

Fatigue, executive function and psychological effects in children with immune thrombocytopenia (ITP): a cross-sectional study

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3 **Fatigue, executive function and psychological effects in children with immune**
4 **thrombocytopenia (ITP): a cross-sectional study**
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Summary

Childhood ITP is often considered to be a relatively mild haematological disorder, with only a minority of patients requiring treatment for troublesome bleeding. Over recent years, wider effects of the condition have been identified in some adults, particularly relating to fatigue and cognitive impairment. In this study, we sought to investigate such effects in a group of children with ITP and further our understanding of their psychological profile. Children attending routine haematology outpatient clinics and their parents were asked to complete standardised questionnaires designed to assess a range of psychological and cognitive factors. Although most children had scores within the normal range, a significant proportion had difficulties with fatigue, emotional and behavioural symptoms and executive functioning. Quality of life and subjective evaluation of the illness (appraisal) correlated significantly with each of these domains, but bleeding severity and platelet count did not. Our findings provide valuable insight into the broader impact of childhood ITP, which could aid in providing holistic care, potentially contribute to decisions regarding medical treatment, and guide future research.

Keywords: childhood ITP, behavioural, cognitive, fatigue, psychology

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3 Immune thrombocytopenia (ITP) is an acquired immune-mediated disorder,
4 characterised by an isolated thrombocytopenia which results in an increased risk of
5 bleeding. In children, bleeding symptoms are usually mild and the spontaneous
6 remission rate is high, with 75-80% of children recovering within 12 months of
7 presentation (Imbach *et al*, 2006; Heitink-Pollé *et al*, 2014). In light of this, most
8 children with ITP in the UK do not receive therapy directed at raising the platelet
9 count, but are managed on an expectant “watch and wait” policy (Grainger *et al*,
10 2012). International consensus guidelines on the management of childhood ITP
11 (Provan *et al*, 2010) advise initiating treatment based largely on bleeding symptoms,
12 along with consideration of lifestyle factors (particularly the restriction of activities
13 with a high risk of head injury).
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31 Studies in adults with ITP have identified a broader impact of the condition. Fatigue
32 is now well-established as a symptom of adult ITP (Zhou *et al*, 2007; Mathias *et al*,
33 2008; Sarpatwari *et al*, 2010; Newton *et al*, 2011) and a range of potential
34 mechanisms have been proposed to account for its occurrence (Hill & Newland,
35 2015). Other studies have shown a significant reduction in health-related quality of
36 life (HRQoL) (reviewed by Trotter & Hill, 2018) and also an association between
37 adult ITP and mild cognitive impairments (Frith *et al*, 2012).
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49 Studies of children have suggested that fatigue may also be a feature of childhood
50 ITP (Blatt *et al*, 2010; Sarpatwari *et al*, 2010) and have described a negative impact
51 of ITP on health-related quality of life (HRQoL) (reviewed by Trotter & Hill, 2018).
52 Anecdotally, some parents also report mood changes or behavioural problems in
53 their children following a diagnosis of ITP. However, to date no study has used
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3 standardised measures of fatigue or emotional and behavioural symptoms to fully
4 explore these issues. Furthermore, a recent review of the management of childhood
5 ITP has called for research into the cognitive profile of patients with the condition
6 (Cooper, 2014).
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14 We, therefore, sought to investigate fatigue, emotional and behavioural symptoms,
15 and executive functioning (an aspect of cognition involving planning, organisation
16 and self-regulation) in a group of children with ITP, using a range of validated age-
17 appropriate measures. Our aim was to better understand the psychological profile of
18 children with ITP, not only to help inform holistic care for such children and their
19 families, but also to further the debate on factors that could influence decisions on
20 whether or not to treat a child with ITP.
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33 **Methods**

34 The study was approved by Royal Holloway University, the National Research
35 Ethics Service and local Research & Development Departments and was conducted
36 at paediatric haematology clinics at two NHS hospitals in London. Eligible children
37 were identified by the consultant haematologists running these clinics. The Chief
38 Investigator then approached these families at a routine clinic appointment or over
39 the phone following the appointment to discuss the study. The potential participants
40 were not known to the Chief Investigator prior to commencement of the study. Both
41 the children and their parents were provided with written information and were given
42 the opportunity to ask further questions. Informed consent was obtained prior to
43 enrolment. The families were then given questionnaire measures to complete, with
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3 the option to complete on site or return by post. Demographic and clinical data were
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5 obtained from medical records for the same clinic visit.
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10 *Participants*

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12 Children with ITP attending outpatient appointments during a specified 6-month
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14 period were eligible for the study. Participants were approached if they had persistent
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16 ITP (3-12 months duration) or chronic ITP (>12 months duration). Children had to
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18 be at least 4 years old to be included in the study and were eligible to complete self-
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20 report measures from the age of 5 years.
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26 Children were excluded if they had developed ITP as a result of a bone marrow or
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28 solid organ transplant, or if they had another medical condition that was poorly
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30 controlled at the time of the study. Families with a poor command of English were
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32 excluded if an interpreter was not already present in the clinic, or if language
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34 translations were not available in the research measures.
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40 *Clinical data*

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42 The following clinical information was obtained: age of patient, time since diagnosis,
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44 platelet count at time of consent to participate, bleeding severity (using the grading
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46 system in Provan *et al*, 2010), current and previous treatments aimed at increasing
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48 the platelet count, side effects of any treatment, details of any other conditions, and
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50 the occurrence of an intracranial haemorrhage at any stage. Clinicians also gave a
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52 subjective rating of severity of illness and were asked to comment on any significant
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54 change in the severity of the child's ITP since the previous clinic visit.
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3 *Psychological and cognitive measures*
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5 Measures were chosen that were appropriate to the population being studied (with
6 reported acceptable or good reliability), were relatively brief to complete and had the
7 potential to capture both parents' and children's perspectives. The questionnaires
8 given to each child and parent varied depending on the age of the child, with younger
9 children completing fewer measures (detailed in Table I).
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16 In addition to these measures, parents and children were asked to appraise the
17 severity and impact of their ITP, by means of up to three (for children) or five
18 questions (for parents) using a bespoke 5-point Likert visual analogue scale and a
19 space for free comments (Appendix 1).
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Table I. Standardised measures used in the study.

Measure	Completed by parent / child (age)	Reference	Score range	Clinically significant difficulties
Strengths and Difficulties Questionnaire (SDQ), subscales:				
Total difficulties score	Parent & Child (11-16 years)	Goodman <i>et al</i> , 1997	0-40	Score 17 or over
Emotional symptoms score			0-10	Score 5 or over
Pediatric Quality of Life Inventory™ (PedsQL™) Multidimensional Fatigue Scale (MFS)	Parent & Child (5-16 years)	Varni <i>et al</i> , 2002	0-100	77.7 or lower (-1SD from population mean)
Behaviour Rating Inventory of Executive Functioning (BRIEF)	Parent only	Gioia <i>et al</i> , 2000	0-216 (raw score)	T score above 65
Kids ITP Tools (KIT) (Quality of Life measure)	Parent & Child (5-16 years)	Klaassen <i>et al</i> , 2007, 2013	0-100	Not available

Analysis

The Chief Investigator performed the data analysis and the clinical team was not involved in this, in order to avoid potential bias. Scores on all measures were examined for normality, outliers and inconsistencies. A square root transformation was applied to the platelet count due to skew. Missing values were treated in accordance with instructions for individual scales. The data were analysed using Statistical Software for Social Scientists (SPSS) version 21. T tests were used to compare scores with available norms (see results section). For the Strengths and Difficulties Questionnaire (SDQ) only children aged between 5 and 15 years were included in this comparison, as normative data were only available for this age group. Bivariate correlations were used for exploratory analysis. Alpha value for significance was considered as $p < 0.05$.

Results

Forty-six families were eligible and approached within the period of the study. All 46 families consented to participate. Ultimately, at least one questionnaire was returned from 37 families (35 parent questionnaires and 35 child self-report questionnaires), an 80% return rate.

Demographics and clinical data

Data on the 37 children from whom completed questionnaires were returned are recorded in Table II. Most children had chronic ITP and were not receiving treatment at the time of the study. Co-morbid conditions were all judged clinically to be well-managed and stable. Bleeding severity as rated by clinicians was generally low, with

only one patient rated as moderate bleeding severity; the remaining children had minor/mild bleeding or no bleeding at the point of study entry.

Table II. Demographic & clinical data.

Children with ITP (N=37)	
Gender	
Male	20
Female	17
Age in years, mean (range)	9.8 (4.8-16.4)
Nature of ITP	
Persistent	5 (14%)
Chronic	32 (86%)
Time since diagnosis in months, median (range)	28 (3-96)
Current platelet count x10 ⁹ /l, median (range) ^a	63 (1-286)
Recent change in condition	15 (41%)
Treatment ^b	
Active treatment ^c	6 (16%)
Previous treatment ^d	19 (51%)
Patients with other conditions ^e	8 (22%)
Previous intracranial bleed	1

^a 7 patients had normal platelet counts on the day of entry into the study, due to either spontaneous improvement since the last clinic visit (4) or recent/current treatment (3)

^b Only treatments aimed at increasing the platelet count included (i.e. tranexamic acid not included)

^c Intravenous immunoglobulin (2), mycophenolate mofetil (2), rituximab (1), eltrombopag (1)

^d Intravenous immunoglobulin (19), prednisolone (12), anti-D (2), rituximab (3), romiplostim (2)

^e Allergic rhinitis (2), asthma (2), coeliac disease (1), congenital talipes equinovarus (1), diabetes mellitus (1), Evans syndrome (2), Klinefelter syndrome, mild IgA and IgM deficiency (1)

Table III. Summary of scores on psychological and cognitive measures, with comparisons to normative data.

	Parent Ratings		Child Ratings	
	Study cohort mean (SD)	Normative mean (SD)	Study cohort mean (SD)	Normative mean (SD)
SDQ	n=35	n=10298	n=14	n= 4228
Total difficulties	10.88* (5.78)	8.40 (5.80)	8.50 (4.62)	10.30 (5.20)
Emotional symptoms	3.30* (1.97)	1.90 (2.00)	2.43 (1.45)	2.80 (2.10)
PedsQL™ MFS	n=34	n=259	n=34	n=209
Total fatigue ^a	67.58* (17.50)	88.20 (11.10)	70.20* (15.78)	81.80 (12.50)
BRIEF	n=31	n=1419		
GEC ^b	54.37* (11.60)	50.00 (10.00)		

SDQ, Strengths and Difficulties Questionnaire; MFS, Multidimensional Fatigue Scale; BRIEF, Behaviour Rating Inventory of Executive Function; GEC, Global Executive Composite

* Study scores significantly different from normative comparison scores

^a Lower scores on the PedsQL™ MFS indicate higher levels of fatigue

^b Completed by parents only

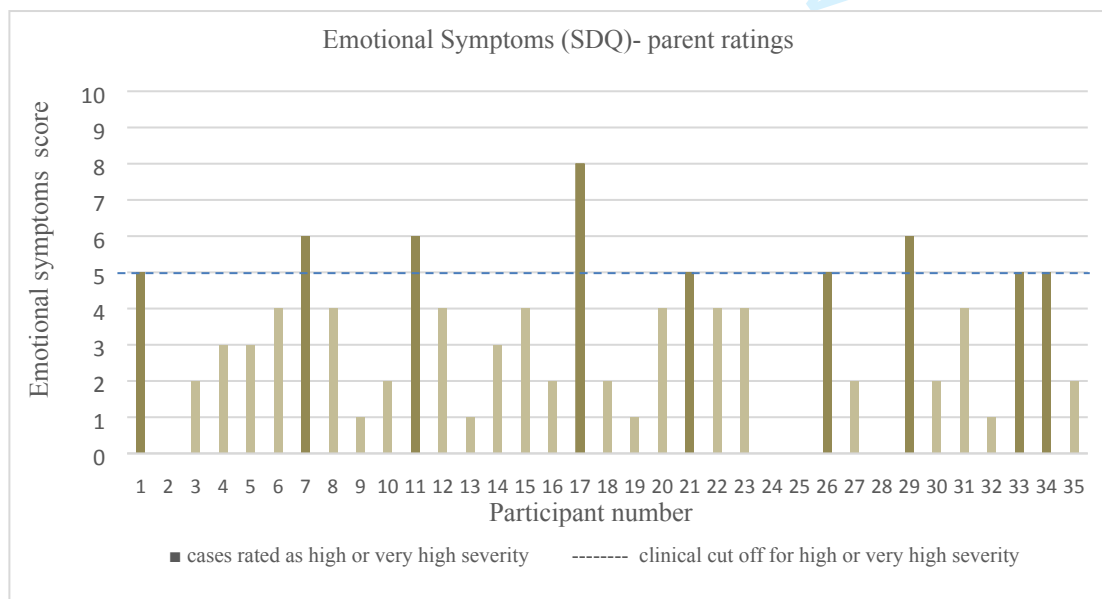
Psychological profile

Scores from the measures used to ascertain a psychological profile for the sample of children with ITP are displayed in Table III.

Emotional and behavioural symptoms (assessed by the SDQ)

T-tests for parent ratings on the SDQ compared with a normative group (using published data from Meltzer *et al*, 2000) showed significant differences for both the Total Difficulties and Emotional Symptoms scores ($t(10328) = 2.41, p = .02$, and $t(10328) = 3.81, p < .001$, respectively). Although most children from the total sample had scores comparable to the normal population, over a quarter of the children (25.7%) were rated by their parents to have problems with emotional symptoms that were of high or very high severity (Figure 1). In the normal population only 10% of the population would be expected to have scores in this region (Goodman & Goodman, 2011). Interestingly, child-reported scores for both Total Difficulties and Emotional Symptoms scores were not significantly different from normative values ($t(4240) = 1.29, n.s.$; $t(4240) = 0.66, n.s.$).

Figure 1: Emotional Symptom scores (parent ratings)



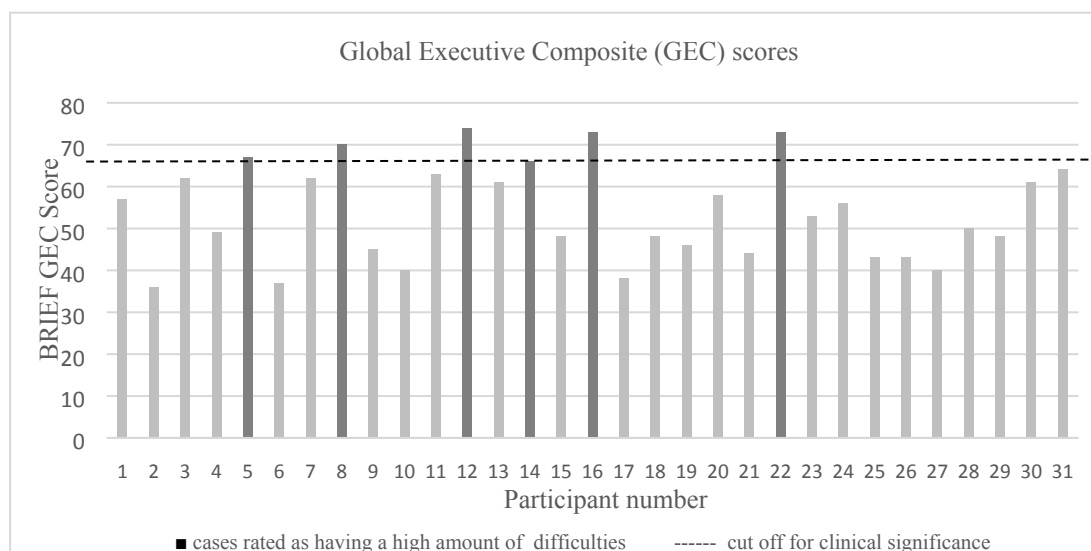
Fatigue

There were significantly lower scores on the PedsQL™ MFS for this sample compared with those for healthy controls (from data published by Panepinto *et al.*, 2014), for both parent and child ratings ($t(291) = 9.42, p < 0.01$; $t(241) = 4.83, p < 0.01$, respectively). This indicates that children with ITP in this sample were reported as having higher levels of fatigue compared with healthy children. Examination of frequencies of parent reports, shows that 24 children had scores that were at least one standard deviation lower than the normative mean, a level proposed (by Varni *et al.*, 2007) as a useful cut off for at risk groups.

Executive functioning

In terms of executive functioning, 19.4% of the sample (6 children) were rated by their parents to have a high amount of difficulties (See Figure 3), compared with an expected 6.6% in the general child population (based on data from Gioia *et al.*, 2000). The mean score for Global Executive Composite (GEC) was significantly higher than the norms for this measure, ($t(1448) = 2.36, p < 0.05$), indicating that children with ITP had more difficulties with executive functioning than the general child population.

Figure 2: Executive function scores, showing clinically significant values



Association between variables

Significant correlations were found by bivariate analysis between the three main variables assessed in the study: emotional and behavioural symptoms (as measured by the SDQ), fatigue (PedsQL™ MFS) and executive functioning (GEC, within BRIEF) as follows: Total Fatigue with SDQ Total Difficulties, $r(32) = -0.52$, $p < 0.01$; Total Fatigue with GEC, $r(29) = 0.59$, $p < 0.01$; GEC with SDQ Total Difficulties, $r(29) = 0.81$, $p < 0.01$. Lower QoL scores, as measured on the Kids ITP Tools were associated both with higher Emotional Symptoms scores (parent: $r(31) = 0.40$, $p = 0.05$; child: $r(14) = 0.67$, $p < 0.01$), parent-rated SDQ Total Difficulties scores ($r(31) = 0.39$, $p = 0.05$) and higher rates of child-reported fatigue ($r(22) = 0.69$, $p < 0.01$). Of note, none of these measures (emotional and behavioural symptoms, fatigue, executive functioning or QoL) correlated significantly with bleeding severity or platelet count.

Appraisal of disease severity

The visual analogue scale that was used to explore appraisal (subjective evaluation of the condition) was shown to have good internal consistency for the parent scale ($\alpha = 0.81$). The child scale showed a poor level of reliability ($\alpha = 0.65$). Clinicians, parents and children had significantly different ratings of severity of the ITP, with clinicians rating the condition as least severe and parents as most severe ($F(2, 52) = 14.95, p < 0.001$). On the Likert scale of 0-5 (5= most severe), the clinicians' mean rating of severity of illness was 1.28, compared with 2.82 as rated by parents and 1.94 for child ratings. Neither platelet count nor bleeding severity correlated with any of the three subjective ratings of severity. Subjective rather than objective severity correlated better with the psychological measures in this study and all appraisal variables were associated with at least one psychological variable. Parents' ratings of both their own ability to cope and their child's ability to cope correlated with their ratings of their perceived child's quality of life ($r(30) = 0.53, p < 0.01$ and $r(30) = 0.45, p < 0.01$, respectively).

In the free comments sections of the measures, 5 parents reported that they were concerned by the uncertainty around the illness and its prognosis, 11 commented on its risk management (including restricting activities) and 6 were bothered by the appearance of bruising caused by the condition. Thirteen children commented on the impact that ITP has in some way on their life, for instance: "not knowing how bad it can get and when, if ever, it can go away", "the platelet count worries me a lot", "it means I am different from my friends", and "I'm not able to play with my friends". Two children commented that they were worried about the blood tests.

Discussion

This is the first study to investigate the psychological profile of children with ITP using validated, standardised, age-appropriate measures. Our results demonstrate that children with ITP reported more difficulties with fatigue, emotional and behavioural symptoms and executive functioning when compared to healthy children. Although most children in the study were functioning at levels similar to the normal population, there were higher proportions of children with clinically significant levels of difficulty in each category. The findings regarding fatigue are congruent with those in adults with ITP (Zhou *et al*, 2007; Mathias *et al*, 2008; Sarpatwari *et al*, 2010; Newton *et al*, 2011) and confirm earlier reports from child surveys (Blatt *et al*, 2010; Sarpatwari *et al*, 2010). The findings relating to emotional and behavioural symptoms add to research showing a range of increased difficulties in children with other chronic health disorders (Barlow & Ellard, 2006; Spencer *et al*, 2009), as well as in adults with ITP (Mathias *et al*, 2008). Cognitive impairment has also been demonstrated in adults with ITP (Frith *et al*, 2012) and our study suggests that ITP may impact on an aspect of cognition (namely, executive functioning) for some children with this condition as well.

Interestingly, in our study, clinical severity (as assessed by bleeding score and platelet count) did not predict problems with fatigue, emotional and behavioural symptoms, executive functioning or quality of life. It should be noted that bleeding severity was generally low and the mean platelet count was relatively high for chronic ITP, but there was a variation in platelet counts. The lack of correlation between platelet counts and fatigue differs from some adult studies reporting more fatigue with lower counts (Newton *et al*, 2011; Kuter *et al*, 2012). However, there are other studies in adults with similar findings to our own, demonstrating a lack of correlation between clinical severity and either fatigue (Sarpatwari *et*

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3 *al*, 2010; Zhou *et al*, 2007), or quality of life (Neunert *et al*, 2009). These combined findings
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5 suggest that other factors associated with the condition, beyond clinical severity, may impact
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7 on the psychological well-being of patients with ITP.
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12 A recent review proposed a variety of potential causes for fatigue in adult ITP, including the
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14 pro-inflammatory disease state (leading to neuro-endocrine disturbance), iron deficiency from
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16 bleeding, side effects of medication, reduction in activity (due to lifestyle restrictions) and
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18 other psychosocial factors (Hill & Newland, 2015). Our study found a significant relationship
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20 between fatigue, emotional and behavioural symptoms and difficulties in executive function,
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22 in keeping with existing but limited research into these variables (Swain, 2000; Emerson *et*
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24 *al*, 2005; Goretti *et al*, 2012). It may well be that the mechanisms causing problems in each of
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26 these variables in ITP are the same, but this requires further study. It is also tempting to
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28 hypothesise that the emotional-behavioural and cognitive effects are mediated through
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30 fatigue; however, not all patients affected on the emotional-behavioural and cognitive
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32 measures (SDQ and BRIEF) scored abnormally on the multidimensional fatigue scale. It
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34 seems likely that there is a complex interaction between fatigue, emotional and behavioural
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36 symptoms and difficulties in executive function, and it remains a challenge for any research
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38 examining these variables to separate their unique and combined contributions.
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47 An additional dynamic in childhood conditions is the parent-child interaction and the
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49 potential for multiple differing perspectives on the severity and impact of the disease. Of note
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51 in our study, in contrast to objective assessment of disease severity, subjective assessment
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53 (particularly by parents, but also by children) did correlate with measures of fatigue,
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55 emotional and behavioural symptoms and quality of life. This may indicate that some
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57 families are more affected by these outcomes than by bleeding severity. Alternatively, a
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3 parent's or child's appraisal of disease severity may be one of the factors influencing these
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5 outcomes. The relationship between appraisal of disease, fatigue and psychological outcomes
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7 is also likely to be a complex one and requires further investigation.
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12 Whilst this study provides a useful insight into the psychological well-being of children with
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14 ITP, there are some limitations. As a cross-sectional study, it is not possible to draw firm
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16 conclusions regarding the causes of our findings or the impact of different treatment
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18 approaches. Further, the sample size was relatively small and drawn from two specialist
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20 centres. It therefore may not have represented the wider population of children with persistent
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22 / chronic ITP. Also, although the return rate was generally good and indeed higher than
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24 expected for a study of this nature, it is possible that the families who did not return the
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26 questionnaires represented a different group. Finally, several of the children had other
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28 medical conditions; although these were considered to be inactive or well-controlled at the
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30 time of the study, it is possible that they influenced the results.
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38 In summary, this study has demonstrated significant non-bleeding effects of childhood ITP,
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40 in terms of fatigue, emotional and behavioural symptoms and difficulties in executive
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42 functioning. These effects may not be clearly apparent in any given patient in clinic,
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44 particularly given their lack of association with bleeding severity or platelet count.
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46 Appropriate questions to elicit symptoms may, therefore, be required in order to identify
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48 those who would benefit from a thorough assessment of psychological and educational needs,
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50 with referral to psychological services where appropriate. This research also broadens the
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52 debate on whether or not to treat a child with ITP. International consensus guidelines on the
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54 management of childhood ITP advise initiating treatment based largely on concerns regarding
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56 bleeding (Provan *et al*, 2010). Our data highlight the wider impact of the condition, with
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3 effects demonstrated on the abilities of children to function normally. Given that the children
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5 in this study all had persistent or chronic disease, it is possible that some of them may have
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7 experienced these effects for many months or even years. It is not yet known whether
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9 treatment of the disease could reduce these effects, but it would be worth exploring. Quality
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11 of life studies in ITP have shown conflicting results, with some showing an improvement
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13 following treatment (Blanchette *et al*, 2010; Kuter *et al*, 2012) and others showing no change
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15 (Bussel *et al*, 2007, 2015; Grainger *et al*, 2013) or only an improvement in the parents, rather
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17 than the children themselves (Klaassen *et al*, 2012; Mathias *et al*, 2016). A detailed
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19 prospective longitudinal study is needed to assess fatigue, emotional and behavioural
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21 symptoms and difficulties in executive functioning, in which the standardised measures used
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23 here are applied at several time points in the disease course of a large cohort of children with
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25 ITP. This may provide more insight into any potential additional benefits of treatment.
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27 However, in the meantime, it is reasonable to consider the broader impact of childhood ITP
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29 suggested here, when making a decision to continue to “watch and wait” for a child with
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31 persistent or chronic ITP.
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51 Contributions

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53 ST., K.T., Z.B. and K.S designed the study; ST conducted the study; S.T., P.T., and G.B were
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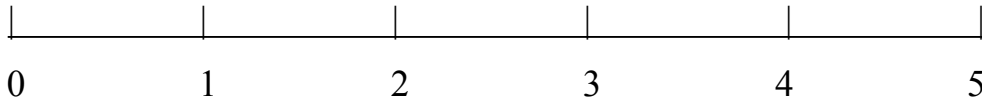
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For Peer Review

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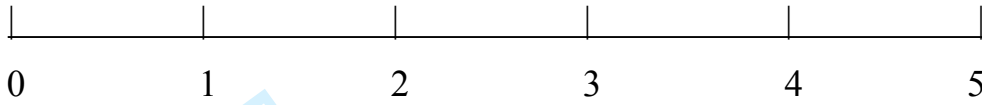
How severe would you rate your child's illness?



Not at all severe

Very severe

How much does your child's ITP affect *their* life?



Has no effect

Affects it a lot

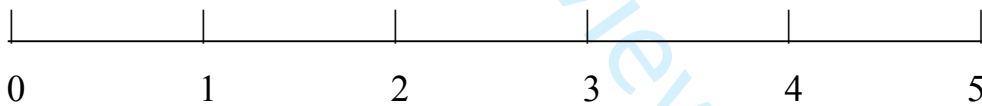
How much does your child's ITP affect *your* life?



Has no effect

Affects it a lot

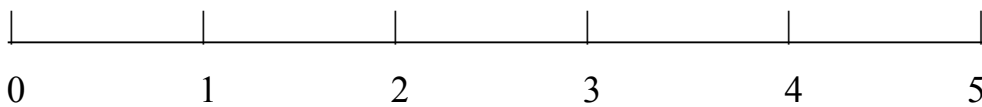
How able do *you* feel to cope with your child's ITP?



Not able to cope at all

Completely able to cope

How able do you feel *your child* is to cope with their ITP?



Not able to cope at all

Completely able to cope

What part of your child's ITP bothers you the most?

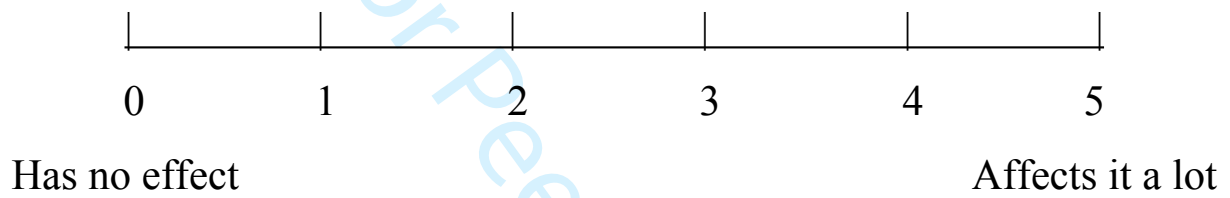
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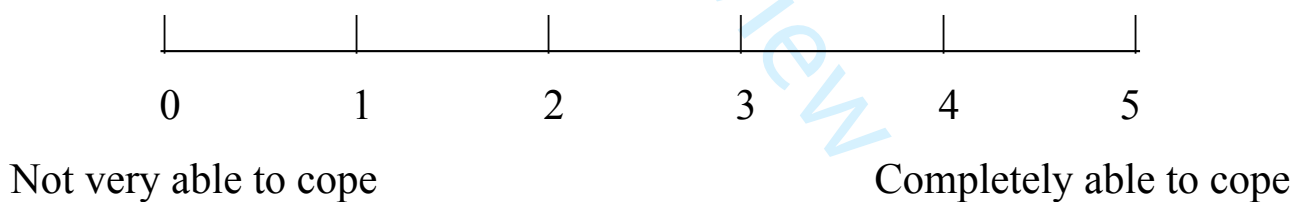
How bad/severe is your illness?



How much does ITP affect your life?



How able do you feel to cope with your ITP?

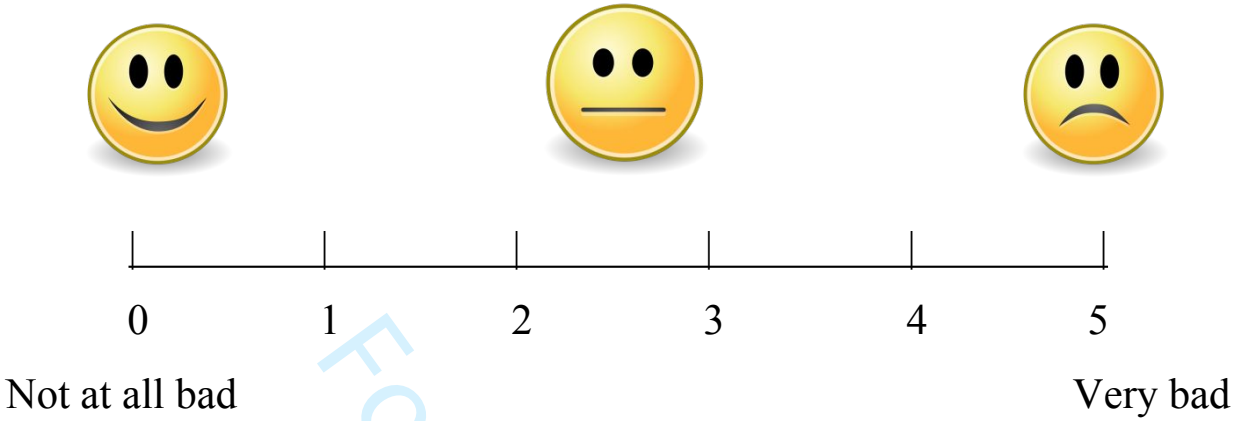


What part of your ITP bothers you the most?

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How bad is your illness?



What part of your illness worries/bothers you the most?

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