a total sample of 87 children: 29 children with DLD, 29 children with CI
169 (propensity matched, CI-PM) and 29 children with TD (see Table 1 for participant
170 characteristics). For research question 2, a new subsample of 29 children with CI was selected
171 to match the sample of children with DLD on language ability as well as the above

background variables (propensity matched also on language, CI-LM). There was a 45 % overlap between these two subsamples, CI-PM and CI-LM, meaning that 13 of the children were in both samples.

The inclusion criteria for all groups were as follows: 1) Norwegian as the first language of the child and a Scandinavian language as the first language of at least one parent; 2) a nonverbal IQ score of 70 or above, indicating the absence of intellectual disability (American Psychiatric Association, 2013), and 3) no diagnosed additional disabilities or conditions suspected to affect QOL or language development (besides hearing loss or a diagnosis of DLD). All children in the TD and DLD group passed an otoacoustic emission screening, indicating typical hearing. The presence of additional disabilities was reported by parents, who were asked whether their child had other types of diagnoses, difficulties, or disabilities. The children in the present study were not reported to have any diagnosed additional disabilities, and children with diagnoses such as ADHD were excluded.

The present study recruited a clinical sample of children with DLD, i.e. children who had been referred to the educational and psychological counseling service in Norway for language difficulties. Nitido and Plante (2020) emphasize the importance of using validated methods to diagnose participants in research studies on DLD, and in particular, tests with adequate sensitivity and specificity. Thus, in the present study, the researchers independently confirmed the DLD status of the recruited participants by administering a battery of standardized language tests. Specifically, the requirement for inclusion was a language score below 1 SD of the normative mean on at least two out of the following four standardized tests: the British Picture Vocabulary Scale II (BPVS-II; Dunn et al. (1997) Norwegian version by Lyster et al. (2010)); the Children's Test of Nonword Repetition (Gathercole et al. (1994); Norwegian version by Furnes and Samuelsson (2009)) and three subtests from CELF 4 (Semel et al., 2003): Recalling Sentences, Formulated Sentences, and Concepts & Following

Directions. These subtests measure core language skills that have been effective in distinguishing between children with DLD and children with typical language in previous studies (see e.g. Conti-Ramsden et al., 2001; Hawker et al., 2008; Håkansson et al., 2022; Schwob et al., 2021). Unfortunately, however, few language tests in Norwegian have been validated as diagnostic tools for DLD. The exception is the CELF 4, and the present inclusion criteria included the three subtests that form part of the CELF 4 Core Language Index (CLI) for all age groups. A study by Akselberg et al. (2021) found that the CLI, which uses a cut off score of 85 (1 SD below the normative mean), had a sensitivity of 90.4% and a specificity of 100% in identification of Norwegian children with DLD. All tests described above were completed by all children participating in the study, and we thus had information on the language skills of all participants regardless of which group they belonged to.

According to patent report, all children in the TD and DLD groups attended mainstream schools. None of the children in the TD group received special education services (data was missing for one child). In the DLD group, 24 children received special education services, three did not receive any special education services, and two parents indicated that they did not know.

In the CI_PM group, 24 children attended mainstream schools, while five attended either a special school for children with hearing loss or a special class for children with hearing loss integrated in mainstream schools. All but four children received special needs services. Amongst the children in the CI_LM group (see research question 2b), 27 children attended mainstream schools, while two children attended special school for individuals with hearing loss. Two children were reported to not receive special education services, while the remainder did. Thirteen of the children in the CI_PM and CI_LM are the same children, as they were matched to the DLD group from the same pool of children with CIs.

Recruitment

Participants for the larger national cross-sectional study were recruited purposefully in accordance with the inclusion criteria listed above. Children with DLD were recruited by contacting an interest group for parents of children with DLD, as well as school speech language therapists or psychologists working with children with DLD. All children who receive CIs in Norway have their annual check-ups at the National CI Centre at Oslo University Hospital in Oslo. Children with CIs were recruited though this hospital in conjunction with their annual appointment. Children in the TD group were recruited through their schools. Participating children in the three groups were recruited from both urban and rural parts of Norway. The data collection took place between 2013 and 2016, except for one child using CIs who was tested in 2019.

Assessments

Quality of Life

QOL was measured using the parent-report version of the PedsQL^{TM} 4.0 Generic Core Scale (Varni et al., 2001). The questionnaire has been developed for use from 2 years old and up until adults as proxy report. In the present study, the versions five to seven years old, and eight to twelve years old were used. The versions are equivalent regarding number of questions, domains and results they return, but there are slight differences in wording adapted to the specific age groups (Varni et al., 2003; Varni et al., 2007). The questionnaire consists of four domains: physical health (eight questions), emotional functioning (five questions), social functioning (five questions), and school functioning (five questions), as well as a total score summing up all the 23 questions. Although the questionnaire has been translated into Norwegian, there are no norms available and it is only validated for use in adolescents (13–15 years old) (Reinfjell et al., 2006). Results from a large group of Norwegian children with TD in the age range 5 to 12 years old has previously been published, and there is thus available comparison data (Haukedal et al., 2018). The questions were answered on a five-point Likert

scale ranging from (0) ‘never a problem’ to (4) ‘almost always a problem’. The items are reversed upon scoring and summed up on a 0–100 scale, with a higher score indicating a better QOL and a lower score indicating a poorer QOL (Varni et al., 2001). We calculated Cronbach’s alpha to determine the internal consistency of the questionnaire, i.e. the extent to which all the items in a test measure the same concept or construct. The combined Cronbach’s alpha for all four groups for the full scale was .87. For the different groups the Cronbach’s alpha was .88 for the DLD group, .84 for the CI_PM group, .82 for the CI_LM group, and .85 for the TD group. These scores are all in the range of acceptable values of alpha (0.70-0.90), indicating adequate internal consistency (Tavakol & Dennick, 2011).

Language skills

Language skills were measured by the Norwegian adaptation of the Clinical Evaluation of Language Fundamentals-4 (CELF-4, (Semel et al., 2003). The CELF-4 is a comprehensive diagnostic test, consisting of 13 subtests measuring different aspects of receptive and expressive language, as well as verbal memory. The test has been normed with a sample of 600 Scandinavian children aged 5;0–12;11 years. The normal range is 86–115. The score used in the analyses for research questions 1-3 was the Core Language Index (CLI), which is the main index of the test, intended as a general measure of language ability. The CLI is a standard score derived from the Scandinavian norming sample. For children aged 5;5–8;9 years the CLI comprises the following subtests: Concepts and Following Directions, Word structure, Recalling Sentences and Formulated sentences. The CLI for children aged 9;0–12;11 years comprises the same subtests except that Word Structure has been replaced with Word Classes 2 Total.

CELF-4 subtests. The Concepts and Following Directions subtest measures the ability to follow oral directions of increasing length and complexity by pointing to one or more images in the correct order. The Word Structure subtest examines morphological knowledge

(mostly inflections, such as plurals and past tense conjugations) by asking the child to complete orally presented sentences in reference to a picture. The Recalling Sentences subtest measures the ability to repeat orally presented sentences of increasing length and grammatical complexity. In the Formulated sentences task, the child is asked to generate sentences in response to orally presented words and pictures. In the Word Classes 2 task, the child is given three or four orally presented words and is asked to identify two words among these that go together and explain their relationship.

Nonverbal IQ

For children younger than 9 years, nonverbal IQ was assessed with the Raven's Coloured Progressive Matrices (Raven, 2004). Children of age 9 and older were tested with the Raven's Progressive Matrices Plus (Raven, 2008). Raven's Progressive Matrices was used due to the test's limited verbal instructions and nonverbal stimulus material, which is important given that tests with verbal materials or extensive verbal instructions may inappropriately penalize children with DLD for their language difficulties (Durant et al., 2019; Gallinat & Spaulding, 2014). Raven's matrices yield a total score in standard scores, with a mean of 100 and SD of 15 points. It has been found that children's language skills can influence performance on non-verbal IQ tests as children may use language-based strategies to solve the tasks (Durant et al., 2019). This entails that although the children were matched on nonverbal IQ, there may still be persisting differences between group that we are not fully able to eliminate.

Background questionnaire

A questionnaire assessing information on demographic factors, the children's development and rearing environment was developed for the purpose of the study and completed by the parents. The background questionnaire included questions on parents' highest completed education, whether the child received special educational services in school

and if they did how many hours it comprised, when the child was first diagnosed with DLD or hearing loss and whether the child had any additional disabilities or diagnosis.

Procedure

Children with DLD and children with TD were tested at their local schools. Children in the CI-group were tested in conjunction with their annual appointments at the National CI Centre at Oslo University Hospital in Oslo. Test administration was carried out individually in a quiet room. The complete battery of test for the overall study took approximately four hours to complete However, only tests that are relevant to the current study are described here. Parents completed the questionnaires either while waiting for their child to finish the test session, or at home. All assessments were scored by the same three research assistants who were certified and experienced in test administration and scoring. One of the three research assistants initially scored the test, and one of the two other research assistants verified the scoring and corrected possible errors.

Analytical approach

Data analyses were performed in three consecutive steps. We used propensity score matching to limit the effect of confounding variables for answering both RQ1 and RQ2. This matching was important, since our aim was to limit the influence of contextual factors as confounders on the result of the between-group comparisons. Although propensity score matching was initially developed for making causal inferences in quasi-experimental studies, it has become a valuable tool for controlling for the effects of contextual variables, too. In particular, Austin (2011) advocated for the use of propensity score matching to reduce the effects of confounding variables as well as its efficiency in reducing bias.

The goal of propensity score matching is, as in any other matching procedure, to balance the covariates of two or more groups. In a situation where covariates are unbalanced, any difference between groups may be due to such covariates, and therefore not substantively

meaningful. In the case of experimental studies, proper randomization to a treatment and a control group will, at least in the long run, result in balanced and thus comparable groups. Clearly, this is not possible in the type of observational study conducted here. One common approach on balancing groups in observational studies is therefore to match the individuals from the groups on background variables or possible confounders. While this is feasible with a low number of simple covariates (e.g. 'old/young' and 'rural'/'urban'), the matching gets more demanding with complex variables. In propensity score matching, these sets of covariates are statistically 'collapsed' into one single score that, in turn, can be interpreted as proxy for the similarities in covariates for that individual. Various statistical techniques exist for arriving at that score(D. Ho et al., 2011). Importantly, based on these propensities scores, groups who are similar in respect to the selected covariates or background variables can be formed. Thus, we can assume that these confounders are taken appropriately care of.

To answer research question 1, participants were selected from a pool of children with TD (n = 73) and children with CIs (n = 106) and were matched to the DLD group (n = 29) through a propensity score matching procedure on age, gender, nonverbal IQ, and maternal education. Once the two comparison groups of children with TD and CI_PM were selected to be matched to the DLD through propensity score matching, we examined whether the groups differed on nonverbal IQ and age. Comparisons were made with the Kruskal-Wallis test. No statistically differences were identified on age $H(2) = 1.79$, $p = .41$, or nonverbal IQ $H(2) = 1.26$, $p = .53$. A Krukal-Wallis test was also used to assess differences in QOL and language scores scores across the groups. Post-hoc tests were performed with Mann-Whitney U tests. Nonparametric analyses were conducted as data were not normally distributed.

To answer research question 2, a second propensity matching procedure was carried out in order to create a second CI group, to match the children in the DLD group on language (the CELF CLI), as well as age, gender, nonverbal IQ, and maternal education. In both these

steps, descriptive statistics were extracted to assess distribution, normality, generate means, medians and standard deviations. Two different analytic approaches were employed to assess whether possible differences between children with DLD and CI are attributable to differences in language ability. First, a one-way between-subjects ANCOVA was conducted with QOL as the dependent variable and the CELF-core score as a covariate to compare groups, while controlling for language skills. Second, median QOL scores were compared in the DLD group and the language-matched CI group, using a Mann-Whitney U test.

For the third research question, we fitted a linear regression model to assess the proportion of variance in QoL that could be explained by language skills in the DLD group. The alpha level was set to .05 for all analyses.

The propensity matching procedure was conducted in the R using the MatchIt package (D. E. Ho et al., 2011), while the inferential statistics were completed in SPSS (Statistical Package for the Social Sciences) (IBM Corp., 2021).

Results

Participant characteristics and median scores on the included measures are shown in Table 1. The participating children were on average almost 10 years old at the time of testing. The TD group had the highest scores on all measures. There was a statistically significant difference between groups on the CELF CLI $H(2) = 48.35$, $p<.001$. Post-hoc comparisons showed that there was a statistically significant difference between the TD group and the three other groups on CELF CLI: TD (Median = 100.00) * DLD (Median= 65.00, U = 18.50, z = -6.25, p< .001), TD (Median = 100.00) * CI_PM (Median= 72.25, U = 66.50, z = -5.04, p< .001) and TD (Median = 100.00) * CI_LM (Median= 65.00, U = 43.50, z = -5.87, p< .001). The median scores were numerically lower in the DLD group than the CI groups. This was true for all measures, both the CELF CLI, the QOL total score and the QOL subdomains

(Table 2). However, on the CELF CLI the difference was not statistically significant different between the clinical groups DLD (Median= 65.00) * CI_PM (Median= 72.25, U = 412.50, z = -1.15, p= .249), and DLD (Median= 65.00) * CI_LM (Median= 65.00, U = 414.50, z = -.093, p= .926).

Research question 1: Are there differences in QOL between the three groups; children with DLD, CIs or TD?

To assess the statistical differences in QOL between children with DLD and the age, gender, maternal education and nonverbal IQ-matched comparison groups were compared with a Kruskal-Wallis ANOVA. As can be seen in Table 3, there was a statistically significant difference between the three groups on the Total score.

Post-hoc tests showed that the DLD group had statistically significantly lower QOL scores in comparison to both the TD group and the CI_PM group, while the CI_PM group had lower QOL scores compared to the TD group only. As can be seen from the effect sizes in Table 3, the difference in QOL between children with DLD and TD was large, while the other group differences were small to moderate in size. Due to high intercorrelations between the subdomains of PedsQL, group differences were tested only for the Total score. However, the descriptives in Table 2 show that the numerically largest group differences were in the social and school subdomains.

A statistically significant difference may not represent a clinically relevant difference. Previous publications suggest that 4.5 change in the total score represents a minimal clinically important difference for change (Varni et al., 2003). Despite this not being an established cut off in a Norwegian adaptation of the questionnaire, the difference from the TD total score and the score in the clinical groups far exceeds this suggested limit. For the CI_PM group the difference from the TD group is eight points, while for the CI_LM it is ten points. For the DLD group the difference is 16 points.

Research question 2: Are possible differences in QOL between children with DLD or CIs attributable to differences in language ability?

For research question 2a, a one-way between-subjects ANCOVA was conducted with QOL as the dependent variable and the CELF-4 CLI as a covariate to compare groups, while controlling for language skills. The results indicated that there was no statistically significant group-effect on QOL when controlling for the effect of language skills $H(2, 78) = 2.36$, $p = .101$.

For research question 2b, we assessed whether the difference between children in the DLD group and CI group remained when the DLD group was compared to a language matched group of children using CIs, CI_LM. There was no statistically significant difference in QOL scores between the groups of children with DLD (Median = 72.83, n = 29) and the CI_LM group (Median= 78.95, n = 29, U = 331.00, z = -1,39, p = .163).

Research question 3: To what degree are language skills associated with QOL in children with DLD?

To assess how much variation in QOL scores that was explained by severity of language difficulties within the DLD group, we fitted a linear regression model for the DLD group only. QOL scores was the dependent variable and language skills the predictor. We found a significant effect of language skills ($\beta = .486$, SE $B_1 = .216$, Std. beta = .396, $p<.05$) where language skills explained 16 % of the variation in QOL scores in the DLD group (see Figure 2).

Discussion

The present study found that the DLD group was reported by parents to have statistically significantly poorer QOL scores than peers with TD or CIs (CI_PM) that were matched to the DLD group on age, gender, nonverbal IQ and maternal education. However,

the children with DLD had numerically lower language scores than both the TD and CI_PM groups, which could be a reason for the observed differences in QOL. Thus, we compared the mean QOL scores across the three groups of children with DLD, CI_PM and TD, while controlling for language skills. There were no statistically significant differences in QOL scores across groups when controlling for language. For robustness purposes, we matched a second comparison group consisting of children with CIs (CI-LM) who were propensity matched to the DLD group on language in addition to age, gender, nonverbal IQ and maternal education. The DLD group had a numerically lower median score on the QOL measure than the CI_LM group. However, the group difference was not statistically significant. Finally, we assessed the association between language skills and QOL within the DLD group only. This analysis showed a positive relation between language skills, as measured by the Core Language Index of the CELF-4, and QOL. Language skills explained 16 % of the variation in QOL within the DLD group.

Research question 1: Are there differences in QOL between children with DLD, CIs or TD?

Children with DLD were reported to have the poorest QOL amongst all groups. This is consistent with previous studies that have found children with DLD to have lower scores on QOL measures than TD peers (Coales et al., 2019; Eadie et al., 2018; Hubert-Dibon et al., 2016; Nicola & Watter, 2015, 2018; Van Agt et al., 2010). However, this study adds strengthened evidence for how language and communication might impact QOL, as the three included groups were matched on a range of background variables. Several of the former studies have also compared QOL in children with DLD to TD to a matched control group, typically matched on age and gender. Although these factors are important for language development, these variables may not be sufficient to control for possible differences across groups. The role of nonverbal IQ in diagnosing DLD has been much debated in the consensus

from the CATALISE committee (Bishop et al., 2016; Bishop et al., 2017). Prior to the CATALISE studies, children were typically required to have a discrepancy between verbal and nonverbal IQ, and a nonverbal IQ score >85 to qualify for diagnosis of 'specific language impairment' (Leonard, 2014). Although useful in a research setting, both clinicians and researchers report that many children struggling with language have a nonverbal IQ score <85, but that the language difficulties experienced by children with low or high nonverbal IQ are similar in nature (Norbury et al., 2016). Thus, the CATALISE committee recommends that a diagnosis of DLD can be set for children with lower IQ levels as long as they do not have an intellectual disability, i.e. a nonverbal IQ <70 (Bishop et al., 2016). When examining a group of children with DLD recruited after these updated criteria, many children may thus have a nonverbal IQ below the population average. When matching a control group, nonverbal IQ is thus an important factor to consider. When children with DLD in the present study still have poorer QOL than carefully matched peers with CIs or TD, it further strengthens the hypothesis that the reduced QOL is associated with the language difficulties, and not merely an underlying third factor such as IQ.

Also, DLD has been found to run in families, and is thought to be partly genetic in origin (Mountford et al., 2022). In line with this, several previous studies have a TD control group where parents' educational level is significantly lower compared to the group of children with DLD. Parental educational level has been found to be associated with educational attainment and better language skills in offspring (Hoff, 2003; Pace et al., 2017). Thus, controlling for this difference though matching groups is yet another way of reducing the impact of other possible variables.

Research question 2: Are possible differences in QOL between children with DLD or CIs attributable to differences in language ability?

An association between language skills and QOL has previously been observed in groups such as children with low language abilities (Le et al., 2021), children with DLD (Arkkila et al., 2011; Eadie et al., 2018) and in children with hearing loss (Ching et al., 2021; Haukedal et al., 2020; Haukedal et al., 2018). The present study compares QOL in children with DLD to children with CIs directly. A main reason for comparing QOL in these two groups who struggle with language for different reasons, is to examine whether language ability and QOL are associated, and to what extent reduced QOL (compared to TD children) is related to low language skills in general or rather diagnosis-specific factors. In the current study, children with DLD had statistically significantly poorer QOL scores than peers with TD or CIs, but when controlling for language, there was no statistically significant difference in QOL scores between the groups. This was also the case when comparing QOL between children with DLD and children with CI who were matched for language. Children in the DLD group had on average poorer language skills than the CI_LM group, although the difference was not statistically significant. While the study design does not allow us to draw causal inferences, the results are consistent with language as the main driver of a lower QOL score, not different background variables related to differences in etiology of language problems or different levels of institutionalized support.

Research question 3: To what degree are language skills associated with QOL in children with DLD?

Most previous studies have focused on establishing whether there is a difference in QOL between children with DLD and TD peers, with the assumption that language and communication difficulties affect children with DLD negatively. In the current study, we found that a substantial amount of variation in QOL within the DLD group was explained by variation in language scores. Although the direction of this relationship cannot be established with the present study's research design, the results are consistent with existing literature

implying that language and communications skills affect psychological and social well-being, and thus ultimately QOL.

Results in the present study are largely consistent with the handful of previous studies have examined whether there is an association between language and QOL within the group of children with DLD. Although Arkkila et al. (2011) found similar levels of QOL in children with DLD as in peers, they found that the question about feelings of distress from the QOL questionnaire was associated with low verbal skills. Eadie et al. (2018) found associations between lower language scores and QOL in children with DLD. Similarly, Le et al. (2021) showed that children with low language, defined as scoring 1.25 SD below populational mean, had significantly lower QOL scores than children with typical language. Furthermore, the authors found that better language scores were associated with better QOL. Children with low language were less likely to follow a stable-high QOL trajectory, and many showed a decline in QOL. Finally, a prospective cohort study of externalizing problems in preschool children, found a significant co-occurrence of problems with language and externalizing behavior (Wang et al., 2018). Language delay significantly predicted aggression, but aggression did not predict language delay Although scarce, these studies point in the direction that language skills may influence QOL.

Clinical implications

Results of the present study suggest that Norwegian school children with DLD have substantially depressed QOL compared to peers with typical development, and also lower QOL than children with cochlear implants. Notably, the school and the social domains are the areas that stand out in showing the largest differences between children with DLD and TD. Thus, the depressed QOL in the DLD group may be driven primarily by social and school functioning. These findings indicate that the needs of children with DLD are not met in current classroom settings. There may be several reasons for this, including the non-visible

nature of the disorder and the lack of effective and commonly accepted diagnostic procedures (McGregor, 2020). Our results point to a need for increased awareness of DLD in preschools, schools and among the general public, which could improve the chances of these children receiving appropriate diagnosis and services. This was the goal of the CATALISE group in agreeing upon a terminology and diagnostic criteria (Bishop et al., 2016; Bishop et al., 2017), an initiative that has been followed up with similar processes in other countries, including Norway (Kristoffersen et al., 2021). Further, assessments of children with DLD should focus on social functioning in addition to academic needs. Critically, our results call for enhanced collaborations between the services that diagnose children with DLD and their classroom teachers to ensure that assessment results are translated into well-tailored interventions.

The findings of the present study align with previous literature on QOL in children with DLD and supports the conclusion that DLD is not a diagnosis affecting the language domain alone. DLD is associated with reductions in children's overall QOL, and the degree to which QOL is reduced depends on the severity of the language impairment. Thus, interventions to improve language in children with DLD may potentially have cascading effects on their quality of life. However, as the children's overall QOL is poorer than in the other groups, this indicates that interventions should address not only language skills, but also the impact DLD has on social and school functioning. Future interventions for children with DLD should thus have a broader focus, acknowledging the range of consequences DLD can have for children's lives.

Strengths and weaknesses

A limitation of the current study is the small sample which limits the possibility for generalization of the results. Furthermore, the QOL scores rely solely on parent-report, although self-reports are usually preferred. Still, parent-reports are a good option in groups of children who are too young or, for different reasons, are not able to complete the

546 questionnaires themselves. It has been pointed to that children with DLD might struggle to
547 accurately assess and report their own experiences concerning emotions and QOL (Coales et
548 al., 2019). The questionnaire used to assess QOL has not been validated for Norwegian in the
549 age group included in the present study. There are however, no available QOL questionnaires
550 for children that have been validated for use in Norwegian. A matched comparison group of
551 children with TD has thus been included in the present study. Furthermore, we have
552 previously published results from the same version of the questionnaire with a sample of n =
553 80 children with TD in the relevant age range that was collected as a comparison group
554 (Haukedal et al., 2018).

555 Similarly, few language assessments have been validated as diagnostic tools for DLD
556 in Norwegian. Thus, the present study used a combination of clinical assessment and
557 subsequent verification by researchers who employed both validated and unvalidated
558 measures. A weakness of the study was that we did not use validated method for verifying the
559 diagnostic accuracy of this combination of assessments. Future studies of Norwegian-
560 speaking children with DLD should aim to identify an easy-to-administer combination of
561 measures that yields acceptable sensitivity and specificity. Furthermore, the DLD group was
562 compared to both a group of children with CIs, and a group of children with TD, both groups
563 propensity matched on a range of background variables known to be associated with language
564 development and QOL. Thus, we can be confident that the group differences found in the
565 present study are not due to differences in nonverbal IQ or parental education, which have
566 rarely been controlled in previous studies of QOL in children with DLD.

567

568 **Conclusion**

569 The results of the present study show that DLD is not a diagnosis which is linked to
570 the language domain alone. DLD is associated with the children's overall QOL, and the

571 degree of reduced QOL relates to the severity of the language impairment. Interventions for
572 children with DLD should thus have a broad focus, targeting both language skills and other
573 domains such as social functioning.

574 (Håkansson et al., 2022)

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