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# The Prevalence of Tic Disorders and Clinical Characteristics in Children

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## Abstract

**Background—**Prevalence is a simple statement about the frequency of a disease in the population. For many medical conditions, including Tourette syndrome, there are true cases that have not been previously diagnosed due to problems of access to appropriate clinical services. Therefore, to obtain a trustworthy estimate of prevalence, it is necessary to go beyond cases identified in clinical settings and evaluate community samples.

**Method—**We reviewed 11 community surveys in children with Tourette syndrome (TS) published since 2000. We also examined the frequency of co-occurring psychiatric conditions in community samples and large clinically-ascertained samples.

**Results—**Transient tics are relatively common affecting as many as 20% of school-age children. The 11 studies reviewed here offer a wide range of estimates from 2.6 to 38 per 1000 children for TS. Six studies provide estimates in a narrower range from 4.3 to 7.6 per 1000, but the confidence interval around this narrower range remains wide. Six studies provided results on chronic tic disorders ranging from 3 to 50 per 1000 for Chronic Motor Tic Disorder and 2.5 to 9.4 per 1000 for Chronic Vocal Tic Disorder. Community samples and large clinically-ascertained samples consistently show high rates of ADHD, disruptive behavior and anxiety disorders in children with TS.

**Conclusions—**The wide range of prevalence estimates for TS and chronic tic disorders is likely due to differences in sample size and assessment methods. The best estimate of prevalence for TS in school-age children is likely to fall between 4 and 8 cases per 1000. Clinical assessment of children with chronic tic disorders warrants examination of other problems such as ADHD, disruptive behavior and anxiety.

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Disclosures
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# INTRODUCTION

Epidemiology considers the prevalence of disease and compares the characteristics of those affected by the condition to those that are not affected. Characteristics that are associated with the disorder under study may prove to be factors that increase risk for the disorder upon further study. Prevalence, which is a simple statement about the frequency of the condition, is an essential metric for understanding the public health impact of the condition of interest. Other essential elements in the assessment of public health impact are the morbidity and mortality associated with the condition. For example, a highly prevalent condition associated with mild disability would have less public impact than a condition of similar frequency marked by greater disability. In chronic neuropsychiatric disorders such as Tourette syndrome (TS), the focus is on morbidity (i.e. disability) rather than mortality.

Obtaining a trustworthy estimate of prevalence of TS faces several challenges. First, there is no objective test for the diagnosis. Second, known and unknown biases can influence who comes to clinical attention. Therefore, counting clinical cases is not a valid approach for estimating prevalence because cases in the community that have not been diagnosed will be missed. Third, by extension, valid estimates of prevalence rely on community surveys. However, the identification and assessment of a large community sample to evaluate prevalence of TS is an expensive proposition. Fourth, TS resides on a spectrum from mild to severe. Separating affected individuals from unaffected may be difficult. For example, a child with a few motor and vocal tics that come and go and do not cause a problem may not be a case of TS. This issue here is whether impairment due to tics should be included in the case definition.

An additional benefit of community sampling is that associations of TS identified in these samples can confirm or contest the observed associations in clinical samples. For example, ADHD is a common co-occurring condition in clinical samples of children with TS. The strength of this association maybe exaggerated because children with TS and ADHD maybe more likely to come to clinical attention than children with TS alone. Results from community samples may help to settle the matter on the association of TS and ADHD. Finally, examination of the full TS spectrum in community samples may also uncover gaps in mental health services. It may be that even children with mild TS identified in a community survey have health service needs that are not being met. Once uncovered, appropriate steps can be taken to fill these gaps and reduce the disability that accompanies chronic tic disorders in children. The purpose of this paper is to describe the prevalence and associated disability of TS in children. To these ends, we review community surveys on the prevalence of TS and tic disorders in children since 2000. The review also examines the co-occurrence of other psychiatric disorders in community samples and selected large clinically-ascertained samples.

## Prevalence of Tic Disorders in Childhood

Isolated and transient tics are relatively common in school age children ranging from 11% to 20% (Cubo et al., 2011;Kurlan et al., 2001; Linazasoro et al., 2006; Snider et al., 2002) with a male to female ratios between 2 to 1 and 3.5 to 1. For most of these children, the tics were mild. Because most studies were cross-sectional, it is impossible to know how many children with transient tics would become cases of TS or chronic tic disorder over time. Because there are no diagnostic tests for tic disorders, the diagnosis relies on history and observation. The Diagnostic and Statistical Manual – Fifth Edition – revised (4 American Psychiatric Association, 2013) defines three tic disorders of interest here. Provisional Tic Disorder consists of motor tics, vocal tics or both lasting less than one year. Persistent Tic Disorder is defined by the presence of motor or vocal tics (but not both) lasting for more than a year. Tourette's Disorder (also known as Tourette syndrome) includes multiple motor tics and at least one vocal tic lasting for a more than a year. For each of these tic disorders, the diagnostic criteria specify the onset of tics before 18 years of age. Although tics may be chronic, tics often show a fluctuating course with a commonly observed tendency to rise and fall in frequency and intensity over time. Tics are suppressible - for at least brief periods of time. By age 10 years, most patients describe a warning or urge before some or all of their tics and momentary relief after the execution of the tic (Leckman, 2002).

Community surveys conducted in various countries over the past twenty years provide estimates of prevalence for TS ranging from 0.5 and 38 cases per 1000 children (reviews Scahill et al., 2005; Hirtz et al., 2007; Robertson, 2008). The lower bound of 0.5 per 1000 came from a survey of Israeli army inductees (Apter et al., 1993). This survey (not listed in Table 1) relied on self-reports from inductees in the Israeli army. The subjects were 16 to 18 years of age, when tics decline is a high percentage of cases (Bloch et al., 2006). It is likely that a parent interview focused on lifetime diagnosis would have identified more cases. The upper bound of 38 per 1,000 came from a study of 1255 school children (Kurlan et al, 2001). Similarly, Cubo and colleagues (2011) reported a prevalence of 36.4 per 1000. These two studies each used two approaches to define cases: TS with impairment and TS without impairment. Not surprisingly, when impairment was included in the case definition, the prevalence estimate went down to 8 per 1000 (Kurlan et al. 2001) and 16 per 1000 (Cubo et al. 2011). If these estimates at the extremes are disregarded, the resulting range of prevalence from studies conducted over the past decade is 1 to 16 per 1000. Although narrower than the extremely broad range of .5 to 38 per 1000, 1 to 16 per 1000 remains imprecise and insufficient to guide estimates of service needs for affected children. For example, the population of children between 6 and 18 years in the United States is roughly 50 million. If the prevalence is 1 per 1000, that would translate into 50,000 cases of TS nationwide. If the prevalence is 10 per 1000, the number of cases jumps to 500,000. The variation in estimates across these community studies is likely due to differences in sampling method, sample size, the rate of subject participation, assessment methods and diagnostic threshold used to define cases.

That the estimate of prevalence would be influenced by the symptom threshold used to define the disorder is clear. Simply stated, if children with mild forms of TS are defined as true cases, the prevalence will increase. If the severity threshold is set higher or includes a requirement of impairment, the prevalence will be lower. What may be less clear is the impact of case definition on associated features. For example, it may worthwhile to determine whether specific associations such as ADHD, anxiety or learning disability hold across the range of severity from mild to more extreme.

Using Medline, we searched with several key words (Tourette syndrome, tic disorders, epidemiology, prevalence) to identify prevalence studies published since 2000. To identify studies missed by our literature search, we also consulted recent reviews (Scahill et al., 2005; Hirtz et al., 2007; Robertson et al., 2008). Studies included in the review were those that provided a lifetime diagnosis of one or more tic disorders. We calculated the 95% confidence interval from the data provided in each report to allow comparison across studies (the legend in Table 1 shows the formula used).

Table 1 presents the lifetime prevalence estimates for TS (per 1000) from 11 community surveys from various countries. All but two of the studies in Table 1 used a multi-stage design. In the typical two- stage design, the sample is screened for tic disorders (Stage One) followed by a diagnostic assessment (Stage Two). The ideal screening procedure is simple and relatively inexpensive. At the same time, the screening procedure should not “miss” many cases (false negatives) and not have too many false positives (cases who screen positive but are not true cases). A screen that does not miss many cases has high sensitivity. On the other hand, a screen with a high percentage of false positives has low specificity. Low specificity is a problem because the more detailed and expensive diagnostic assessment would be conducted on a large number of unaffected subjects. No screen is perfect. But an efficient screen must somehow avoid missing cases (false negatives) and avoid the expense of conducting unnecessary diagnostic assessments on unaffected subjects (false positives). In a disorder such as TS, the screening test may be a brief set of questions to the parent about the presence of tics in the child. Available data suggest that parents and teachers do not agree and that teachers miss more cases of tic disorders than parents (Hornsey et al. 2001). To protect against the possibility of missing cases in the screening phase, a well-designed community survey includes evaluation of at least a subsample of randomly selected false negatives. In TS community surveys, however, this has rarely been done.

The wide range of sample sizes across studies presented in Table 1 is striking (range 435 to 9,712). For example, consider two imaginary studies each with a prevalence estimate of 7 cases of TS per 1000 children. A study with a sample size of 1000 would have a 95% confidence interval of , the other with 5000. If the observed prevalence was 7 cases per 1000 children, the 95% confidence interval for the sample size of 1000 would be 2-12 cases per 1000 compared to 6 to 8 cases per 1000 in a sample of 5000.

Studies with smaller sample sizes prompt obvious questions concerning the representativeness of the sample and, as noted, result in wide confidence interval. For example, Kadesjo & Gillberg (2000) estimated a prevalence of 11 per 1000, which is greater than the upper bound of the 95% confidence interval (CI) for all but three studies presented in the Table. The 95% CI of 4 to 27 per 1000 indicates that 4 per 1000 is equally plausible as 27 per 1000. The 4 per 1000 figure is consistent with findings of several studies presented in Table 1. By contrast, the upper limit of the confidence interval (27 per 1000) is exceeded by only two studies (Cubo et al. 2011; Kurlan et al. 2001). Taken together, these findings suggest that the estimate based on the sample of 435 is unstable and unreliable.

Although the study sample by Kurlan et al. (2001) is nearly 3 times larger than the report by Kadesjo and Gillberg (2000), only 11% of the sample participated in the survey. This low participation rate raises serious questions about the representativeness of the sample. Because the status of 89% of the sample is unknown, the validity of the survey results is highly questionable. As noted by the authors, it seems likely that subjects affected by tics (even those who had not been previously diagnosed) were more likely to participate. If so, the direction of the bias inflates the estimate of prevalence.

The study by Hornsey and colleagues (2001) has confidence interval that includes the prevalence estimate reported by Kadesjo and Gillberg (2000). These investigators estimated TS prevalence at 7.6 per 1000 (95% confidence interval = 2 to 13.2 per 1000). The survey sample began with 1012 potential subjects. Teachers provided screening results on 85% of the Stage One sample. Parents completed the screening questionnaire on 57% of subjects (574 of 1012). Parent and teacher agreement on screen positive subjects was poor. Less than 10% of the 189 screen positives were classified as screen positives by parents and teachers. Despite the higher participation rate by teachers, parents identified two thirds of the screen positive cases at Stage One. At Stage Two, only 107 of the 189 subjects who screened positive in Stage One participated in the diagnostic assessment. Using rigorous assessment procedures, the investigators identified 7 cases of TS. Nonetheless, it is difficult to interpret the findings of this study due to the nagging problem of non-participation at each stage of the survey. In partial recognition of the problem, the authors surprisingly recommended an upward adjustment of the observed prevalence from 7.6 to 18.5 cases per 1000. This adjustment was based on the assumption that 10 addition cases of TS would have been identified among the screen positives who did not participate in the diagnostic assessment. This is hazardous speculation. It seems equally or more plausible that parents concerned about a possible tic disorder in their child would have been more likely to participate in the study. If so, the assumption of 10 additional cases among non-participating screen positives would not hold. Moreover, the estimate of 18.5 cases per 1000 is not consistent with most prevalence studies before or since.

Cubo and colleagues (2011) invited 1,047 children (5 to 17 years of age) and families to participate in the survey. The sample was drawn from randomly selected schools in urban and rural areas in Spain. The screening questionnaires were obtained from parents and teachers on 741 (71% of original sample). Screening also included direct observation in the classroom. One hundred seventy nine (179) children screened positive for tics. A sample of 145 children who screened negative was identified as a control sample. The diagnosis was based on a semi-structured telephone interview. A neurologist evaluated subjects classified with TS. The study estimated a prevalence of TS with impairment at 16.1 per 1000 and 36.4 per 1000 if the impairment criterion was not included in the case definition. The prevalence estimate for TS without impairment is similar to the figure reported by Kurlan et al. (2001). However, the prevalence of TS without impairment is two times larger than the 8 per 1000 reported by Kurlan et al. (2001). The sample size of 741 in the study by Cubo et al. (2011) is larger than the sample ascertained by Kadesjo & Gillberg (2000), but it is smaller than most studies listed in Table 1. It may well be that a separate sample of 750 children would provide different results.

Thus, the validity of these three studies with estimates 8 to 16 per 1000 are open to question due to small sample size (Cubo et al., 2011; Kadesjo and Gillberg, 2000) and low participation rate (Kurlan et al., 2001).

Six studies listed in Table 1 provided prevalence estimates of TS between 4 and 8 per 1000 children. Four reports fall between 5 and 6 per 1000 (Khalifa & von Knorring, 2003; Kraft et al, 2012; Stefanoff et al., 2008; Wang & Kuo, 2003). As shown in Table 1, sample sizes for these four surveys ranged from 2000 to just under 6000. The participation rate at Stage One: Khalifa & von Knorring = 65.7%; Kraft et al. = 72.5%; Stefanoff et al. = 88.5%; Wang & Kuo – not reported. All four studies used broad screening with follow-up assessment of screen positives, though assessment methods varied. The 95% confidence interval across the four studies is 3.6 to 9.4. Taken together, the findings from these studies suggest that the prevalence of TS is 6 per 1000 (95% confidence interval of 4 to 9 cases per 1000) in children between 6 and 15 years of age.

## Gender Distribution of TS

Reports from clinical samples show male to female ratios of TS between 3 or 4 to 1 (Mol Debes et al. 2008; Centers for Disease Control, 2009). Community samples provide greater variation: 1 to 1 (Peterson et al., 2001), 4 to 1 (Kraft et al., 2012), 9 to 1 (Khalifa and von Knorring, 2003) and 10 to 1 (15 Jin et al., 2005). Few studies provide estimates of male to female ratios for Chronic Motor or Chronic Vocal Tic Disorder.

## Prevalence of Transient Tic Disorder and Chronic Tic Disorders

Table 2 presents the prevalence estimates for Transient Tic Disorder (TTD), Chronic Motor Tic Disorder (CMT) and Chronic Vocal Tic Disorder (CVT) available in six reports. Of the 11 studies presented in Table 1, five reports did not provide usable estimates on these disorders (Kadesjo & Gillberg, 2000, Peterson et al., 2001; Hornsey et al., 2001, Wang & Kuo, 2003, Jin et al., 2005). For example, Peterson et al. (2001) estimated a prevalence of 22 per 1000 for motor tics and 2.6 per 1000 for vocal tics. in a sample of 776 community subjects between 9 and 20 years of age, However, the investigators did not report on duration of tics making it difficult to differentiate between transient and chronic tic disorders.

The table shows a range of estimates across Transient, Chronic Motor and Chronic Vocal Tic Disorders. Khalifa and von Knorring (2003) reported a high rate of Transient Tic Disorder compared to the other studies presented in Table 2. By contrast, Stefanoff et al. (2008) and Cubo et al., 2011 reported prevalences of Chronic Motor Tic Disorder of 22.2 and 50 per 1000, respectively. These estimates are considerably higher than the 6 to 8 cases per 1000 estimated by Khalifa and von Knorring (2003), Scahill et al. (2005), Kraft et al. (2012). Given that the differential diagnosis of Transient Tic Disorder and Chronic Motor Tic Disorder turns on the duration of the tics, the variation in the estimated prevalence in these conditions may reflect differences in the methods used to elicit lifetime history of tics or the age of the sample at the time of assessment. For example, in the study by Kraft et al. (2012) there was a lag between the screening and the diagnostic interview, which may have interfered with recall of transient tics in the diagnostic interview.

Despite similar sample sizes, Kurlan et al. (2001) and Stefanoff et al. (2008) reported a large difference in the estimated prevalence of TS (38 per 1000 versus 5.7 per 1000 with no overlap in the confidence intervals (see Table 1). As shown in Table 2, these two surveys provided remarkably similar estimates for Transient Tic Disorder, but again remarkably different estimates of Chronic Motor Tic Disorder (CMTD) with non-overlapping confidence intervals. Although both studies used in-person interviews, these differences reveal the challenges of defining diagnostic boundaries across the range of tic disorders. For example, a 16-year-old with remitted tics and a history of mild tics may not present a convincing history of chronic tic disorder and be classified as a case of Transient Tic Disorder in one study. Use of a more detailed interview, however, may portray more information about the duration of tics and the same subject would be classified as a case of CMTD in another study. Variations on this theme could also play out with TS versus CMTD – incomplete or unconvincing description of vocal tics could result in a diagnosis of CMTD by default. The detection of any tics in a community survey forces the classification into one and only one diagnostic category. Kurlan et al. (2001) identified 73 of 1255 children with a tic disorder (38 with TS, 4 CMTD, 6 CVTD and 25 Transient Tic Disorder). Stefanoff and colleagues (2008) identified 77 of 1579 children with a tic disorder (9 with TS, 35 with CMTD, 4 with CVTD and 29 with Transient Tic Disorder). The bias caused by the low participation rate in the study by Kurlan and colleagues (2001) may have enriched the number of subjects with TS versus CMTD – but this seems unlikely to explain the large difference in identified cases of TS across these two studies. Regional differences also seem unlikely to explain the different distributions of tic disorders in these two studies. These differences in the distribution of cases may be due to differences in how historical data were collected and interpreted.

Although results from currently available studies on the prevalence of TTD, CMTD and CMVT are not definitive, tentative conclusions are possible. As shown in Table 2, the confidence intervals for TTD are extremely wide suggesting that it is premature to offer a precise estimate. Based on available data, the TTD prevalence probably falls between 8 and 40 cases per 1000. For CMTD, if the estimate by Stefanoff et al. (2008) and Cubo et al. (2011) are regarded as outliers, the range of 3 to 8 cases per 1000 appears plausible. Chronic Vocal Tic Disorder may be as high as 8 cases per 1000.

## Associated Problems

The higher than expected rates of ADHD, disruptive behavioral problems, Obsessive-compulsive disorder (OCD) and anxiety in children with TS have been observed for many years (Leckman, 2002). There is ongoing debate whether these conditions are part of TS, due the burden of chronic illness, or simply unfortunate coincidence (Sukhodolsky et al., 2003). The early reports on concomitant disorders in samples of children with TS came from specialized clinical centers and are likely to be biased. (Spect et al., 2011). To examine the frequency of co-occurring problems, we begin with community samples. As shown in Table 1, few community surveys identified more than 20 cases of TS and only two studies applied systematic diagnostic assessment methods for other psychiatric disorders in identified cases of TS (Kurlan et al., 2002; Khalifa and von Knorring, 2003). Therefore, in order to evaluate the impact of co- existing problems such as ADHD, disruptive behavior, OCD and anxiety on children with TS, we also examined large, clinically-ascertained samples.

**Community Samples—**Lanzi and colleagues (2004) surveyed 2,300 children (ages 5 to 12 years). This report was not included in Tables 1 or 2 because the case definition of tic disorders was not clearly stated. Following training sessions with teachers on tics and the definition of tic disorders, teachers identified a total of 2.9% of the sample with a probable tic disorder (2.0% with motor tics; 0.26% with vocal tics and 0.68% with motor and vocal tics). This classification, which was based on observation by teachers, did not include assessment about the onset and duration of tics. Thus, differential diagnosis was not possible. Of the 68 children identified with a probable tic disorder, teachers reported that school performance was classified as unaffected in 40 subjects (XX%); mildly impaired in16 subjects (XX%) and severely impaired in 12 subjects. Whether this impairment was related to tic severity, a co- occurring problem (e.g., ADHD) or both was not reported.

Gadow and colleagues (2002) collected teacher-rated checklists on a range of psychiatric symptoms in 3,006 children (age 3 to 18 years). Using cut-off scores on a DSM-IV-referenced checklist, the sample was divided into four groups: tics alone; ADHD alone, tics and ADHD and unaffected controls. The study did not classify children with tics into specific tic disorders. Therefore, it does not provide a prevalence estimate for tic disorders.. Using the response “occurs often” or “very often” as a “yes” response for motor or vocal tics (or both), the prevalence of tics was 8.2% (246 of 3006) with a 3 to 1 male to female ratio. As expected, the prevalence of current tics went down with age. Teachers rated just over half (128 of 246) of the children with tics in the clinical range for ADHD. By contrast, only 7.3% of children without tics were rated in the clinical range on ADHD. This observation suggests that children with tics are at a much higher risk for ADHD than children without tics.

Kurlan and colleagues (2002) and Khalifa and von Knorring (2006) presented findings on the co-occurrence of TS and psychiatric disorders in separate reports from their original prevalence. As noted previously, the dramatically low participation rate in the Kurlan et al. (2001) study suggests that an estimated prevalence questionable that is likely to be biased toward a higher prevalence for TS. Nonetheless, the assessment methods used in the study were rigorous and comprehensive. Khalifa and von Knorring (2006) also used rigorous assessment methods. Table 3 summarizes the rate of co- occurring disorders in these two studies. Based on these results, ADHD occurs in a third to two-thirds of children with TS, OCD occurs less frequently, and less is known about the co-occurrence of non-OCD anxiety disorders.

**Clinical Samples—**To explore the impact of co-existing psychiatric disorders in children with TS, we also evaluated large samples from specialized clinics and patient registries. Over the past decade, there have been several descriptive reports on case series from specialty clinics (Specht et al. 2011; Sukhodolsky et al. 2003). The rates of concomitant psychiatric conditions in clinically ascertained samples vary according to source of the sample and assessment methods. ADHD in clinical samples of children with TS has been observed in the range of 26% to 60% (Mol Debes et al., 2008; Specht et al. 2011;

Sukhodolsky et al., 2003). The rates of OCD and other anxiety disorders in these same samples range from 20-30% in youth with TS. Less is known about the co-occurrence of mood disorders.

The Centers for Disease Control and Prevention (2009), conducted a national telephone survey of 64,000 randomly selected households with children between 6 and 17 years of age. Parents were asked about the child's prior history of medical conditions (diabetes, asthma, seizures), psychiatric disorders (TS, ADHD, depression, autism), as well as emotional and behavioral problems (anxiety and disruptive behavior). The frequency of a prior diagnosis of TS was 3 children per 1,000 – resulting in an estimate of 148,000 cases nationwide. The male:female ratio was 3 to 1. Compared to data presented in Table 1, this is lower than the likely prevalence of 5 to 6 per 1,000 children, suggesting that as many as an additional 3 cases per 1000 remain undetected. According to the parents, most cases were mild. In the subgroup of adolescents between ages 14 and 17 years, less than half were described as currently affected, suggesting that the tics had declined or remitted altogether in these adolescents. There were significant differences in the rate of identified cases across racial and ethnic groups. In non-Hispanic white children, the identified prevalence was 3.9 per 1000 compared to 1.6 and 1.5 per 1000 for Hispanic and black children, respectively. In the sample as a whole, parents reported that 64% of the children with TS also had a diagnosis of ADHD; 43% had a history of disruptive behavior and 40% had a history of anxiety problems. These rates of coexisting problems were significantly higher than the population of children without a history of TS.

A second report from the national survey conducted by the CDC focused on care coordination (Bitsko et al., 2012). After parents reported on the child's medical or psychiatric diagnosis, they answered questions about health service needs and utilization and overall functioning. Children with TS were compared on these characteristics to children with asthma and children without TS or asthma (Bitsko et al., 2012). Based on parental report, just over two thirds of children with TS had a history of at least one additional mental disorder compared to 23% children with asthma and 11% for those without TS or asthma. More than half (57%) of children with TS received medication treatment for co-occurring emotional or behavioral problems. By contrast, parents reported a history of treatment with psychotropic medication in 15% of children with asthma and 7% for those without TS or asthma. On overall health status, 14% of children with TS were rated fair or poor; 11% and 3% of children with asthma and those unaffected by asthma or TS were rated fair or poor, respectively. Collectively, the data from these CDC reports indicate that a substantial number of children with TS are missed suggesting that improved recognition is needed (Centers for Disease Control, 2009). The gap between identified cases and expected cases based on the prevalence of 6 per 1000 appears to be greater in Hispanic and African-American children. Finally, care coordination for children diagnosed with TS appears less than adequate (Bitsko et al. 2012).

Patient registries are another source for examination of co-occurring psychiatric disorders in patients with TS. Because patient registries can provide data on large samples of children pooled from multiple clinics, they can reduce the referral biases that are present in single clinics. Roessner et al. (2007) examined data on 5060 youth with TS (age rage 5-17 years) collected from 65 sites in 22 countries. Clinicians at participating sites completed a brief, but common, data entry form that included questions about TS and other psychiatric diagnoses. The rates of ADHD and OCD in this sample were 61% and 19%, respectively, which are consistent with figures from previous clinical reports (Mol Debes et al., 2008; Sukhodolsky et al., 2003).

## CONCLUSION

Tics are common in childhood. In many cases, tics are isolated and transient. The best estimate for the prevalence of TS in school-age children is 6 per 1000 (range 4 and 9 cases per 1000). The prevalence of 6 cases per 1000 results in a count of 300,000 cases of TS among school-age children in the United States. The prevalence of Chronic Motor Tic Disorder falls in the range of 3 to 8 per 1000. The estimates of prevalence for Chronic Vocal Tic Disorder in school-age children are less stable and more study is needed. Most cases of chronic tic disorders are mild and tics tend to decline in the late teen years. Nonetheless, children with chronic tic disorders, even those with mild conditions, have a higher likelihood of other problems such as ADHD, disruptive behavior and anxiety. Children with tics alone, regardless of severity, appear to have only slightly greater risk for disability than children in the general population. Given the wide range of tic severity in children with chronic tic disorders, appropriate treatment properly targets the primary problem. Thus, clinical assessment of children with chronic tic disorders warrants examination of other problems such as ADHD, disruptive behavior and anxiety. In the US, recognition of TS in children, especially minority children, is inadequate. Although improved recognition is essential, recognition alone does not ensure effective care coordination and application of evidence-based treatment. Therefore, effective communication between specialists and primary care providers and dissemination of evidenced-based treatments are also essential.

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## Table 1

Prevalence of Tourette Syndrome in the Pediatric Population in Studies Conducted between 2000-2012

| Author/ Year | N | Age | Country | Source of Sample | Diagnostic Assessment | Diagnostic Criteria | # of cases | Prevalence (per 1000) | 95% CI (per 1000)[a] |
|---|---|---|---|---|---|---|---|---|---|
| Kadesjo & Gillberg, 2000 | 435 | 10-11 | Sweden | Birth cohort | In person interview with parent, child & teacher | DSM-IV | 5 | 11 | 4-27 |
| Kurlan et al., 2001 | 1255 | 8.5-17.5 | United States | Randomly Selected Schools | In person structured interview with parent & child | DSM-IV[b] | 48 | 38[c] | 28.5 – 49.9[b],[c] |
| Peterson et al., 2001 | 776 | 9-20 | United State | Community cohort | In person structured interview with parent & child | DSM-III | 2 | 2.6 | 0-6.2 |
| Hornsey et al., 2001 | 918 | 13-14 | England | Six Schools – single mainstream class | In person structured interview with parent & child | DSM-III-R | 7 | 7.6 | 2-13.2 |
| Khalifa & von Knorring, 2003 | 4479 | 7-15 | Sweden | Community; all available in township | In person structured interview with parent & child | DSM-IV | 25 | 5.6 | 3.4-7.7 |
| Wang & Kuo, 2003 | 2000 | 6-12 | Taiwan | School | In person structured interview with parent & child | Tourette Syndrome Study Group | 11 | 5.5 | 2.3-8.7 |
| Jin et al., 2005 | 9742 | 7-16 | China | Community | In person interview parent& child | Chinese Diagnostic Standard for Psychiatric Disorders (3rd edition) | 42 | 4.3 | 3.0-5.6 |
| Scahill et al., 2006 [e] | 910 | 6-12 | United State | Community | In person structured parent interview | DSM-IV | 3 | 3.3 | 0 –7 |
| Stefanoff et al., 2008 | 1579 | 12-15 | Poland | School | In person interview parent & child | ICD-10 | 9 | 5.7 | 2.0-9.4 |
| Cubo et al., 2011 | 741 | 5-17 | Spain | Regional community sample | Semi-structured interview via telephone | DSM-IV | 27 | 36.4 | 22.9-49.8[b],[d] |
| Kraft et al. (2012) | 5974 | 9-15 | Denmark | Birth cohort | Structured parent interview via telephone | DSM-IV | 33 | 5.5 | 3.7-7.3 |

A similar table appeared in Tourette Syndrome, D. Martino and JF Leckman (eds); Oxford, New York, 2013

[a] = Calculated from reported prevalence data and sample size 95% CI = estimate ± 1.96 X square root of pq/n (where p=prevalence, q=1-p, n= sample size)

[b] = did not use the “impairment” criterion

[c] =Regular Education classes, and additional 24 cases were identified from Special Education classes

[d] = Regular Education classes, and additional 7 cases were identified from Special Education classes

[e] =screening was for behavioral problems, not tics specifically

## Table 2

Prevalence of Transient, Chronic Motor and Chronic Vocal Tic Disorder

| Author/Year | Transient Tic Disorder | | | Chronic Motor Tic Disorder | | | Chronic Vocal Tic Disorder | | |
|---|---|---|---|---|---|---|---|---|---|
| | **# of cases** | **Prevalence (per 1000)** | **95% CI (per 1000)** | **# of cases** | **Prevalence (per 1000)** | **95% CI (per 1,000)** | **# of cases** | **Prevalence (per 1000)** | **95% CI (per 1,000)** |
| Kurlan et al., 2001 | 25[a] | 20 | 12.3-27.7 [a] | 4[a] | 3 | 0-6.3 | 6[a] | 5 | 1.1-8.9 |
| Khalifa and von Knorring, 2003 | 214 | 47.7 | 41.5-53.9 | 34 | 7.6 | 5.1-10.1 | 24 | 5.3 | 3.3-7.5 |
| Scahill et al., 2006 | 7 | 7.7 | 2.0-13.4 | 7 | 7.7 | 2.0-13.4 | 4 | 4.4 | 0.1-8.7 |
| Stefanoff et al., 2008 | 29 | 18.4 | 11.8-25.0 | 35 | 22.2 | 14.9-29.5 | 4 | 2.5 | 0-5.0 |
| Cubo et al., 2011 | 20 | 27 | 15.3-38.7 | 37 | 50 | 34.3-66.0 | 7 | 9.4 | 2.5-16.3[b] |
| Tabori-Kraft et al., 2012 | 16 | 3 | 1.6-4.4 | 37 | 6 | 4.0-8.0 | NR | NR | NR |

[a] =estimated from Table 4 in the original report; NR= not reported. A similar table appeared in Tourette Syndrome, D. Martino and JF Leckman (eds); Oxford, New York, 2013

## Table 3

Prevalence of Co-Occurring Psychiatric Conditions in Community Samples of children with TS

| **Author/Year** | **N of cases** | **Age Range** | **ADHD** | **OCD** | **Disruptive Behavior** | **OTHER ANX** |
|---|---|---|---|---|---|---|
| Kurlan et al., 2002 | 72[a] | 9-17 | | | | |
| Khalifa and von Knorring, 2006 | 25 | 7-15 | 68% | 16% . | 4% | N.R. |

[a] = the number of cases shown in Table 1 are those identified in regular education classes only.