




ORIGINAL ARTICLE

Rapid onset functional tic-like behaviours in children and adolescents during COVID-19: Clinical features, assessment and biopsychosocial treatment approach

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Aim: To report the prevalence and clinical characteristics of children with rapid onset functional tic-like behaviours during the COVID-19 pandemic.

Methods: Single centre, retrospective cohort study of children (<18 years) referred to the tic clinic from January 2018 to July 2021. We calculate the prevalence of newly diagnosed functional tics, and compare the clinical features to chronic tic disorder/Tourette syndrome (CTD/TS).

Results: A total of 185 new patients were referred to the tic clinic between 2018 and 2021. There was a significant increase in the percentage of functional tics in 2020 and 2021 (2% in 2018, 5.6% in 2019, 10.6% in 2020 and 36% in 2021). Differences between functional tics ($n = 22$) and CTD/TS ($n = 163$) include female predominance (100 vs. 28%, $P < 0.0001$), later age of onset (mean age 13.8 vs. 6.8 years, $P < 0.0001$) and higher rates of anxiety/depression (95 vs. 41%, $P < 0.0001$). The functional tic group were more likely to present with coprolalia-like behaviours (77 vs. 10%, $P < 0.0001$), complex phrases (45 vs. 0.6%, $P < 0.0001$), copropraxia (45 vs. 2%, $P < 0.0001$), self-injury (50 vs. 4%, $P < 0.0001$), hospitalisation/emergency visits (36 vs. 2%, $P < 0.0001$) and school absenteeism (56 vs. 7%, $P < 0.0001$). A total of 18.2% of patients with functional tics reported preceding exposure to social media content involving tics.

Conclusions: There is an increase in adolescent females presenting with rapid onset functional tic-like behaviours during the COVID-19 pandemic. We highlight differences in clinical features between the functional tic group and CTD/TS to aid diagnosis and management in the community. Based on our findings, we propose a mixed model of neuropsychiatric vulnerability and social media contagion in this group of adolescents with functional tics.

Key words: general paediatrics; neurology; psychiatry/mental health.

What is already known on this topic

1 During the COVID-19 pandemic, there has been an increase in young people presenting with stress-related symptoms including anxiety, depression, self-harm, suicide ideation, suicide attempts, and complex tic-like behaviours.

What this paper adds

- 1 There is an increase in acute explosive-onset functional tics in adolescent females during the COVID-19 pandemic.
- 2 Underlying undiagnosed or untreated psychiatric disorders, coprolalia-like behaviours, copropraxia, self-harm, hospitalisations and school absenteeism, are common in adolescents with functional tics.
- 3 A biopsychosocial approach – beginning with body-based regulation strategies – as used in other paediatric neurological disorders, may be helpful in enhancing neurophysiological regulation, managing the focus of attention and settling functional tic-like symptoms.

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The COVID-19 pandemic has resulted in fear of illness to oneself or loved ones, in addition to a sudden restriction of social connection. This coincided with an epidemic of young people presenting with a range of stress-related symptoms including anxiety, depression, self-harm, suicide ideation, suicide attempts and complex tic-like behaviours.^{1,2}

In recent months, international paediatric neurology and psychiatric communities noticed an increase in adolescent females presenting with sudden onset functional tic-like behaviours

(a subtype of functional neurological disorder, FND).³ The tic-like movements can be difficult to discriminate from tics seen in the neurodevelopmental disorder, Tourette syndrome, resulting in significant challenges in diagnosis and treatments. Many of the functional tic sufferers describe following ‘influencers’ on social media with tic-like behaviours, suggesting ‘disease modelling’ is occurring due to social media contagion.⁴

In this study, we investigate the increase of newly diagnosed functional tic disorders in our tic clinic over the last 3 years. We determine the differences in clinical characteristics between functional tic-like behaviours and Tourette syndrome. Lastly, we describe a biopsychosocial intervention that focuses on a stress-system approach, involving the use of body-oriented psychotherapies to enhance neurophysiological regulation, manage the focus of attention and settle functional tic-like symptoms.

Methods

Phenotyping children with tics referred to tic clinic in 2018–2021

We collated data involving all new patients (<18 years old) referred with tics to the tic clinic at Children’s Hospital at

Westmead from 2018 to July 2021 (seen by RCD). We retrospectively collected clinical data through clinic letters and video recordings including their demographics, first-degree family and personal history of neurodevelopmental (chronic tic disorder/Tourette syndrome – CTD/TS, autism spectrum disorder – ASD, attention deficit/hyperactivity disorder) or psychiatric disorders (obsessive compulsive disorder, anxiety and depression). We recorded presence of copropraxia, complex words/phrases, coprolalia/coprolalia-like behaviours, self-harm, hospitalisation/emergency visits and school absenteeism. These features are standardised components of our semi-structured new patient interview, and therefore the presence or absence of these features in clinic notes can be considered valid, despite the retrospective data capture. We did not include urge and suggestibility, as these were not assessed in a standardised manner.

Clinical description of patients with functional tics and comparison with CTD/TS

Two clinicians (RCD, VXH) recorded the phenomenology of the movements and sounds through physical examination and video recordings of patients with functional tics. In the functional tic

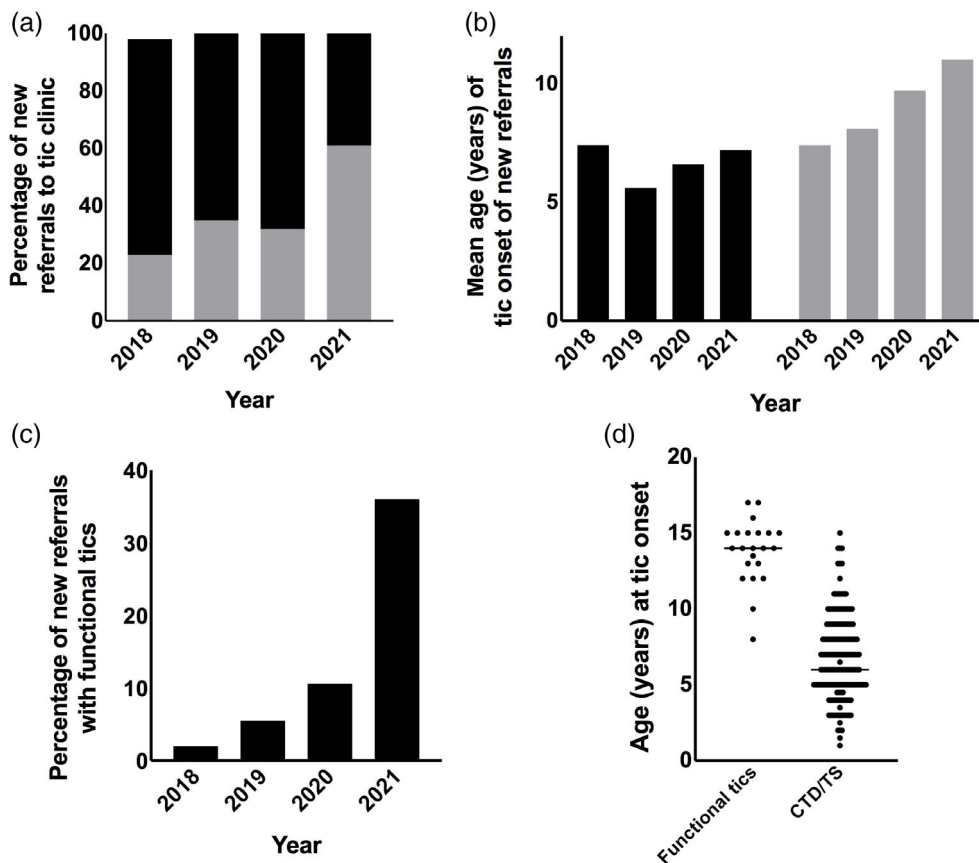


Fig. 1 Trend of new patient assessments at the tic clinic in 2018–2021 and trend of children with functional tic disorders seen at the tic clinic in 2018–2021. (a) Proportion of female and male patients seen in the tic clinic in 2018–2021, shows increasing proportion of females over time. (b) Mean age of patients referred to tic clinic in 2018–2021, shows increasing age over time in females. (c) Percentage of patients with rapid onset functional tic-like behaviours referred to tic clinic shows increasing percentage over time. (d) Age of patients with rapid onset functional tic-like behaviours versus patients with chronic tic disorder/Tourette syndrome (CTD/TS) shows the functional tic patients are older. (■), Male; (▒), female.

Table 1 Differences in demographics, family/proband history of neurodevelopmental and psychiatric disorders, and clinical features between functional tics and the chronic tic disorder/Tourette syndrome (CTD/TS) group

	Functional tics (<i>n</i> = 22), <i>n</i> (%)	CTD/TS (<i>n</i> = 163), <i>n</i> (%)	<i>P</i> value
Demographics			
Female	22 (100)	46 (28)	<0.0001
Male	0 (0)	117 (72)	
Mean age at tic onset	13.8	6.8	<0.0001
First-degree family history			
CTD/TS	3 (14)	34 (21)	0.58
ASD	4 (18)	13 (8)	0.23
ADHD	6 (27)	29 (18)	0.38
OCD	1 (5)	15 (9)	0.7
Anxiety/Depression	11 (50)	65 (40)	0.5
Proband history			
ASD	2 (9)	27 (17)	0.53
ADHD	3 (14)	61 (37)	0.03
OCD	5 (23)	27 (17)	0.55
Anxiety/Depression	21 (95)	67 (41)	<0.0001
Clinical features			
Coprolalia	17 (77)	16 (10)	<0.0001
Complex words/phrases	10 (45)	1 (0.6)	<0.0001
Copropaxia-like behaviours	10 (45)	4 (2)	<0.0001
Self-injury	11 (50)	6 (4)	<0.0001
Hospitalisation/ED	8 (36)	3 (2)	<0.0001
School absentee	12 (55)	11 (7)	<0.0001

ADHD, attention-deficit/hyperactivity disorder; ASD, autism spectrum disorder; ED, emergency department; OCD, obsessive compulsive disorder.

group, we also recorded previous/current medication, psychological therapies received, prescribed by community paediatrics or by our clinic, as well as treatment outcomes at last follow-up. Written consent was obtained from individuals or legal guardians of all functional tic patients, for their clinical data to be included into our Neuroconnect database, according to hospital ethics guidelines (2020/ETH03064). We compared the prevalence and phenomenology of functional tics versus CTD/TS, referred to the tic clinic between pre-COVID-19 (2018–2019) and during the COVID-19 pandemic (2020–ongoing).

Statistical analysis

We performed statistical analysis using GraphPad Prism v8.2.0, for Windows (GraphPad Software, San Diego, CA, USA) and compared the functional tic and CTD/TS group using *t*-tests and Mann–Whitney *U*-tests.

Results

Change in demographics and phenomenology of tic patients referred to the tic clinic between 2018 and 2021

Functional tics were identified in 22 children, and CTD/TS diagnosed in the other 163 children. The following clinical descriptions are based on 185 new patient referrals (117 males and 68 females, mean age 10.9 years, aged 4–17) to the tic clinic in

2018–2021. The number of new assessments was stable across the years (2018 (*n* = 48), 2019 (*n* = 54), 2020 (*n* = 47) and 2021 (January to July, *n* = 36)).

There was a shift in demographics in new assessments by the tic clinic in 2020 and 2021 (Fig. 1a,b). Firstly, there was an increased proportion of females seen at the clinic in 2021 (25–32% females in 2018–2020 and 61% females in 2021, Fig. 1a). Secondly, the mean age of tic onset in females increased over the years (mean age of tic onset 6 years in 2018, 7 years in 2019, 11 years in 2020 and 12 years in 2021), whereas the mean age of tic onset in males remained stable at 5.6–7.4 years (Fig. 1b).

There was a significant increase in the prevalence of functional tic-like diagnoses in 2020–2021 (2% in 2018, 5.6% in 2019, 10.6% in 2020 and 36% in 2021, Fig. 1c).

Demographics, family and proband history of neurodevelopmental or psychiatric disorders

Significant differences between functional tics (*n* = 22) and CTD/TS (*n* = 163) include female predominance (100 vs. 28%, *P* < 0.0001) and later onset of tic-like behaviours (mean age onset 13.8 vs. 6.8 years, *P* < 0.0001, Fig. 1d) (Table 1). There was no significant difference between the functional tic group and CTD/TS in terms of family history of neurodevelopmental or psychiatric disorders (Table 1).

Children with functional tics compared to CTD/TS were more likely to have preceding anxiety or depression (95 vs. 41%,

Table 2 A list of common differences between Tourette syndrome and functional tic disorder

Chronic tic disorder/Tourette syndrome	Acute onset functional tic disorder
Pre-school males	Adolescent females
Gradual onset	Acute explosive onset
Half have attention deficit/hyperactivity disorder	Most have underlying anxiety, depression
Simple tics common, complex tics rare	Complex tic-like movements
Coprolalia, copropraxia rare	Coprolalia, copropraxia (including complex words/phrases) common
Prolonged tics rare	'Tic-like' attacks manifesting as prolonged periods of dysregulated movements or panic attacks
Premonitory urge including tingling sensation or pressure	Physical symptoms of anxiety/arousal prior to tics including sweaty palms, palpitations, tummy ache
Self-injury and aggression rare	Self-injury and aggression common
Mild to moderate impact on functioning, typically does not affect school attendance	Significant impacts on school and family functioning, school absenteeism common
Does not require any investigations	Severity warrants hospitalisation, investigations or inpatient rehabilitation in some cases
Majority do not need treatment, severe cases typically respond to dopaminergic agents	Refractory to dopaminergic agents, may respond to multimodal (biological, social, psychological) treatment
Tics peak at 10–12 years of age and improve towards 20s	Prognosis unpredictable

$P < 0.0001$), whereas attention deficit/hyperactivity disorder was more prevalent in the CTD/TS group (14 vs. 37%, $P < 0.03$) (Table 1).

Clinical features of functional tics versus CTD/TS

The functional tic group compared to CTD/TS were more likely to present with coprolalia-like behaviours (77 vs. 10%, $P < 0.0001$), complex phrases (45 vs. 0.6%, $P < 0.0001$), copropraxia-like behaviour (45 vs. 2%, $P < 0.0001$), self-injury (50 vs. 4%, $P < 0.0001$), hospitalisation/emergency visits (36 vs. 2%, $P < 0.0001$) and school absenteeism (55 vs. 7%, $P < 0.0001$) (Table 1).

Predisposing factors and other clinical characteristics of children with functional tics

Twenty-two patients with functional tic-like behaviours are described in Table S1 (Supporting Information). Prior CTD/TS was noted in 27%. Precipitating acute and chronic stressors were

present in 81.8% of the patients (Table S1, Supporting Information). A subgroup of patients (18.2%) reported exposure to social media content involving tics prior to onset of functional tics. Other associated psychiatric features co-occurring with the tic-like behaviours included suicidal ideation (31.8%), frequent anxiety/panic attacks (22.7%) and auditory and/or visual hallucinations (13.6%).

In patients with functional tics, common stereotypical repetitive movements include head jerks/nods (77.3%), eye blinking/facial twitching (31.8%) and shoulder shrugging (22.7%). Atypical motor tic-like features include copropraxia-like behaviours (36.3%), tongue thrusting (13.6%) and thumping of the chest (9%). The movements were highly associated with self-injury or aggression towards others (36.3%) and prolonged 'tic-like attacks' (36.3%). Vocal tic-like features included stereotypical repetitive sounds include coprolalia-like behaviours or complex words and phrases (72.7%) and high-pitched whistling (31.8%). A few patients with functional tics used the same words including 'beetroot', 'beans', 'peppa pig' and 'Gordon Ramsay', which were not used in patients with CTD/TS.

Treatments used and treatment outcomes in children with functional tics

Patients tried one (18.2%), two (27.2%), three or more (31.8%) medications including combinations of alpha-2 adrenergic agonist, antidepressants or antipsychotic agents (Table S1, Supporting Information). A significant number of patients (27.2%) were referred to a specialised programme for management of FND, which is now overwhelmed by the high number of referrals in a short period of time.⁵ The follow-up time for our patients with functional tic-like behaviours ranged from 2 months to 3 years. At last follow-up, the majority of patients had persistent tic-like behaviours (68.2%), some had partial improvements in functional tics (18.2%) and only a minority of patients (13.6%) had complete resolution of tic-like behaviours (duration of tic-like behaviours 6–9 months in the three patients with full recovery). We were not able to determine response to treatments and predictors of good or poor outcomes as many patients were in the early stages of medical and psychological therapies.

Discussion

During the COVID-19 pandemic, we observed a rise in children presenting to our centre with rapid onset functional tic-like behaviours. Although we cannot establish a causal relationship between the COVID-19 pandemic and functional tic-like behaviours in children, we hypothesise that the significant stress and uncertainty surrounding this global pandemic played a significant role in the increased prevalence. Other contributing factors include pre-existing family conflict, financial strain, academic difficulties and peer difficulties, all exacerbated by repeated lockdowns. Other potential stressors unique to our local setting includes the bush fires (2019–2020) and flash floods affecting Australia (February 2020). In addition, in recent years, tics have been made 'popular' and 'infamous' by certain TikTok stars (e.g. thistrippyhippie (<https://www.instagram.com/eviemeg/?hl=en>)) and YouTube channels (e.g. TouretteTeens (https://www.youtube.com/channel/UCNOume_VesWl0SxPJ9vXLTW)).⁴

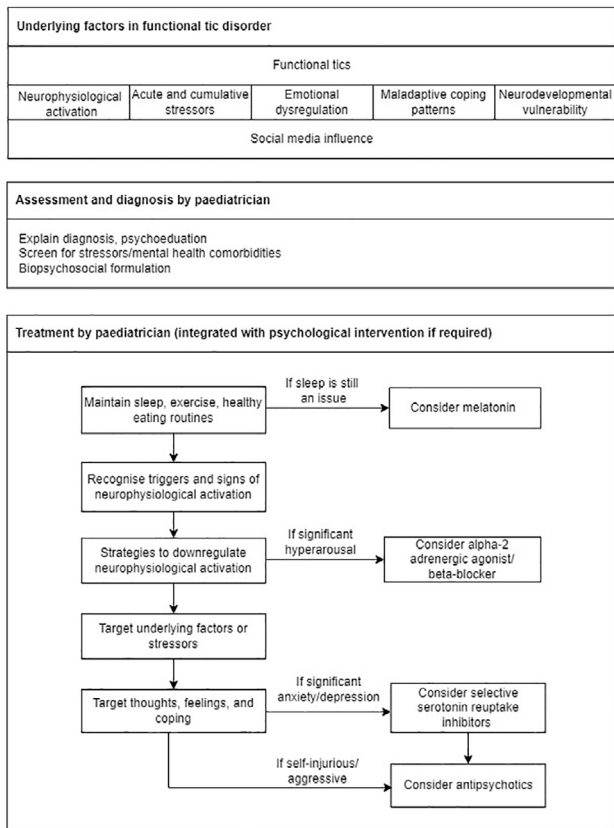


Fig. 2 Underlying factors in functional tic-like disorder, proposed assessment and treatment pathway for functional tic disorders. (a) Underlying factors in functional tic disorder: Functional tics likely represents the tip of the iceberg in terms of underlying problems including neurophysiological activation, acute and cumulative stressors, emotional dysregulation, maladaptive coping patterns and neurodevelopmental vulnerabilities. In addition, a subgroup of adolescents with functional tics are influenced by social media modelling of tic-like behaviours. (b) Assessment and diagnosis by paediatrician: Based on the predisposing, precipitating and perpetuating factors identified, the paediatrician constructs a biopsychosocial formulation with the patient and family. (c) Treatment by paediatrician (integrated with psychological intervention if required): The treatment strategy is two-pronged involving the psychological intervention (on the left) and pharmacotherapy (on the right).

Similar coprolalic-like words and phrases were used by some patients with functional tics suggests the prominent influence of social media in a subgroup of patients, and the ‘contagion’ or ‘suggestibility’ of this problem. However, our data suggest that a large proportion of patients with functional tics have preceding vulnerabilities to emotional disorders, thus the tic-like behaviours are likely a somatic expression of a mix of cumulative stress, in addition to social media influence.

Patterns of somatic stress response – the ‘signature’ patterns in which stressors come to be expressed – change over time and in the context of particular historical, social or political periods.^{6,7} The French Revolution, the Napoleonic Wars and World War I witnessed epidemics of functional neurological symptoms including paralysis, loss of speech, stuporous states, tremors and tics.^{8–10}

Box 1 Example of use of questions and clinical markers of hyperarousal to explore understanding and provide psychoeducation in adolescents with functional tic-like behaviours

‘The events that have happened in your life sound stressful. Many of the symptoms you told me about, or that we documented during the assessment, are physical symptoms of stress—the way that the body signals stress. [Clinician proceeds to objectively measure the patient’s respiratory rate]. For example, your current respiratory rate is elevated at 30 breaths per minute (normal is less than 18 breaths per minute) and your palms are sweaty. These are clinical signs of stress. In addition, you mentioned having difficulty falling asleep or staying asleep. Disrupted sleep routines are also one of the body signals of stress. Other physical symptoms that you mentioned or may have experienced include heart palpitations, dry mouth, nausea, stomach ache/‘butterflies in tummy’ or unexplained dizziness are also due to activation of your stress system. Currently, you might not be aware of these symptoms of stress, which is not uncommon. But it is important to understand that activation of your stress system is associated with increased tics, panic attacks as well as pain and fatigue. The psychologist I work with will teach you strategies (such as biofeedback, slow breathing, grounding and imaginary exercises) to help you cope when you recognise elevated symptoms of stress’. Refer to open access book available online (<https://www.palgrave.com/us/book/9783030461836>)¹⁵ for more examples.

10 The American Civil War was followed by an epidemic of cardio-respiratory symptoms.¹¹ In the post-World War II era, an epidemic of functional gut disorders in both the veteran and civilian populations was seen.¹² After the first Gulf War, a constellation of fatigue and pain symptoms occurred in masses.¹³ Thus, it is highly plausible that the increase in functional tic disorders in recent months is related to multiple stressors stemming from COVID-19 pandemic, in addition to modelling present on social media.⁴

In our cohort, we observed a general theme of severe and functionally impairing tic-like behaviours of adolescents with functional tic disorder, which differs from TS (Table 2). Functional tic-like behaviours emerged in the context of five patterns of psychosocial function, also seen in other FNDs that are not mutually exclusive (Fig. 2). First, onset of tics following acute stressors, on the background of cumulative stressors over months or years. Second, a history of undeclared or undertreated anxiety, depression and emotional dysregulation. Internalisation of emotional symptoms was common in these adolescents. Third, a coping pattern involving the use of maladaptive psychological processes – catastrophising, rumination and perfectionism – which function as top-down cognitive stressors.¹⁴ Fourth, a history of undiagnosed ASD/ASD-like traits – mental rigidity and difficulties with adapting to change – which had been overly challenged during COVID-19. And lastly, onset of tics after exposure to social media or peer influence of tic-like behaviours.

Neurophysiology research in paediatric FND points to a state of activation of the body’s stress systems including autonomic arousal, cortical arousal, fatigue and pain systems (Box 1,

Box 2 Example of explanation of diagnosis, psychoeducation and biopsychosocial formulation for functional tic-like behaviours in adolescents

‘Let me show you a picture that summarises current research findings about functional tics and that shows you—in a simple way—what is happening in the brain. When everything is going well, the brain stress systems—the areas of the brain that activate with stress—and motor-processing regions in the brain work together in a balanced equal way. Sometimes, however, illness, injury, emotional stress, or trauma can switch on the brain stress systems and make them bigger and stronger. When this happens, they disrupt the motor-processing regions, and they can produce motor symptoms—including functional tics. In your case, the brain stress systems were switched on by [event or series of events from child’s history]. So, the treatment for functional tics includes interventions that will help switch off the brain stress systems. We use a range of interventions to do this [describe the necessary interventions: mind-body interventions that down-regulate the stress system; treatment of comorbid anxiety and depression; addressing problems at school or home that are contributing to the stress; trial of medication, and so on] based on the biopsychosocial formulation. Does that all make sense to you?’ (Adapted from Kozłowska *et al.* 2020- see Kozłowska *et al.* 2020 for visual metaphors used with families²¹).

Fig. 2).^{16–20} In adolescents with FNDs, common clinical symptoms and signs of stress-system activation included disrupted sleep, heart and respiratory rates above the 75th centile, physiological symptoms of autonomic dysregulation, difficulties attaining a state of coherence using biofeedback, and the presence of comorbid pain and fatigue (6–11). Psychological processes are also part of the model. Attention to symptoms (by the child and family members), expectations, catastrophising, illness beliefs – such as illness models found on the internet – can all amplify symptoms and potentially activate new symptoms by shaping the adolescents’ symptom expectations.^{14,21,22}

The assessment for rapid onset functional tics follows the general principles used to treat the broad range of FND (Fig. 2). The first point of contact may be a general practitioner or local paediatrician.¹⁵ Differentials for this condition include other movement disorders or psychiatric disorders (e.g. acute psychosis, Paediatric Acute Neuropsychiatric Syndrome (PANS)). After clinical assessment, the paediatrician provides the adolescent and family with a confident diagnosis of FND.¹⁵ The paediatrician can utilise distraction to highlight that the tics increase with attention and reduce with distraction. In this way, the paediatrician can explain how psychological processes (e.g. attention) interact with motor processes, to modulate changes in motor functions. Psychosocial assessment with the adolescent includes a developmental history and assessment of response to stressors before and during the COVID-19 pandemic. This process allows the paediatrician and family to co-construct a biopsychosocial formulation (Fig. 2, Box 2) based on specific factors identified to activate the child’s stress system and that have triggered the illness.

The treatment intervention is made up of multiple components – biological, psychological and social – led by the paediatrician and supported by a multidisciplinary team of professionals. Each treatment component, encompassing psychological interventions and pharmacotherapies, targets a specific problem area identified during the formulation process (Fig. 2, Box 2). Psychological work includes implementation of routines, emotion-regulation interventions, cognitive behavioural therapy or trauma-specific therapies, to address identified problem areas.^{21,23} Intervention with the school and family includes education about FND and addressing factors that may increase stress levels in the child and family system. Adjunct pharmacotherapy can be considered and includes medications that help to regulate sleep, down-regulate arousal or treat emotional symptoms (Fig. 2). It is always emphasised that medications may provide some support but are not able to return the dysregulated stress system to a regulated state. In our experience, dopaminergic medications may not be useful in functional tic disorders as the pathogenesis is different from TS.

Conclusion

During the COVID-19 pandemic, we observed an increase in adolescent females presenting with rapid onset functional tic-like behaviours. We highlight differences in clinical features between the functional tic group and Tourette syndrome to aid diagnosis in the community. Based on our findings, we propose a mixed model of neuropsychiatric vulnerability and social media contagion in this group of adolescents with functional tics. Lastly, we provide a biopsychosocial treatment strategy that focuses on a stress-system approach to settle functional tic-like symptoms.

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Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Clinical characteristics of children presenting with rapid onset functional tic-like disorder. This table includes description of individual patients' motor and vocal functional tics, underlying predisposing and precipitating factors, medication use and treatment outcomes. ADHD, attention deficit hyperactivity disorder; ASD, autism spectrum disorder; OCD, obsessive compulsive disorder; PTSD, post-traumatic stress disorder.