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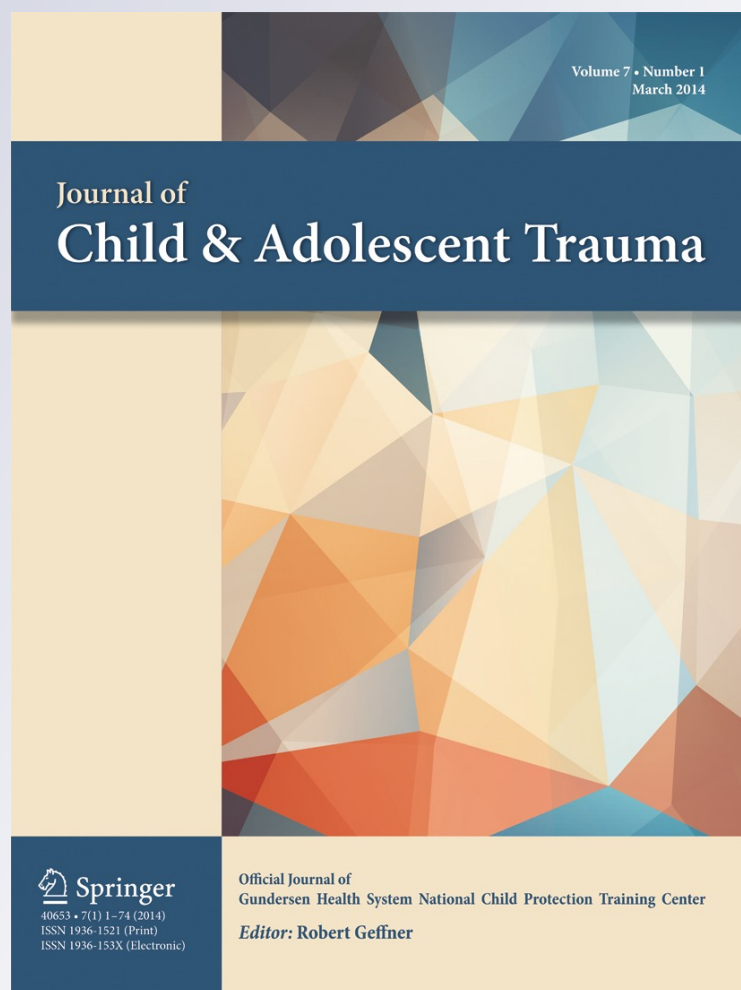
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Abstract This paper describes the risk factors for the development of posttraumatic stress reactions in children after a technological disaster in Ghislenghien, Belgium in 2004. Children were assessed at five months (T1, $N=128$) and at fourteen months (T2; $N=69$). At T1 and T2 respectively, 7 % and 4 % of the responding children showed severe posttraumatic stress reactions. Of those who showed posttraumatic stress reactions at T1, 60 % recovered from these symptoms at T2. One child developed severe posttraumatic stress reactions between T1 and T2. Risk factors related to posttraumatic stress reactions were: (a) type of exposure to the disaster; (b) peritraumatic dissociation during or immediately after the disaster; and (c) dissatisfaction with the received psychological help.

On July 30th, 2004, an accidental leakage in a high-pressure natural gas pipe, that passed under the industrial zone of Ghislenghien, Belgium, created an explosion that killed 24 people and injured more than 100 people. Debris from buildings on site was projected up to six kilometers away from the epicenter. The explosion was registered up to 16 km from the explosion site. Due to the magnitude of the fire columns and the intense temperature, people burned in their cars while driving on the nearby highway. Hundreds of fire, rescue, and police personnel rushed to the disaster area and all of the regional hospitals received numerous victims. Not since the coal mine disaster in Marcinelles (August 8th, 1956) in which 278 people died has such a wide area of Belgium been affected by a large scale technological disaster.

The present study aimed at assessing the risk factors for posttraumatic stress reactions in children involved in the disaster. It examined the extent and severity of posttraumatic stress reactions in these children in regard to the type of disaster exposure and to assess the value of the psychological help that was recieved. Peritraumatic dissociation and the type of exposure were expected to be significant predictors of posttraumatic stress reactions in children.

Background

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Adult survivors of disaster are typically the focus of research, but studies including child and adolescent survivors are

expanding quickly. Norris et al. (2002) conducted a review of the empirical literature on disaster victims between 1981 and 2001 and found 27 relevant studies on young survivors: 17 studies concerned natural disasters, six studies involved technological disasters, and four studies focused on mass violence. Most of these studies concentrated on posttraumatic stress reactions and related disorders, but some studies focused on other problems such as health concerns and loss of resources. Fifty-two percent of the school-age samples in the review were found to suffer from severe or very severe effects. These figures indicate that children can be strongly affected by disasters. However, posttraumatic stress disrder (PTSD) rates after a disaster varied enormously in children, ranging from 0 % to 95 % (Saigh et al. 1999). The large variability in prevalence rates may be caused by differences in age of the children, proximity to the potentially traumatizing stimuli, use of different diagnostical instruments, study design, time-lapse between exposure and assessment, and the nature of the disaster (Shaw et al. 1996). Since Pfefferbaum's review of the literature in 1997, several authors have again noted the need for longitudinal studies on children and adolescents exposed to traumatic events, including technological disasters, because of the possibility of delayed onset or chronic persistence of PTSD symptoms (e.g., McFarlane and Van Hooff 2009; Shah and Mudholkar 2000).

The studies mentioned above also reported differences in factors predicting PTSD in children. For example, with regard to age, no significant differences between age groups have been found (John et al. 2007). Also, with regard to gender, contradictory results have been found, although most studies reported higher symptom levels in girls (Norris et al. 2002). Other predictors of PTSD in children have been studied to a far lesser extent. Among others, a recent study on trauma exposure and PTSD in the general population (Copeland et al. 2007) found children to be more vulnerable to developing PTSD symptoms when they had suffered from an anxiety disorder prior to the exposure, when they came from an impoverished or less educated background, or when they had experienced multiple traumas. While the study of Copeland et al. (2007) took a broad approach, including psychiatric history and environmental factors, other studies have zoomed in on predictive aspects of the potentially traumatizing event itself, such as injury severity, perceived distress or negative emotions, and peritraumatic dissociation (Bryant et al. 2007; Ehlers et al. 2003). In adults, indications have been found that subjective aspects of the event (e.g., level of fear during the event) play an important role in the development of subsequent PTSD symptoms (Bernat et al. 1998). In the aftermath of a trauma, an important challenge involves the identification of individuals who will develop PTSD. Harvey and Bryant (2002) expected the diagnosis of acute stress disorder (ASD), which differs from posttraumatic stress disorder in its requirement of three or more dissociative

symptoms, to meet this challenge. The rationale is that the dissociative symptoms in the acute phase may identify those at risk of later developing PTSD. One of the most important trauma predictors appears to be peritraumatic dissociation. According to Marmar et al. (1998), peritraumatic dissociation is the occurrence of dissociative symptoms during or shortly after exposure to extreme events. It also involves acute alterations in cognitive and perceptual functioning at the time of a traumatic event.

In children, peritraumatic dissociation has hardly been studied, although some indications have been found that it is a risk factor in children as well. In a study including 45 young victims of traffic accidents, peritraumatic dissociative experiences were reported by 62 % of the sample (Schäfer et al. 2004). Among the peritraumatic responses measured (i.e., depersonalization, derealization, and emotional numbing), derealization accounted most strongly for the variance in posttraumatic stress reactions three months after the accident, explaining 33 % of the variance. Also in child survivors of sexual abuse and in children hospitalized for burns, peritraumatic dissociation has been shown to predict PTSD development (Kaplow et al. 2005; Saxe et al. 2005).

Bui et al. (2010) found that the studies that examined the relationship between peritraumatic reactions and the development of subsequent PTSD symptoms in children (Dalgleish et al. 2008; Pfefferbaum et al. 2003; Schäfer et al. 2004) relied on non-validated instruments and did not discriminate between distress and dissociation. The study by Bui et al. (2010), in which children aged 8 to 15 were enrolled to participate after a traffic accident, revealed a significant association between peritraumatic variables and two measures of PTSD symptoms. The objective was to assess the predictive power of both peritraumatic distress and peritraumatic dissociation for developing acute PTSD symptoms in school-aged children. Peritraumatic distress indexes reactions such as "fear, helplessness and horror," referring to the PTSD criterion A2 in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association 1994; Brunet et al. 2001). Peritraumatic distress appeared to be a robust predictor of who will develop PTSD symptoms among the sample.

Meiser-Stedman et al. (2007) investigated the relationships between ASD and a number of demographic, trauma, cognitive, and trauma memory variables in a sample of children and adolescents (N=93) involved in assaults and motor vehicle accidents. Several cognitive variables and the quality of trauma memories, but not demographic or trauma variables, were correlated with ASD and also mediated the relationship between peritraumatic threat and ASD.

Adult research (Lensvelt-Mulders et al. 2008; Van der Hart et al. 2008) suggests that the dissociation criterion of ASD has limited validity in predicting PTSD. Dalgleish et al. (2008) addressed this issue in child and adolescent survivors (N=367)

of road accidents and found that dissociation accounted for no significant unique variance in later PTSD, over and above ASD criteria. Furthermore, thresholds of either three or more re-experiencing symptoms, or six or more re-experiencing/hyperarousal symptoms, were as effective at predicting PTSD as the full ASD diagnosis.

We could not locate any studies on peritraumatic dissociation in children who were victims of a disaster nor empirical evidence on the efficacy of any kind of psychological help in the immediate aftermath of a disaster. Despite this, Furr et al. (2010) conducted a meta-analytic examination of posttraumatic stress symptoms and found that disasters had a significant effect on youths' posttraumatic stress symptoms; female gender, higher death toll, child proximity, personal loss, perceived threat, and distress at the time of the event were each associated with increased posttraumatic stress symptoms. They concluded that youths are vulnerable to appreciable posttraumatic stress symptoms after disaster, with pre-existing child characteristics (i.e., gender), aspects of the disaster experience (i.e., natural vs. man-made), and study methodology each associated with variations in the magnitude of the effect.

Alisic et al. (2011) concluded, from their meta-analysis of longitudinal studies, that the most notable predictors of long-term posttraumatic stress were symptoms of acute and short-term posttraumatic stress, depression, anxiety, and parental posttraumatic stress. Female gender, injury severity, duration of hospitalization, and heart rate shortly after admission to the hospital accounted for small effects.

Method

Procedure

In the context of a general survey of people potentially involved in the accident, inhabitants living no farther than 5 km away from the explosion epicentre and employees of all companies located on the industrial site of Ghislenghien were contacted to participate in the study. Family members living at the same address and family members of all deceased persons were also invited to participate. Questionnaires were sent by mail five months (T1) after the disaster. Those who did not reply within one and a half months were contacted by telephone. Individuals agreed to participate in the study by sending a consent form or by simply filling in and sending back the questionnaire in the preaddressed envelope with stamp. Fourteen months (T2) after the disaster, each person who responded to the first questionnaire and their family members received a second questionnaire for the longitudinal follow-up of the impact of the disaster. A reminder was sent in an attempt to reach a higher response percentage at T2.

Participants

The target group of the larger study, approved by an ethical board belonging to the Scientific Institute of Public Health, comprised the survivors of the Ghislenghien gas explosion and their family members, as well as family members of deceased victims: 3,448 households, including 7,148 adults (persons aged 15 years and older on August 1st, 2004) and 820 children between the ages of 8 and 14. Children below the age of 8 years were excluded from the study sample for reliability reasons because the study included self-report data from the children's point-of-view. Five months after the disaster (T1), the response rate at household level was 18 % ($N=$ 607 households). Valid questionnaires were filled out by 1,027 adults (response rate of 14 %) and 128 children (response rate of 16 %). Fourteen months after the disaster (T2), the response rate at household level was 56 % of the 607 households who received the second questionnaire. Valid questionnaires were filled out by 579 adults (46 % of those who received the second questionnaire) and 69 children (53 % of those who received the second questionnaire). At T1, 54.4 % of the children were male and 45.6 % were female. At T2, 51.4 % of the children were male and 48.6 % were female.

Measures

Children ranging from 8 to 14 years old received a questionnaire adapted to their age at T1. The second questionnaire (at T2) was shorter because it ommitted open questions as well as questions with invariable content such as demographics, exposure, etc.

The questionnaire contained two sections: one section with questions that had to be filled in by an adult caregiver of the child and a second section with questions that could be directly answered by the child. The first section contained questions concerning socio-demographic data, absenteeism in school, consumption of medications, utilization of health services, and both specialized medical and psychosocial care. Questions regarding recollections of the proximity and exposure to the disaster, experienced life threat, peritraumatic experiences, and posttraumatic stress reactions had to be answered by the children themselves.

Assessment of Posttraumatic Stress Reactions The type of disaster exposure and posttraumatic stress reactions in the children involved in the Ghislenghien disaster were assessed using a French translation of the Child Posttraumatic Stress Reaction Index (CPTS-RI; Dewulf 2005; Frederick et al. 1992). The CPTS-RI does not allow for a specific PTSD assessment (cf., the re-experience, avoidance, and hyperarousal symptom clusters described in the DSM-IV [American Psychiatric Association 1994] and International Classification

of Diseases-10 [ICD-10; World Health Organization 1992]). However, this instrument allows assessment of the severity of posttraumatic stress reactions on a 5-point Likert scale ranging from 1 (*not at all or never*) to 5 (*a lot or always*). The total score is normed as follows: 12 or less indicates an absence of symptoms; between 12 and 24 refers to a pattern of mild symptoms; between 25 and 39 suggests a pattern of moderate symptoms; between 40 and 59 refers to a clinical image of severe symptoms, and more than 60 is an indication of very severe symptoms.

Type of Exposure Twenty-three yes or no questions, based on the various possible disaster-related experiences, assessed how the children were involved in or have been exposed to the disaster, allowing for a classification of the type of exposure. This classification contained three main categories which fall into seven subcategories. The first category was composed of primary victims (i.e., having been exposed to direct life threat and/or human damage and/or to the disaster itself). Three subcategories were created: (a) children who experienced direct life threat including injured children (Cat 1); (b) children who directly witnessed human suffering (burned, injured, and/or deceased victims; Cat 2); and (c) children who directly witnessed the explosion (Cat 3). The second category contained secondary victims (i.e., indirect witnesses or those who had been confronted with the disaster through the affective proximity to a primary victim). These were the family members or close relatives who either fall in subcategory four (i.e., were injured or killed in the disaster; Cat 4) or in subcategory five (i.e., who could have been injured or killed in the disaster; e.g., family members or colleagues at work who were not present at the site of the explosion; Cat 5). The third subcategory of secondary victims encompassed the children who were exposed to the disaster in a sensory way but without witnessing human damage (e.g., smell, sound, and viewing the explosion from a distance; Cat 6). Finally, the third main category, defined as tertiary victims, were children who had not been directly exposed to the disaster but were informed about it through media coverage or conversations; this class did not contain any subcategories (Cat 7). Children who did not fit in any of the previous categories were considered non-victims (Cat 8).

Peritraumatic Dissociation Reactions indicative of peritraumatic dissociation were measured by the Child Dissociation Experience Scale (Dewulf 2005), a self-rating scale for children age 8 to 14 years, which is an adapted version of the Dissociative Experiences Scale developed for adults (Carlson and Putnam 1993). The nine items of this scale assess sensations of emotional numbness, distancing, tunnel vision, unreality, depersonalization, out-of-body experiences, amnesia, time distortion, and anaesthesia. Children answered each question using a 5-point Likert scale ranging from 1 (*not at*

all) to 5 (*to a great deal*). Since internal consistency was adequate (Cronbach's $\alpha = 0.85$), an index of peritraumatic dissociation was computed by adding the scores on the nine items. Thus, a higher total score represented a higher amount of peritraumatic dissociation.

Psychological Help The assessment of psychological help was related to the psychosocial interventions provided by psychologists or other mental health professionals and to the type (collective, individual, telephone, etc.) and number of sessions. These questions were answered by one of the parents of the child at T1. Psychological help was evaluated through the following yes or no question: "Did the child receive psychological help (personally or by telephone) after the event?" The timing of first receiving psychological help (conversation) was coded as follows: (1) the day of the event; (2) the next day; (3) during the 2 or 3 following days; (4) during the 4 or 5 following days; and (5) during the 6 or 7 following days. The amount of help received and its origin were assessed by the next two questions: "How many conversations of psychological help have there been?" and "Who took the initiative for those conversations?" The possible answers for the latter were: "I asked for help"; "I have been invited and I accepted on voluntary basis"; "I have been forced to take part in these conversations"; and "Other." Two questions related to the perceived benefits of the psychological sessions for the child were: "How much has the session been useful for the child" and "How much has the session allowed him/her to feel better?" Those questions were rated on 5-point Likert scales ranging from 1 (*not at all*) to 5 (*very much*). Finally, two yes or no questions were asked regarding the children who had not received psychological help. The first question examined whether the parent would have liked his or her child to receive psychological help and the second asked whether they had been offered help.

Results

Posttraumatic Stress Reactions in Children

The results have been interpreted using the DSM-IV-TR (American Psychiatric Association 2000) PTSD criteria as a reference, even though the researchers did not proceed to conduct formal clinical diagnostic interviews with the children who participated in the study. As Table 1 shows, nearly all of the children who responded were exposed, to some degree, to the Ghislenghien disaster and, therefore, meet the A1 criterion (exposure to a potentially traumatic event) required for a PTSD diagnosis (American Psychiatric Association 1994). With respect to the subjective exposure (criterion A2), at least one of the subcriteria must have been experienced in order to classify for a PTSD diagnosis. In the present sample, 75 % of

Table 1 Posttraumatic Stress Reactions in Children Involved in the Ghislenghien Disaster

		T1		T2		p T1-T2
		N=28	% valid	N=69	% valid	
Criterion A1: Objective exposure	Overall	120	99.2	67	98.5	n.s.
	Cat 1: Primary victim – direct life threat	23	19.2			
	Cat 2: Primary victim – direct witness of human suffering	18	15.0			
	Cat 3: Primary victim – direct witness of the explosion (without exposure to human suffering)	29	24.2			
	Cat 4: Secondary victim – close relative injured or dead	1	0.8			
	Cat 5: Secondary victim – close relative could have been injured or dead (but was not)	5	4.2			
	Cat 6: Secondary victim – partial exposure at a distance (e.g., smells, sounds, vibrations)	18	15.0			
	Cat 7: Tertiary victim – exposure via media or conversations	25	20.8			
	Cat 8: No exposure	1	0.8			
Criterion A2: Subjective exposure	Overall	89	75.4	51	75.0	n.s.
	Intense anxiety	75	63.6			
	Powerlessness	59	49.6			
	Horror	52	44.1			
	Agitation	61	51.3			
Criterion B, C, & D: Symptoms	Overall	47	39.2	20	27.4	0.0001
	No symptoms	73	60.8	53	72.6	
	Mild symptoms	25	20.8	15	20.5	
	Moderate symptoms	17	14.2	3	4.1	
	Severe symptoms	4	3.3	2	2.7	
	Very severe symptoms	1	0.8	0	0	
Criterion E: Duration and current presence of symptoms	Symptoms started immediately after the disaster	15	14.0			
	Current presence of symptoms	12	11.3	4	5.6	0.008
Criterion F: Dysfunction	Overall	27	22.7	10	13.7	0.0001
	Disaster experience led to unhappiness	17	14.2	4	5.5	
	Difficulties in social relationships	3	2.5	1	1.4	
	Difficulties in school work	2	1.7	2	2.7	
	Difficulties in family life	16	13.2	7	9.6	
PTSR	Current PTSR	9	7.5	3	4.3	0.0001
	Resolved PTSR at T1	3	2.5			
	Resolved PTSR at T2			3	4.3	
	Onset PTSR after T1			1	1.6	
	No PTSR			57	89.1	
Presence of peritraumatic dissociation during the disaster		4	3.4			

Note. T1 Time One; *T2* Time Two; *n.s.* non-significant; *PTSR* Posttraumatic Stress Reactions

the children satisfy this criterion, while 64 % of those children have experienced intense anxiety, 51 % experienced hyperagitation at the moment of the explosion or immediately after, 50 % felt powerless when the disaster occurred, and 44 % reported horror.

The answers on the items indicative of symptoms belonging to the common B, C, and D clusters of the PTSD syndrome (American Psychiatric Association 2000) were grouped in one single severity score. At T1, 21 % of the children reported mild symptoms, 14 % moderate symptoms, 3 % severe symptoms, and 1 % very severe symptoms. Conversely, this means that 61 % of the sample did not report any posttraumatic stress reactions at T1. At T2, the proportion of children reporting mild symptoms was similar (21 %), but the proportion of moderate to very severe symptoms had decreased over time to 4.3 % and 0 % respectively.

With respect to the duration (criterion E) of these symptoms, only 11 % of the children reported the three types of posttraumatic stress reactions at T1, and only 6 % did so at T2. This indicates that the number of posttraumatic stress reactions decreased over time.

Finally, in relation to impairment (criterion F), the disaster was found to have elicited interpersonal difficulties in 2.5 % of the cases at T1 and 1 % at T2. School problems, as a result of the disaster, were reported by only two children (2.5 %) at both T1 and T2. Thus, it appears that the Ghislenghien disaster provoked only rather small problems in the children's social relations and at school. However, 13 % of the children reported family problems at T1 and 10 % at T2. At T1, 14 % of the children confirmed that their disaster-related experiences made them unhappy. In sum, criterion F was endorsed by 23 % of the children at T1 and 14 % at T2.

The Development and Evolution of Posttraumatic Stress Reactions

Nearly half of the children (*N*=4) showing severe posttraumatic stress reactions at T1 had experienced a direct threat to their life (Cat 1). Two of them developed severe posttraumatic stress reactions in the aftermath of the disaster which appeared to be resolved at T1. Of the children who reported a direct life threat at T2 (*N*=23) only one suffered from severe posttraumatic stress reactions while he/she did not report these symptoms at T1. One child reporting severe posttraumatic stress reactions at T1 no longer showed these symptoms at T2. These results show that most children remained resilient over time. Two children out of the 18 children belonging to Cat 2 suffered from severe posttraumatic stress reactions at T1. These children still showed posttraumatic stress reactions at T2. One of the children presented with posttraumatic stress symptoms in the immediate aftermath of the disaster, but no longer showed these symptoms at T1 or T2. Of the children with posttraumatic stress symptoms at T1, two children out of the 28 in Cat 3 reported having been direct witnesses of the explosion, but did not see any burned or deceased victims. The 12 children who witnessed the explosion and responded at T2 did not develop severe posttraumatic stress reactions. One of these children developed posttraumatic stress reactions at T1 but did not display these symptoms at T2. The results also indicate that throughout the study 93 % of the responding children did not develop severe posttraumatic stress reactions. One child, with a family member who was wounded or died (Cat 4), developed posttraumatic stress reactions at T1 but did not show a significant amount of symptoms at T2.

Degree of Exposure

Table 1 provides an overview of the children's degree of exposure to the disaster. Since none of the responding children were injured in the disaster, the most intense type of exposure experienced by the children was life threat, due to the explosion, without having been injured (*N*=23).

In general, taking into account the norms used in the questionnaire for assessing the severity of the posttraumatic stress reactions, the results show that children who were exposed as primary or secondary victims presented with moderate to mild posttraumatic stress reactions (scores between 12 and 24). The child who had a family member that was injured or killed (Cat 4) still presented with moderate posttraumatic stress reactions at T1 (severity score between 25 and 39). The other children showed an absence of symptoms. At T2, only the Cat 1 children still presented with mild symptoms. In the other groups of children, the posttraumatic stress reactions had disappeared.

These results were confirmed through a statistical analysis (ANOVA) examining the evolution of the severity of PTSD symptoms in the different groups. The results revealed that the mean severity scores were lower at T1 than at T2, $F(1, 58)=15.65$, $p=0.0001$. The effect of the type of exposure was also significant, $F(6, 58)=3.72$, $p=0.003$. Cat 1 children showed the same amount of symptoms as the Cat 2 and Cat 3 children. These groups showed more symptoms than the Cat 5 children, whose close relative could have been injured but was not. Cat 6 and 7 children showed the least amount of symptoms. The interaction between the time of measurement and the type of exposure was not significant, $F(5, 59)=1.36$, $p=0.25$.

PTSD Risk Factors at T1 and T2

Table 2 and Table 3 show the correlations between the potential predictors, such as the degree of exposure and the severity of posttraumatic stress reactions at T1 and T2, respectively. The results of the regression analysis in Table 4 indicate that the severity of posttraumatic stress reactions at T1 was strongly related to the type of exposure (from primary to tertiary victims), peritraumatic dissociative reactions, and to received psychological help. Age and gender were not found to be linked to symptom severity. The regression model explains 42 % of the total variance.

At T2, the severity of PTSD-related symptoms was best predicted by peritraumatic dissociative reactions and the severity of symptoms at T1 (see Table 5). This regression model explains 60 % of the total variance.

Psychological Help

At T1, five children (4.2 %) had received psychological help in the form of a personal contact. Two of those children belonged to Cat 1, two others to Cat 2, and one to Cat 3. No one in the other categories received psychological help.

Only three of the nine children with severe posttraumatic stress reactions at T1 received psychological help. Of the six

Table 2 Correlations Between the Main Variables for the Children Included at T1

	1	2	3	4	5
1. Severity of PTSD at 5 months	–				
2. Age	−0.039	–			
3. Gender	0.079	0.159*	–		
4. Type of exposure	−0.393***	0.008	0.065	–	
5. Severity of dissociation	0.488***	0.136†	−0.061	−0.308***	–
6. Psychological support received	0.394***	−0.154†	0.220**	−0.191*	−0.048

Note. T1 Time One, *PTSD* Posttraumatic Stress Disorder, $N=112$, Gender (0=boy; 1=girl); Type of exposure (higher scores indicate lower degree of exposure); Psychological support received (0=no; 1=yes)

†$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.0001$

children with severe posttraumatic stress reactions at T1 who did not receive psychological help, three belonged to Cat 1, two to Cat 2, and one to Cat 3. The parents of two Cat 1 children, who developed severe posttraumatic stress reactions at T1, had expected and hoped to receive some kind of support or help, but ultimately they did not receive any help.

Type, Timing, and Perceived Benefits of Psychological Help

The timing, frequency, and kind of psychological help that children received after the disaster was diverse. Some children received psychological help three days after the disaster. Two children attended a single session, two other children received two sessions, and one child attended 10 sessions. These sessions were both individual and collective: (a) in the context of a family session ($N=1$); (b) in the form of a telephone contact ($N=1$); and (c) in the context of a session with someone from outside the family ($N=1$).

Of the five children who received psychological help between the time of the disaster and T1, three developed a significant amount of posttraumatic stress reactions at T1. There was an equal proportion of each possible type of primary exposure. Between T1 and T2, two children continued to receive psychological help (five and 15 sessions, respectively). The child who received more intensive psychological

help still showed a significant amount of posttraumatic stress reactions at T2, while the other child did not show any posttraumatic stress reactions at T1 or T2. Due to the small number of children who received psychological help and the diversity of interventions, it was impossible to analyze the efficacy of the interventions.

However, it was possible to examine the beneficial effects of treatment, as perceived by the parents, at T1. The parents of the children who received psychological help estimated this help as very useful for their child (four out of five parents reported the highest possible score of usefulness) and reported that the help had allowed their child to feel better or relieved (the same four out of five parents reported the highest degree of satisfaction). In just one case, the psychological help was seen as unbeneficial for the child. This child developed severe posttraumatic stress reactions at T1, but no information was available at T2 because the second questionnaire was not answered.

Discussion

This study examined risk factors influencing the severity of posttraumatic stress reactions in children involved in a technological disaster (i.e., the type of exposure to the disaster,

Table 3 Correlations Between the Main Variables for the Children Included at T2

	1	2	3	4	5	6
1. Severity of PTSD at 14 months	–					
2. Age	−0.207†	–				
3. Gender	0.230*	0.024	–			
4. Type of exposure	−0.442***	0.060	0.006	–		
5. Severity of dissociation	0.501***	0.106	0.020	−0.407***	–	
6. Severity of PTSD at 5 months	0.742***	−0.203†	0.198†	−0.477***	0.458***	–
7. Psychological support received	0.358***	−0.229*	0.205†	−0.202†	−0.067	0.306**

Note. T2 Time Two, *PTSD* Posttraumatic Stress Disorder, $N=62$

†$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.0001$

Table 4 Predictors of the Severity of PTSD Symptoms at 5 Months

Severity of PTSD Symptoms at 5 Months	Std. β	t	Equation	Adj. R^2	ΔR^2
Model 1: Sociodemographic Variables			$F(2, 109)=0.490$	−0.009	0.009
Age	−0.053	−0.544			
Gender (0=male; 1=female)	0.087	0.903			
Model 2: Exposure Type			$F(3, 108)=7.277$***	0.145	0.159
Age	−0.053	−0.602			
Gender (0=male; 1=female)	0.114	1.274			
Exposure (from primary victim to no victim)	−0.400	−4.547***			
Model 3: Peritraumatic Dissociation			$F(4, 107)=13.235$***	0.306	0.163
Age	−0.117	−1.446			
Gender (0=male; 1=female)	0.141	1.755†			
Exposure (from primary victim to no victim)	−0.269	−3.226**			
Peritraumatic dissociation	0.430	5.103***			
Model 4: Psychological Help Received			$F(5, 106)=17.001$***	0.419	0.114
Age	−0.051	−0.677			
Gender (0=male; 1=female)	0.047	0.617			
Exposure (from primary victim to no victim)	−0.185	−2.363*			
Peritraumatic dissociation	0.458	5.929***			
Received psychological support (0=no; 1=yes)	0.363	4.667***			

Note. PTSD Posttraumatic Stress Disorder; $N=112$

†$p<0.10$; *$p<0.05$; **$p<0.01$; ***$p<0.001$

peritraumatic dissociation, and the type of psychological help that was received).

Prevalence and Prediction of Posttraumatic Stress Reactions

The results of this study show that in the sample of responding children between the ages of 8 and 14 years, 7.5 % presented severe posttraumatic stress reactions at T1 and 4.3 % still showed these reactions at T2. For these children, 60 % of those who presented with posttraumatic stress reactions at T1 did not present with these symptoms at T2 (three out of five responding children at T2).

These results indicate that several risk factors were associated with the severity of posttraumatic stress reactions. The first risk factor was the type of exposure, which referred to the subjective experiences of the children. Perceived life threat, experienced by the children who were primary victims, was the highest level of exposure. The secondary victims, who were direct witnesses of severe human suffering (e.g., burned, injured, and/or deceased victims), family members or close relatives of someone who was injured or died during the disaster, or direct witnesses of the explosion, were also affected, but to a lesser degree. Children who were exposed to the disaster in a sensory way (e.g., smells, sounds, and viewing the explosion) were still less affected. It might be surprising

that children only showed moderate to mild posttraumatic stress symptoms after being directly confronted with life threat and/or human suffering or bereavement. While the type of exposure was expected to lead to a different subjective experience, this experience may also have been different in children exposed to the same objective facts.

The second risk factor that came out of this study was peritraumatic dissociation during or immediately after the disaster, i.e., dissociative reactions such as out of body experiences, amnesia, automatic pilot behavior, tunnel vision, disorientation, and depersonalization. Reactions of peritraumatic dissociation appeared to be the most important factor in the development of posttraumatic stress symptoms at T1. This finding is in accordance with Ozer et al. (2003) and Lensvelt-Mulders et al. (2008), but to our knowledge there are no other studies with which our findings on the impact of peritraumatic dissociation on children's disaster experiences can be compared. In a meta-analysis on predictors of PTSD in adults, one subjective response during a potentially traumatizing event stood out among risk factors for PTSD: peritraumatic dissociation (Ozer et al. 2003). A more recent meta-analysis of studies published between 1995 and 2004 (Breh and Seidler 2007) confirmed Ozer et al.'s results (2003), but it is not clear whether or not these findings are valid in respect to children. According to Van der Velden and Wittman (2008), a limitation in most of these studies is the absence of the evaluation of possible confounding variables in the relationship between

Table 5 Predictors of the Severity of PTSD Symptoms at 14 Months

Severity of PTSD Symptoms at 14 months	Std. β	t	Equation	Adj. R^2	ΔR^2
Model 1: Sociodemographic Variables			$F(2, 59)=3.202$*	0.067	0.098
Age	−0.213	−1.718†			
Gender (0=male; 1=female)	0.235	1.899†			
Model 2: Exposure Type			$F(3, 58)=8.562$***	0.271	0.209
Age	−0.240	−2.193*			
Gender (0=male; 1=female)	0.238	2.180*			
Exposure (from primary victim to no victim)	−0.458	−4.182***			
Model 3: Peritraumatic Dissociation			$F(4, 57)=11.314$***	0.403	0.136
Age	−0.273	−2.746**			
Gender (0=male; 1=female)	0.230	2.324*			
Exposure (from primary victim to no victim)	−0.295	−2.727**			
Peritraumatic dissociation	0.405	3.724***			
Model 4: Psychological Help Received			$F(5, 56)=17.746$***	0.579	0.171
Age	−0.130	−1.466			
Gender (0=male; 1=female)	0.122	1.414			
Exposure (from primary victim to no victim)	−0.102	−1.026			
Peritraumatic dissociation	0.222	2.258*			
Severity of PTSD at 5 months	0.542	4.968***			
Model 5: Psychological Help Received			$F(6, 55)=15.952$***	0.595	0.022
Age	−0.102	−1.165			
Gender (0=male; 1=female)	0.095	1.106			
Exposure (from primary victim to no victim)	−0.070	−0.714			
Peritraumatic dissociation	0.264	2.663**			
Severity of PTSD at 5 months	0.497	4.537***			
Received psychological support (0=no; 1=yes)	0.167	1.821†			

Note. PTSD Posttraumatic Stress Disorder; *N*=62

†*p*<0.10; *p*<0.05; **p*<0.01; ***p*<0.001

peritraumatic dissociation and posttraumatic stress reactions. For instance, controlling for mental health problems occurring in the first few days or weeks post-event could modify the current insights about peritraumatic dissociation. This is in line with other findings which suggest that the reports of peritraumatic dissociation during or immediately after the particular event may be biased by the current psychological state of the affected individual (Bryant 2007; Candel and Merkelbach 2004; Harvey and Bryant 1999; Marschall and Schell 2002). Since the Ghislenghien study did not offer the possibility of gathering data on the pre-disaster mental health of the participants, it is unclear whether or not these findings are also applicable to children. According to Bui et al. (2010), it is possible that peritraumatic dissociation predicts the persistence of PTSD rather than its development. Our results cannot verify that, but future research could measure the peritraumatic reactions more immediately after the explosion. Although early posttraumatic stress symptoms are robust predictors of later posttraumatic stress symptoms, measuring peritraumatic distress in the children belonging to different

victim categories might also have been extremely useful in predicting the development of chronic posttraumatic symptoms. Another point of discussion concerns the fact that the questions regarding the proximity and exposure to the disaster, experienced life threat, peritraumatic experiences, and posttraumatic stress reactions relied on recollections reported by the children themselves. These retrospective data could imply a memory bias in these children but a lack of empirical evidence makes it impossible to draw conclusions on this subject. Future research could benefit from collecting data from younger children as their greater dependence on adults may provide additional useful insights to the investigation of trauma associated with disaster exposure, however this was not possible in this study.

Nevertheless, it is advisable to include peritraumatic dissociation and/or distress in screening measures intended to identify children at risk for the development of chronic posttraumatic sequelae. In an explorative study with survivors of severe motor vehicle accidents, De Soir and Goffings (2012) propose utilizing a set of grounding and psychological

stabilization techniques in order to counter peritraumatic dissociative states. Explorative quantitative and qualitative research on this kind of advanced psychological support indicates beneficial effects on preventing the development of posttraumatic stress reactions in accident survivors, but this still needs to be confirmed by randomized controlled trials with disaster survivors and children, more specifically.

The results mentioned above indicate that, even if the numbers are small, the children in our study should have received more help in the immediate aftermath of the disaster. Although, it is important to note that it was the parents who answered the questions regarding the psychological help that their children received and the perceived benefits of that help. This shows a possible mediating relationship between the impact of the disaster on adults and the well-being of their children. It remains unclear whether or not the provided help reached its targets.

Limitations

Although this study followed children on a longitudinal basis, results also reflect the problems inherent to retrospective research after a technological disaster. Among others, it did not take into account the psychiatric history nor the environmental factors which might have had an effect on the disaster experiences of the involved children. As always, disasters are sudden and there is difficulty in creating a control group.

Another limitation is the low overall response rate of 18 % and 16 % for the children. This response rate makes generalization and interpretation of the prevalence levels quite difficult. The study population included all people who could possibly have been affected. No exclusion criteria were established. The overall response rate at household level at 5 months was 18 %. In order to increase the response rate among the direct victims, they were contacted by psychologists who tried to motivate them to participate in the study. A majority of the people who declined to participate did not want to be confronted with the disaster again. Furthermore, bureaucratic and political issues regarding the responsibility of a disaster situation often lead to a delay in the onset of scientific study. The low response rate necessitates careful interpretation of subsequent results. Differences in respondent characteristics may lead to a bias in prevalence estimates and associations. In order to increase the participation rate in disaster research, questionnaires could be completed during a face-to-face interview, but this implies more resources. A higher response rate in other studies could also be a result of the shorter time interval between the disaster and the first administration of measures.

There could be three different causes for the lack of response to the present study. First, people might not have been able to answer the questionnaire due to hospitalization or recovery, be it physical or emotional. These people may not have wanted to be confronted with the disaster again. Secondly, it is possible that those living farther away from the epicenter of the disaster have not filled in the questionnaires because they did not feel involved or concerned with the disaster. This could lead to a non-response bias related to the exposure. Finally, this study was not integrated in the global management of the disaster. Several official institutions approached the affected victims and provided numerous official forms to complete. This may have led to disappointment in the authorities and lack of willingness to participate in a scientific study.

The suddenness of a technological disaster puts time pressure on the researchers regarding the development of an adequate research protocol. A methodological problem concerns the definition of "affected" population. In addition to the direct victims who were on the site of the disaster, a rather large group of residents were included in the study population in order to not miss any potentially affected victim. Nevertheless, a response percentage of 20 %, which was almost reached, is considered normal for postal questionnaires (Collectif 1995).

Recommendations for Future Research

In the future, a specific monitoring system for general practitioners could be set up in order to allow for more detailed monitoring of children involved in a disaster. The results of this study indicate the variety in both the evolution of posttraumatic symptomatology and the need for psychological help. A personalized contact would raise the probability of a better diagnosis, an identification of the needs of victims, and a more valid diagnosis of posttraumatic sequelae. This would increase the quality of trauma research in groups of children involved in disasters, allowing for the development of more specific instruments to identify posttraumatic stress reactions in children involved in technological disaster.

References

Alisic, E., Jongmans, M. J., Van Wesel, F., & Kleber, R. (2011). Building child trauma theory from longitudinal studies: A meta-analysis. *Clinical Psychology Review, 31*(5), 736–747. doi:10.1016/j.cpr. 2011.03.001.

American Psychiatric Association. (1994). *Diagnostic and statistical manual for mental disorders* (4th ed.). Washington: APA.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders (4th ed. Text edition)*. Washington DC: Author.

Bernat, J. A., Ronfeldt, H. M., Calhoun, K. S., & Arias, I. (1998). Prevalence of traumatic events and Peritraumatic predictors of posttraumatic stress symptoms in a non-clinical sample of college students. *Journal of Traumatic Stress, 11*(4), 645–664. doi:10.1023/A:1024485130934.

Breh, D. C., & Seidler, G. H. (2007). Is peritraumatic dissociation a risk factor for PTSD. *Journal of Trauma and Dissociation, 8*(1), 23–69. doi:10.1300/J229v08n01_04.

Brunet, A., Weiss, D. S., Metzler, T. J., Best, S. R., Neylan, T. C., Rogers, C., Fagan, J., & Marmar, C. R. (2001). The peritraumatic distress inventory: A proposed measure of PTSD criterion A2. *American Journal of Psychiatry, 158*(9), 1480–1485.

Bryant, R. A. (2007). Does dissociation further our understanding of PTSD? *Journal of Anxiety Disorders, 21*, 183–191. doi:10.1016/j.janxdis.2006.09.012.

Bryant, R. A., Salmon, K., Sinclair, E., & Davidson, P. (2007). A prospective study of appraisals in childhood posttraumatic stress disorder. *Behaviour Research and Therapy, 45*(10), 2502–2507. doi:10.1016/j.brat.2007.04.009.

Bui, E., Brunet, A., Allenou, C., Camassel, C., Raynaud, J.-P., Claudet, I., Fries, F., Cahuzac, J.-P., Grandjean, H., Schmitt, L., & Birmes, P. (2010). Peritraumatic reactions and posttraumatic stress symptoms in school-aged children victims of road traffic accident. *General Hospital Psychiatry, 32*, 330–333. doi:10.1016/j.genhosppsych.2010.01.014.

Candel, L., & Merkelbach, H. (2004). Peritraumatic dissociation as a predictor of post-traumatic stress disorder : A critical review. *Comprehensive Psychiatry, 45*, 44–50. doi:10.1016/j.comppsych.2003.09.012.

Carlson, E. B., & Putnam, F. W. (1993). An update on the Dissociative Experiences Scale. *Dissociation: Progress in the Dissociative Disorders, 6*, 16–27.

Collectif (1995). Enquête de santé par interview: Aspects méthodologiques. Document de travail. Bruxelles: CROSP/IHE, École de santé publique ULB.

Copeland, W. E., Keeler, G., Angold, A., & Costello, E. J. (2007). Traumatic events and posttraumatic stress in childhood. *Archives of General Psychiatry, 64*, 577–584.

Dalgleish, T., Meiser-Stedman, R., Kassem-Adams, N., Ehlers, A., Winston, F., Smith, P., Bryant, B., Mayou, R. A., & Yule, W. (2008). Predictive validity of acute stress disorder in children and adolescents. *The British Journal of Psychiatry, 192*, 392–393. doi:10.1192/bjp.bp.107.040451.

De Soir, E., & Goffings, K. (2012). Directe opvang van verkeersslachtoffers. [Direct care of victims of traffic accidents]. In E. Vermetten, R. J. Kleber, & O. van der Hart (Eds.), *Handboek Posttraumatische stressstoornissen* (pp. 321–335). Utrecht: De Tijdstroom.

Dewulf, A. C. (2005). *Impact of accidental injuries on children and their parents: traumatic stress, social sharing and emotions. Unpublished doctoral thesis.*. Belgium: Université Catholique de Louvain.

Ehlers, A., Mayou, R. A., & Bryant, R. A. (2003). Cognitive predictors of posttraumatic stress disorder in children: results of a prospective longitudinal study. *Behaviour Research and Therapy, 41*(1), 1–10. doi:10.1016/S0005-7967(01)00126-7.

Frederick, C. J., Pynoos, R. S., & Nader, K. (1992). The Child Post-Traumatic Stress Disorder Reaction Index. In K. Nader (Ed.), *Childhood trauma: A manual and questionnaires.* Unpublished manuscript. Copyrighted instrument.

Furr, J. M., Comer, J. S., Edmunds, J. M., & Kendall, P. C. (2010). Disasters and youth: A meta-analytic examination of posttraumatic stress. *Journal of Consulting and Clinical Psychology, 78*(6), 765–780. doi:10.1037/a0021482.

Harvey, A. G., & Bryant, R. A. (1999). Dissociative symptoms in acute stress disorder. *Journal of Traumatic Stress, 12*, 673–680. doi:10.1023/A:1024773202939.

Harvey, A. G., & Bryant, R. A. (2002). Acute stress disorder: A synthesis and critique. *Psychological Bulletin, 128*, 886–902. doi:10.1037/0033-2909.128.

John, P. B., Russell, S., & Russell, P. S. S. (2007). The prevalence of posttraumatic stress disorder among children and adolescents affected by tsunami disaster in Tamil Nadu. *Disaster Management and Response, 5*, 3–7. doi:10.1016/j.dmr.2006.11.001.

Kaplow, J. B., Dodge, K. A., Amaya-Jackson, L., & Saxe, G. N. (2005). Pathways to PTSD, part II: Sexually abused children. *American Journal of Psychiatry, 162*, 1305–1310. doi:10.1176/appi.ajp.162.7.1305.

Lensvelt-Mulders, G., Van der Hart, O., Van Ochten, J. M., Steele, K., & Breeman, L. (2008). Relations among peritraumatic dissociation and posttraumatic stress: A meta-analysis. *Clinical Psychology Review, 28*, 1138–1151. doi:10.1016/j.cpr.2008.03.006.

Marmar, C. R., Weiss, D. S., & Metzler, T. J. (1998). Peritraumatic dissociation and posttraumatic stress disorder. In J. D. Bremner & C. R. Marmar (Eds.), *Trauma, memory, and dissociation* (pp. 229–252). Washington: American Psychiatric Press.

Marschall, G. N., & Schell, T. L. (2002). Reappraising the link between peritraumatic dissociation and PTSD symptom severity: Evidence from a longitudinal study of community violence survivors. *Journal of Abnormal Psychology, 111*, 626–636. doi:10.1037//0021-843X.111.4.626.

McFarlane, A. C., & Van Hooff, M. (2009). Impact of childhood exposure to a natural disaster on adult mental health: 20-year longitudinal follow-up study. *British Journal of Psychiatry, 195*(2), 142–148. doi:10.1192/bjp.bp.108.054270.

Meiser-Stedman, R., Smith, P., Yule, W., Dalgleish, T., & Glucksman, E. (2007). Diagnostic, demographic, memory quality, and cognitive variables associated with acute stress disorder in children and adolescents. *Journal of Abnormal Psychology, 116*(1), 65–79. doi:10.1037/0021-843X.116.1.65.

Norris, F. H., Friedman, M. J., Watson, P. J., Byrne, C. M., Diaz, E., & Kaniasty, K. (2002). 60,000 disaster victims speak, Part I: An empirical review of the empirical literature, 1981-2001. *Psychiatry; 65*, 207–239. doi:10.1521/psyc.65.3.207.20173.

Ozer, E. J., Best, S. R., Lipsey, T. L., & Weiss, D. S. (2003). Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin, 129*, 52–73. doi:10.1037/0033-2909.129.1.52.

Pfefferbaum, B., North, C. S., Doughty, D. E., Gurwitch, R. H., Fullerton, C. S., & Kuyla, J. (2003). Posttraumatic stress and functional impairment in Kenyan children following the 1998 American Embassy bombing. *American Journal of Orthopsychiatry, 73*(2), 133–140. doi:10.1037/0002-9432.73.2.133.

Saigh, P. A., Yasik, A. E., Williams, H., Sack, M. D., & Koplewicz, M. D. (1999). Child-adolescent posttraumatic stress disorder: Prevalence, risk factors, and comorbidity. In P. A. Saigh & J. D. Bremner (Eds.), *Posttraumatic stress disorder: A comprehensive text* (pp. 18–43). Boston: Allyn & Bacon.

Saxe, G. N., Stoddard, F., Hall, E., Chawla, N., Lopez, C., Sheridan, R., King, D., King, L., & Yehuda, R. (2005). Pathways to PTSD, Part I: Children with burns. *American Journal of Psychiatry, 162*, 1299–1304. doi:10.1176/appi.ajp.162.7.1299.

Schäfer, I., Barkmann, C., Riedesser, P., & Schulte-Markwort, M. (2004). Peritraumatic dissociation predicts posttraumatic stress in children and adolescents following road traffic accidents. *Journal of Trauma & Dissociation, 5*(4), 79–90. doi:10.1300/J229v05n04_05.

Shah, N., & Mudholkar, S. (2000). Clinical aspects of post-traumatic stress disorder in children and adolescents. In K. N. Dwivedi (Ed.), *Post-traumatic stress disorder in children and adolescents* (pp. 97–112). Philadelphia: Whurr Publishers.

Shaw, J. A., Applegate, B., & Schorr, C. (1996). Twenty-one-month follow-up study of school-age children exposed to Hurricane Andrew. *Journal of the American Academy of Child and Adolescent Psychiatry, 35*, 359–364. doi:10.1097/00004583-199603000-00018.

Van der Hart, O., Van Ochten, J., Van Son, M. J. M., Steele, K., & Lensvelt-Mulders, G. (2008). Relations among peritraumatic dissociation and posttraumatic stress: A critical review. *Journal of Trauma & Dissociation, 9*(4), 481–505.

Van der Velden, P. G., & Wittman, L. (2008). The independent predictive value of peritraumatic dissociation for PTSD symptomatology after type 1 trauma: A systematic review of prospective studies. *Clinical Psychology Review, 28*, 1009–1020. doi:10.1016/j.cpr.2008.02.006.

World Health Organization. (1992). *The ICD-10 Classification of Mental and Behavioural Disorders: Clinical Descriptions and Diagnostic Guidelines*. Geneva: Author.