Relationships between tic disorders and obscure neurodevelopmental disorders in preschool-aged children: a cross-sectional study

Miyuki Fujio  
Teikyo University

Takao Kawai  
Tokyo Metropolitan Bokutoh Hospital

Mayu Fujiwara  
The University of Tokyo Hospital

Natsumi Matsuda  
The University of Tokyo Hospital

Maiko Nonaka  
The University of Tokyo Hospital

Ryunosuke Goto  
The University of Tokyo Hospital

Toshiaki Kono  
The University of Tokyo Hospital

Marina Nobuyoshi  
The University of Tokyo Hospital

Yukiko Kano (kano-tky@umin.ac.jp)  
The University of Tokyo Hospital

Research Article

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Abstract

Background

Associations between tic disorders and other neurodevelopmental disorders, such as stuttering, dyslexia, and developmental coordination disorder (DCD) in preschool children are unknown, especially in Japan. This study investigated these associations and their relationship with the support requirements using new screening tool named “Check List of obscure disabilities in Preschoolers” (CLASP).

Methods

We distributed questionnaires to the guardians of children aged 5 or 6 years old in the final grade of preschool. In total, we collected 103 responses. After excluding the responses with missing answers and those that did not provide consent, we analyzed 98 responses. We used t-tests with unequal variances and Spearman's correlation coefficients to investigate the associations between tic disorders and other neurodevelopmental disorders. We also conducted a two-step hierarchical multiple regression analysis to examine how the severity of tic and other neurodevelopmental disorders symptoms was associated with the support requirements of parents.

Results

T-tests and correlation analyses suggested weak relationships between tics and stuttering and dyslexia. Conversely, tics and DCD had a significant and robust correlation. Furthermore, multiple regression analyses demonstrated that tics and DCD were significantly associated with parents requiring support.

Conclusions

These results suggest a relationship between tics and DCD in preschool children. More research on these relationships could promote additional support for children of this age with tic and neurodevelopmental disorders and their parents.

Introduction

Tics are rapid, recurrent, nonrhythmic movements or vocalizations common in children [1]. Generally, symptoms begin in preschool age, between 4 to 6 years old [2, 3]. Previous studies have shown that 3 to 16% of children have some type of tic despite that only approximately 3% of children are diagnosed with transient tics [4–7].

Tic disorders are not well known compared with attention-deficit hyperactivity disorder (ADHD) and autism spectrum disorder and difficult to early intervene [8]. Other neurodevelopmental disorders,
including stuttering, dyslexia, and developmental coordination disorders (DCD) are also not well known \cite{8, 9} in Japan. However, early detection and intervention are critical in these disorders \cite{10–13}.

Stuttering has a similar course to tics, with onset between ages 2 and 5 years \cite{14}. Dyslexia and DCD are often problematic after elementary school enrollment, but the signs likely appear in preschool age. Thus, tics, stuttering, dyslexia, and DCD are all developmental disorders arising in preschool age. Despite some similarities, associations between these disorders are unclear. Though tic disorders have been associated with stuttering \cite{15}, research regarding these associations in Japan is insufficient. And it is unclear whether tics are associated with dyslexia and DCD in preschool age. Elucidating the relationships between these neurodevelopmental disorders can improve clinical assessment and the available support for children with symptoms and their parents.

There is no systematic method for assessing tics, stuttering, dyslexia and DCD currently. However, the research team with grants of Japan's Ministry of Health conducted studies with these four neurodevelopmental disorders “obscure neurodevelopmental disorders” and developed a screening tool for obscure neurodevelopmental disorders called the “Check List of obscure disabilities in Preschoolers” (CLASP) \cite{8}. Therefore, this study investigated the relationships between tics and the other obscure neurodevelopmental disorders in preschool children using CLASP and examined how the severity of tic symptoms is associated with the support requirements of parents.

**Methods**

**Study Design**

We conducted a cross-sectional study investigating the prevalence of and relationships between four obscure neurodevelopmental disorders. Written informed consent was obtained from all guardians of the included participants. The ethics committee of the University of Tokyo (IRB number: 11316) approved this study.

**Participants**

We distributed questionnaires to the guardians of children aged 5 or 6 years old in the final grade of preschool. These guardians participated in our previous study \cite{16} and had agreed to participate in further research. In our previous study, we distributed 2,592 questionnaires in a specific ward in Tokyo, Japan and 776 questionnaires were collected. Of 776 guardians, 134 guardians agreed to participate in current study. The guardians received the questionnaires by mail, answered the questionnaire in writing, and then mailed it back to the address provided if they agreed to participate.

In total, we collected 103 responses (response rate = 76.9%). After excluding the responses with missing answers and those that did not provide new consent, we analyzed 98 responses; 44 children were boys and 54 were girls.

**Instruments**
The questionnaires were administered in Japanese. Some original questions were written in English but translated into Japanese by a group of clinicians with extensive knowledge and experience in the child psychiatry field.

1) The tic questionnaire

We used a questionnaire derived and translated from the questions regarding Tourette's disorder and chronic tics from the Avon Longitudinal Study of Parents and Children Cohort (ALSPAC) to assess the presence of tics [17]. These questions had been used in a previous study that assessed Tourette's symptoms with a Japanese questionnaire [18]. We used three of the original six questions for our analysis because two questions were not tic-specific, and one was about the chronicity of tics rather than the symptoms. Two of the three included questions were about motor tics and one was about vocal tics. For all the questions, the participants were asked to choose from “Definitely,” “Probably,” and “Not at all” regarding the presence of a symptom. Children were included in the tic group if the guardian answered one of the three questions as “Definitely.” Children were included in the non-tic group if the guardian answered all three questions as “Not at all.”

2) CLASP

The symptoms of tics and other developmental disorders, such as stuttering, dyslexia, and DCD, were evaluated using CLASP. There were 19 questions in total; four were about stuttering, five were about tics, five were about dyslexia, and five were about DCD. For all questions except one about stuttering (Q4), the participants were asked to choose from “Definitely,” “Probably,” “Maybe,” “Rarely,” and “Not at all.” Q4 was about the symptom’s chronicity, and the participant was asked to choose between “Yes” and “No.”

There are two CLASP scoring methods. In the first method, questions answered as “Definitely” or “Probably” are scored as 1. Questions answered as “Maybe,” “Rarely,” and “Not at all” are scored as 0. In the second scoring method, each answer except Q4 is given a score of 1 (“Not at all”) to 5 (“Definitely”). As this study aimed to identify relationships between the severity of tics and obscure developmental disorder traits (rather than merely the presence of symptoms), we scored the questionnaires using method two. First, the answer scores were summed per disorder, then the total score of each disorder was compared between the tic and non-tic groups.

3) Parental Support Requirements

The guardians were asked the following questions: 1) “Do you worry about parenting and want to talk or get some advice?” and 2) “Do you ever want to talk about or get advice on your child’s development?” The participant was asked to rate their answer from 1 (“Never”) to 3 (“Always”).

Data analyses
First, the mean stuttering, dyslexia, and DCD CLASP scores were compared between the tic and non-tic groups using t-tests with unequal variances. An F-test was used before the t-test to determine if the variances of the two groups were equal. Next, correlations between tics, stuttering, dyslexia, DCD, and parental support requirements were examined using Spearman's correlation coefficients. Finally, a two-step hierarchical multiple regression analysis was conducted with parental support requirements as the dependent variable. The main associations of tics, stuttering, dyslexia, and DCD were assessed in Step 1. Then, two-way interactions between tics and other obscure developmental disorders (i.e., stuttering, dyslexia, and DCD) were added in Step 2. Each variable was centered at the mean to address multicollinearity. The statistical analyses only included respondents with answers for all variables. All statistical analyses were performed using SPSS (version 18.0), and the significance level was set at \( p < .05 \).

**Results**

**ALSPAC Analyses**

Overall, 55 children were in the non-tic group and 24 were in the tic group. Nineteen samples could not be categorized based solely on the questionnaire and were excluded from this analysis because the guardian did not answer as “Definitely” for all three questions and answered as “Probably” for at least one question.

The tic group consisted of 12 boys and 12 girls. 8 children were 5 years old, and 16 were 6 years old. The non-tic group had 24 boys and 31 girls; 15 children were 5 years old, and 40 were 6 years old.

Table 1 presents the t-test results per group. The mean stuttering and dyslexia scores in the tic group were higher than in the non-tic group, though the estimate was imprecise (3.875 vs. 3.273 [\( p = 0.052 \)] and 8.542 vs. 6.273 [\( p = 0.053 \)], respectively). The mean DCD scores in the tic group were statistically higher than in the non-tic group (7.958 vs. 5.945 [\( p = 0.035 \)]).

<table>
<thead>
<tr>
<th></th>
<th>Tic group (n = 24)</th>
<th>Non-tic group (n = 55)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Range</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Stuttering</td>
<td>3.875 (1.361)</td>
<td>3–7</td>
<td>3.273 (0.781)</td>
</tr>
<tr>
<td>Dyslexia</td>
<td>8.542 (5.183)</td>
<td>5–25</td>
<td>6.273 (2.870)</td>
</tr>
<tr>
<td>DCD</td>
<td>7.958 (4.154)</td>
<td>5–20</td>
<td>5.945 (2.483)</td>
</tr>
</tbody>
</table>

\(^{a} p < 0.10\) and \(^{b} p < 0.01\) (t-tests). SD, standard deviation; DCD, developmental coordination disorder.
CLASP Analyses

We analyzed 98 responses. Table 2 presents the mean CLASP score and parental support requirements, and Table 3 details the correlations between tics, stuttering, dyslexia, DCDs, and parental support requirements. The tic scores were significantly correlated with the stuttering, dyslexia, DCD, and the parental support requirements scores ($r = 0.207 \ [p = 0.041]$, $r = 0.331 \ [p = 0.001]$, $r = 0.396 \ [p < 0.001]$, and $r = 0.321 \ [p = 0.001]$, respectively). The stuttering scores were not significantly correlated with the dyslexia scores or the parental support requirements scores ($r = 0.183 \ [p = 0.072]$ and $r = 0.161 \ [p = 0.112]$, respectively).

Table 2

<table>
<thead>
<tr>
<th>Variables (Range)</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tics (5–25)</td>
<td>6.245 (2.234)</td>
<td>5–17</td>
</tr>
<tr>
<td>Stuttering (3–15)</td>
<td>3.500 (1.105)</td>
<td>3–9</td>
</tr>
<tr>
<td>Dyslexia (5–25)</td>
<td>6.857 (3.581)</td>
<td>5–25</td>
</tr>
<tr>
<td>DCD (5–25)</td>
<td>6.490 (3.033)</td>
<td>5–20</td>
</tr>
<tr>
<td>Parental support requirements (2–6)</td>
<td>3.418 (1.346)</td>
<td>2–6</td>
</tr>
</tbody>
</table>

SD, standard deviation; DCD, developmental coordination disorder.
Table 3
Correlations between tics, obscure developmental disorders and parental support requirements

<table>
<thead>
<tr>
<th></th>
<th>Stuttering</th>
<th>Dyslexia</th>
<th>DCD</th>
<th>Parental support requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tics</td>
<td>0.207&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.331&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.396&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.321&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>(p = 0.041)</td>
<td>(p = 0.001)</td>
<td>(p &lt; 0.001)</td>
<td>(p = 0.001)</td>
</tr>
<tr>
<td>Stuttering</td>
<td>-</td>
<td>0.183&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0.331&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0.161</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(p = 0.072)</td>
<td>(p = 0.001)</td>
<td>(p = 0.112)</td>
</tr>
<tr>
<td>Dyslexia</td>
<td>-</td>
<td>-</td>
<td>0.612&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0.365&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(p &lt; 0.001)</td>
<td>(p &lt; 0.001)</td>
</tr>
<tr>
<td>DCD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.482&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(p &lt; 0.001)</td>
</tr>
</tbody>
</table>

<sup>a</sup> p < 0.05, <sup>b</sup> p < 0.01, <sup>c</sup> p < 0.001, and <sup>d</sup> p < 0.10. DCD, developmental coordination disorder.

Table 4 presents the results of the hierarchical multiple regression analysis. In the Step 1 regression, we identified an association between the tics and DCD scores and the parental support requirements score ($\beta = 0.195$ [p = .044] and $\beta = 0.370$ [p = .011]). However, in the Step 2, we only observed an association between the DCD scores and the parental support requirements score and did not observe significant two-way interactions between tics and other obscure developmental disorders or $R^2$ changes.
Table 4
Hierarchical multiple regression analyses for predicting parents requiring support

<table>
<thead>
<tr>
<th>Predictor Measure and Step</th>
<th>β</th>
<th>t</th>
<th>Adjusted R²</th>
<th>R² change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Tics</td>
<td>0.195</td>
<td>2.046</td>
<td>0.252&lt;sup&gt;a&lt;/sup&gt;</td>
<td>0.283&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Stuttering</td>
<td>0.104</td>
<td>1.138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslexia</td>
<td>0.058</td>
<td>0.403</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCD</td>
<td>0.370</td>
<td>2.610&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Tics</td>
<td>0.127</td>
<td>1.039</td>
<td>0.245</td>
<td>0.016</td>
</tr>
<tr>
<td>Stuttering</td>
<td>0.088</td>
<td>0.950</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dyslexia</td>
<td>-0.052</td>
<td>-0.300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DCD</td>
<td>0.510</td>
<td>2.913&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tics * Stuttering</td>
<td>0.043</td>
<td>0.319</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tics * Dyslexia</td>
<td>0.180</td>
<td>0.926</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tics * DCD</td>
<td>-0.176</td>
<td>-0.967</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup> p < 0.001. <sup>b</sup> p < 0.05. DCD, developmental coordination disorder.

Discussion

In this study, we investigated the relationship between tics and other obscure developmental disorders in preschool children, and found a significant association between tics and DCD. However, the associations between tics and stuttering and dyslexia were not strong at this age.

The mean DCD score was significantly higher in the tic group than in the non-tic group. There was also a significant positive correlation between the tic score and the DCD score. This result suggests that tic symptoms in preschool-aged children might also indicate the presence of DCD symptoms. Often, difficulties with motor skills accompany tic disorders and DCD, and some have suggested that motor skill deficits could predict future tic severity in children aged 8 to 14 with Tourette Syndrome [19]. Our study’s results indicate that this relationship might be detectable from preschool age. In addition, early detection of DCD will help children improve their symptoms through early intervention [20]. Therefore, if clinicians thoroughly assess DCD symptoms in preschool children with tics, DCD symptoms may become evident, resulting in earlier and more appropriate child and parental support.

The mean stuttering and dyslexia scores in the tic group were higher than in the non-tic group, though the estimate was imprecise. These results are contrary to a previous study that reported an association
between tic disorders and stuttering [14]. A previous study has also suggested that children who begin stuttering may recover by 6 years of age [21], so assessing the association between tics and stuttering may be difficult. However, given that early-onset tic disorder is linked to an increased stuttering rate [22], additional studies may reveal differences in the stuttering rate between the tic and non-tic groups. Future studies should investigate this by increasing the number of participants and the target age.

Finally, the multiple regression analysis including the main effect of each disorder (Step1) demonstrated that tics and DCD were significantly associated with parents with 5-and 6-year-old children requiring support. However, main effect of tics on the parental support requirements disappeared in the model consisted of main effects and two-way interaction effects between tics and other obscure developmental disorders. These results suggest that effect of tics on the parental support requirements tend to appear when children also have stuttering, dyslexia, and/or DCD traits. It is important to assess not only tics but the other obscure developmental disorders comprehensively. Also, this analysis implied that DCD largely effected on the parental support requirements compared to tics, stuttering and dyslexia. Though DCD are thought to be problematic after elementary school enrollment, it is suggested that parents need support with DCD traits since preschool age. It will be important to provide appropriate information on DCD to parents with children this age.

**Strengths and Limitations**

This study has several limitations. First, we distributed the questionnaire only to the guardians who previously agreed, and only 76.9% responded. Therefore, only the guardians with a genuine interest in this study may have participated. Thus, the disorder prevalence rates might be higher than the general population, and future studies should address this by distributing the questionnaire to a more inclusive sample.

Second, we did not consider the effects of ADHD, but some children with tics also have ADHD, which might be a confounding factor. Children with ADHD can score higher in the CLASP evaluation. For example, Q19 (“When your child sits for a long time, does your child get tired, lose posture, or fall off the chair?”) is related to both DCD and the hyperactivity symptom of ADHD. Therefore, the DCD score might increase in children with ADHD. Further research on the relationship between CLASP and ADHD is necessary.

Third, the questionnaire was answered by the guardians, and professional clinicians did not evaluate the disorders based on the CLASP. Hence, it is difficult to fully elucidate the clinical relationships among the four disorders based on this study’s results alone, and more research using clinical data is necessary.

Lastly, the stuttering and dyslexia scores did not differ between the tic and the non-tic groups partly because of the small sample size. Larger data sets are required to better evaluate this.

However, the CLASP analyses provide novel evidence on the relationships between tic symptoms and individual disorders. CLASP is a new screening tool, and epidemiological data about the relationships
among obscure neurodevelopmental disorders in Japan are lacking. Despite this, our findings imply that the presence of tic symptoms might indicate the presence of other obscure neurodevelopmental disorders.

Conclusions

Our results indicated an association between tics and DCD in early childhood. Furthermore, parents of preschool-aged children with tics or DCD symptoms tended to require more support. Therefore, more information on the relationship between tics and DCD may help parents address their children's specific needs.

Abbreviations

DCD: developmental coordination disorder; CLASP: Check List of obscure disabilities in Preschoolers; ALSPAC: Avon Longitudinal Study of Parents and Children Cohort; ADHD: attention-deficit/hyperactivity disorder.

Declarations

Ethics approval and consent to participate

The ethics committee of the University of Tokyo (IRB number: 11316) approved this study. All procedures involving human participants were completed following the ethical standards of the institutional and national research committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all participants included in this study.

Consent for publication

Not applicable

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to compromising individual privacy but are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that they have no competing interests.

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Authors’ contributions

MF, TK, MF, and YK designed the research. MF, TK, MF, NM, MN, RG, and YK contributed to the implementation of the research. TK and MN provided aid in the interpretations of the results. MF, TK, MF analyzed the data. MF and TK wrote the manuscript, and all authors provided critical feedback on the research. YK directed the project. All authors read and approved the final manuscript.

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References

8. Inagaki M. Kitsuon? Chikku? Yomikakishogai? Bukiyou? no kodomotachi he hoikujo youchien junkaisoudan de yakudatsu “kizukitotedate” no hintosyu. [For children who have stutter, tics, dyslexia and difficulty of coordination: A collection of suggestions for awareness and support that are useful in nursery schools, kindergartens and itinerant consultations.] Tokyo: Shindan to Chiryosya; 2020. (In Japanese, translated by the author of this article.)


