

Preliminary Evidence for a Classroom Based Psychosocial Intervention for Disaster Exposed Children with Posttraumatic Stress Symptomatology

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Abstract

Background In 2004, a firework factory in a residential area of a large Danish city exploded. The children at the local school were screened for symptoms of posttraumatic stress disorder (PTSD) 16 months and 3½ years after the incident. A large proportion of the children still suffered from a substantial number of symptoms 3½ years after the incident. Thus, a treatment program designed to target PTSD symptoms in trauma-exposed children was established.

Objectives The first aim of this study was to provide preliminary evidence that a classroom-based psychosocial intervention program for children with posttraumatic stress would be associated with reductions in symptoms. The second aim was to evaluate the usefulness of the Darryl, a cartoon-based PTSD screening instrument.

Methods One hundred and eight children participated in the treatment program, all of whom fulfilled at least two out of the three DSM-IV PTSD symptom clusters. The children were screened for PTSD symptoms at baseline and 1 month after treatment using Darryl.

Results There was a statistically significant reduction in PTSD symptoms from pre-treatment to post-treatment. Furthermore, a logistic regression analysis revealed that being female, being young, and having a high PTSD score at baseline predicted a probable PTSD diagnosis post-treatment.

Conclusion The present study provides preliminary evidence of feasibility and that the treatment program described may help to alleviate PTSD symptoms children with chronic PTSD symptoms. Furthermore, the results indicated that the Darryl instrument is a useful screening tool for assessing PTSD symptoms in this sample of children.

Keywords Trauma · Disaster · Treatment · Children · Assessment

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Introduction

There is growing evidence to suggest that children are highly vulnerable to exposure to potentially traumatizing events and that they often develop posttraumatic stress disorder (PTSD) based on such experiences (Costello et al. 2002; Elklit and Petersen 2008; Finkelhor et al. 2007). Exposure to potentially traumatizing events early in life can affect the biological, emotional, social, and cognitive functioning of children (Chu and Lieberman 2010). Early exposure to trauma has been found to be a risk factor for the development of psychiatric disorders such as PTSD later on in life (Elklit and Guðmundsdóttir 2006). There are many types of potentially traumatizing events that can lead to the development of PTSD symptoms in children (Donnelly and Amaya-Jackson 2002; Somasundaram and van de Put 2006). Potentially traumatizing events include violence, sexual assault, fire, illness, traffic accidents, and natural or technical disasters.

Disasters such as explosions, hurricanes or earthquakes may have an especially negative psychological impact on children and adolescents given that these events are unpredictable and often affect whole societies. Such disasters may lead to children being separated from their parents or even losing one or both parents. The children may have been injured or they may have been exposed to injured, dying, or dead people. Post-disaster, children are often continuously exposed to wreckage such as damaged homes or schools and they may further be exposed through media coverage of the event. Indeed very high rates of PTSD have been found among children exposed to such disasters. For example, La Greca et al. (1996) examined posttraumatic stress symptoms (PTS) among 442 school-age children 3, 7, and 10 months after Hurricane Andrew. After 10 months, it was found that one third of the sample (34 %) reported moderate to severe levels of PTS symptoms, and that 13 % of the sample reported severe to very severe levels, which may reflect clinically relevant PTSD (La Greca et al. 2010). In a study that examined children who were geographically distant from the Oklahoma city bombing in 1995, it was found that approximately 20 % of the children still showed difficulties in life functioning 2 years after the bombing. Prolonged media exposure and indirect exposure to the event were found to be important predictors of PTSD in this study (Pfefferbaum et al. 2000). Shaw et al. (1996) examined PTS symptoms among 30 children, 8 and 21 months after hurricane Andrew. Persistently high levels of symptoms were found over time. As many as 70 % of the children reported moderate to very severe symptoms after 21 months, and about 33 % reported severe to very severe levels. These findings suggest that elevated PTS symptoms present in children 7–9 months post disaster may persist for months or even years afterwards.

Several studies have found that if children develop PTSD symptoms these often have a more chronic nature (Scheeringa et al. 2011). If children at risk of developing PTSD are not detected and offered relevant treatment early on, then this may lead to both psychological and financial costs.

According to the DSM-IV (Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; American Psychiatric Association [APA]: 2000), children exhibit the same PTSD symptom clusters as adults: re-experiencing, avoidance, and hyper-arousal (APA 2000). In addition, children often express age-specific features of PTSD that differ from adult PTSD symptomology in some respects (McNally 1996). Children may experience trauma-related nightmares that, over time, evolve into generalized nightmares involving threats to oneself or significant others. Children may also exhibit repetitive play whereby they reenact the traumatic event. Regarding children and adolescents, symptoms associated with the avoidance/numbing PTSD cluster include a sense of foreshortened future where it is believed that one will not live long enough to become an adult. Hyper-arousal symptoms

for children and adolescents include insomnia, irritability, and concentration difficulties (APA 2000). Moreover, children often exhibit somatic symptoms such as headaches and stomach aches (Anthony et al. 1999). Most of these PTSD symptoms are difficult for parents to detect due to their intrinsic nature. Indeed, studies have shown that parents often underreport PTSD symptoms in their children (Charuvastra et al. 2010). Thus, it is important to utilize age-appropriate, screening measures upon exposure to traumatic events in order to identify children that are in need of treatment. A promising measure that may be used for this purpose is known as Darryl; a cartoon-based instrument designed to screen for PTSD symptoms in school-aged children (Neugebauer et al. 1999).

A number of studies have examined the effect of interventions designed to treat PTSD symptoms in children who have been exposed to disasters (Chemtob et al. 2002; Goenjian et al. 2005; Jaycox et al. 2010; Berger and Gelkopf 2009). Among the trauma-focused psychotherapies, cognitive behavioral therapy has received the most empirical support for the treatment of childhood PTSD after disasters (Cohen et al. 2010). One study has shown that treatment endorsed immediately after traumatic events has the strongest effect (Berkowitz 2003). In real-life, however, financial and practical constraints often result in delayed treatment opportunities, especially following a disaster that has affected a whole community. Furthermore, little is known about the early treatment interventions that are typically provided to children during the immediate aftermath of disasters, and whether they may cause harm to children, as they have been found to do in some adult studies (Litz and Gray 2004). There is some evidence to suggest that interventions carried out as long as 2–5 years after major disasters may still have a beneficial effect (Chemtob et al. 2002; Goenjian et al. 2005; Salloum and Overstreet 2012).

It is stated in the AACAP Practice Parameter for the Assessment and Treatment of Children and Adolescents With Posttraumatic Stress Disorder, that there is growing support for psychotherapies that focus not only on symptom improvement, but also on enhancing functional resiliency, and/or developmental trajectory (Cohen et al. 2010). A promising intervention designed to enhance resiliency and coping skills among children who have been exposed to uncertainty and stress—“the safe place program”, has been successfully used to treat over 6000 children in Israeli kindergartens following the Second Lebanese War (Berger et al. 2007). The program is based on a model developed by Ayalon and Lahad (1990); “the BASIC-Ph”. The safe place program has been shown to reduce the levels of anxiety among Israeli children and to lessen the overall degree of violence displayed by children in the kindergartens. The program has been shown to enhance the self-confidence of Israeli children as well as their ability to express emotions and their capacity to cope with change and uncertainty (Berger and Lahad 2010).

The purpose of the present study was twofold: (1) to provide preliminary evidence that that a classroom-based psychosocial intervention program for children with posttraumatic stress would be associated with reductions in symptoms; (2) to evaluate the usefulness of Darryl as an instrument for assessing treatment effect.

The Present Study

On the 3rd November 2004, a firework factory in a residential area of a large Danish city exploded. One fireman was killed and 760 households had to be evacuated. The explosion measured 2.2 on the Richter scale, and the financial damage reached to approximately 100 million euros. More than 175 houses burned down or were rendered uninhabitable as a result of the explosion. The explosion occurred during the afternoon. Many children had already finished school and were in their homes by that time.

Parents often look to schools to provide directions about how best to support children in times of crisis. Furthermore, schools are often the first to notice negative behavioral changes related to attention, abstract reasoning, IQ, as well as school attendance in children following exposure to traumatic events (Beers and DeBellis 2002). Thus, the local school situated in the area where the firework factory exploded was chosen as the location to assess and treat affected children.

The children ($n = 430$, aged 6–16) affected by the disaster participated anonymously in this preliminary study, which took place 16 months after the explosion. This preliminary study was conducted by a clinical psychologist from the Danish National Center for Psychotraumatology (Duch 2007; Duch and Elklit 2008). The parents of the affected children were informed of the results during a subsequent meeting that was held more than 1 year later. Several parents pointed out that their children were still suffering substantially. Therefore, an additional screening for PTSD (which was not anonymous) was carried out. The results of the screening showed that even 3½ years after the explosion, a large proportion of the children (25.1 %) still displayed substantial PTSD symptoms. Based on this finding, the Danish Ministry of Social Affairs agreed to fund an intervention study aimed at empowering and treating children in need.

Method

Procedure

The present study is non-randomized and non-controlled. The study was conducted almost 4 years after the explosion. All of the children at the local school were given the opportunity to be screened for PTSD using Darryl. Parents were informed about the objectives of the study and asked to provide written consent for their child/children to participate. Only one child did not participate because of lack of parental consent. A total of five psychologists, trained in use of Darryl conducted the screenings. Screening were conducted in the classroom on an individual level. The Darryl took an average of 20 min to fill out. The Darryl was read out loud to the children in the younger classes (grades 1 to 3). The present study was conducted in accordance with the ethical principles for Nordic psychologists¹ and was approved by both the parents and the local school authority. All of the children who fulfilled the criteria for at least two of the three DSM-IV PTSD symptom clusters were invited to participate in the treatment groups. This was the only inclusion criteria. One hundred and eight of the children who were initially screened fulfilled the inclusion criteria.

The treatment program consisted of four sessions as well as one follow-up session. Each session lasted 3 h and was conducted in the morning on four consecutive days. This was done in order to optimize the children's levels of energy and motivation. The assessment setting consisted of a familiar classroom at the local school. The follow-up session, which also lasted 3 h, was conducted 1 month after the final intervention session.

Participants

A sample of 108 children, aged 6–16 years, participated in the present study. The children were all attendees at the local school situated in the area affected by the firework factory

¹ <http://www.iupsys.net/index.php/iupsysresources/299-world-ethics/13245-ethic>.

explosion. Altogether, 59 (45 %) of these children attended first to third grade, 44 (41 %), attended fourth to sixth grade, and, 15 (14 %) attended seventh to ninth grade. The children were divided into 15 groups ranging from four to ten participants based on class level. This was done in order to target the specific parts of the treatment at a cognitively and emotionally appropriate developmental level.

Measures

Darryl: Darryl (in Danish “Thomas”) is a cartoon-based, screening instrument designed to measure PTSD symptoms among school-age children who have experienced one or more potentially traumatizing events (Neugebauer et al. 1999). An important advantage of using Darryl for screening purposes in children is that it employs both visual and auditory clues to gather information. Thus, smaller children and children with reading and/or writing difficulties can also be screened using this measure. Furthermore, it is a simple and quick measure that easily can be administered not only by doctors and psychologists, but also by school teachers, nurses etc.

The pictures featured in the measure illustrate the emotional, cognitive, and behavioral symptoms of PTSD. The cartoons feature Darryl, a pre-adolescent boy of indeterminate ethnicity, and each cartoon depicts a PTSD symptom. Originally, the Darryl was designed to assess community violence-related PTSD among school-aged children. With the permission of Dr. Neugebauer, the cartoon pictures were adapted to resemble situations from the fireworks disaster. For each cartoon, the interviewer reads out loud a short script describing the symptom content. The sentences offer an auditory description of the symptoms that complements the visual stimulus provided by the cartoons. Cognitive theory suggests that a combination of visual and auditory stimuli allows for better information-processing and a better understanding of abstract concepts compared to visual or auditory stimuli alone (Valla et al. 2000). The pictorial format of Darryl also aids children’s understanding of the abstract concepts by stimulating their attention and focusing their interest.

A recent study has confirmed the validity of the adapted scale by showing that it is strongly associated with two commonly used measures of PTSD as well as three measures of trauma exposure (Elklit et al. 2012). The response choices are “never”, “some of the time,” or “always” and are coded as 0, 1, or 2 respectively. The response choices are shown on a thermometer (empty, half full and full).

The Darryl that was employed in the present study contained 27 items designed to measure DSM-IV PTSD symptomology in children. The symptoms were divided into the following core symptom clusters: re-experiencing, avoidance, and hyper-arousal. Participants met the DSM-IV diagnostic criteria for PTSD if they endorsed at least: (a) one re-experiencing symptom; (b) three avoidance symptoms; and, (c) two hyper-arousal symptoms, corresponding to DSM-IV criteria. Symptoms were rated as being endorsed if the answers to the specific cartoons were “sometimes” or “always.” The Darryl instrument showed very good internal consistency; Chronbach’s alpha coefficients were .91 and .95 for pre-treatment and post-treatment, respectively.

Intervention

The therapeutic intervention program for the Danish children (Elklit et al. 2009) was manualized in cooperation with Dr. Ofra Ayalon. Dr. Ayalon has extensive experience in treating children who have been exposed to various traumatic events in Israel and other

parts of the world. Her theoretical framework consists of a combination of cognitive and narrative methods and includes many of the commonly provided TF-CBT components as described by Cohen et al. (2006).

The intervention is designed to facilitate the cognitive restructuring of children's perception of their own inner resources and the creation of a coherent trauma narrative. The main goal of the therapeutic intervention is "to train children in the acquisition of generic coping skills such as self-trust, tolerance of ambiguity, communicative skills, and problem solving techniques" so that they will become better at enduring stressful situations and using their own resources to handle them (Ayalon 1992). The present treatment program is inspired by the aforementioned safe program (Berger and Lahad 2010), which is based on the BASIC-Ph model developed by Ayalon and Lahad (1990).

The BASIC-Ph assumes that all individuals possess coping resources that can be divided into the following six dimensions: belief, affect, social interaction, imagination, cognition, and physiology. The six coping dimensions are presented in Fig. 1. According to Ayalon (1998), the cognitive coping dimension (C) comprises strategies such as information gathering, problem solving, and positive thinking. The affective coping dimension (A) comprises the wide range of emotions that can be triggered by trauma as well as their verbal or non-verbal expression. The social coping dimension (S) encompasses group belonging, role-fulfillment, and the mutual function of receiving and giving support. The imaginative coping dimension (I) enables the amelioration of stress through denial and fantasy, however, it is also responsible for creative problem solving strategies like imagery and dreams. The spiritual coping dimension (B) comprises religious beliefs and value systems. The physical coping dimension (Ph) is responsible for the neuro-chemical and behavioral responses to stress, as well as physical ways of handling stress e.g. relaxation and physical activity.

The methods featured in the present intervention reflect these six dimensions and aim to help children develop and strengthen their coping skills across all dimensions. Dr. Ayalon spent 3 days in Denmark training the group of therapists to employ the intervention strategies. The therapist group consisted of five senior child psychologists and five junior psychologists.

Elements of the Treatment Program

Overall, the structure and elements of the treatment program were the same across classes. The structure and elements of the treatment program are presented in Table 1. However, some of the exercises and structural elements were adjusted in order to match the cognitive and developmental levels of the children in the different classes. For example, a "talking stick" was introduced to the children in some of the younger classes. Children were only allowed to speak when they held the "talking stick". This method was used only with 1st to 6th graders. The aim of the initial part of the treatment was to enhance the children's coping competences as well as to induce a sense of individual and group empowerment. These treatment goals were pursued during the first 2 days of the program. On the third day, the focus of the program shifted to debriefing, empowerment, and creating a coherent trauma narrative which focuses on meaning and future life. The youngest children would draw whilst listening to other children's narratives. Drawing represents a learned, creative coping mechanism. It functions as an emotional outlet for negative emotions that may be aroused during revelations of traumatic memories, and it also assists concentration.

Each session consisted of several cycles of activities; energizing activities were followed by more quiet and deepening activities. The children were given breaks and snacks

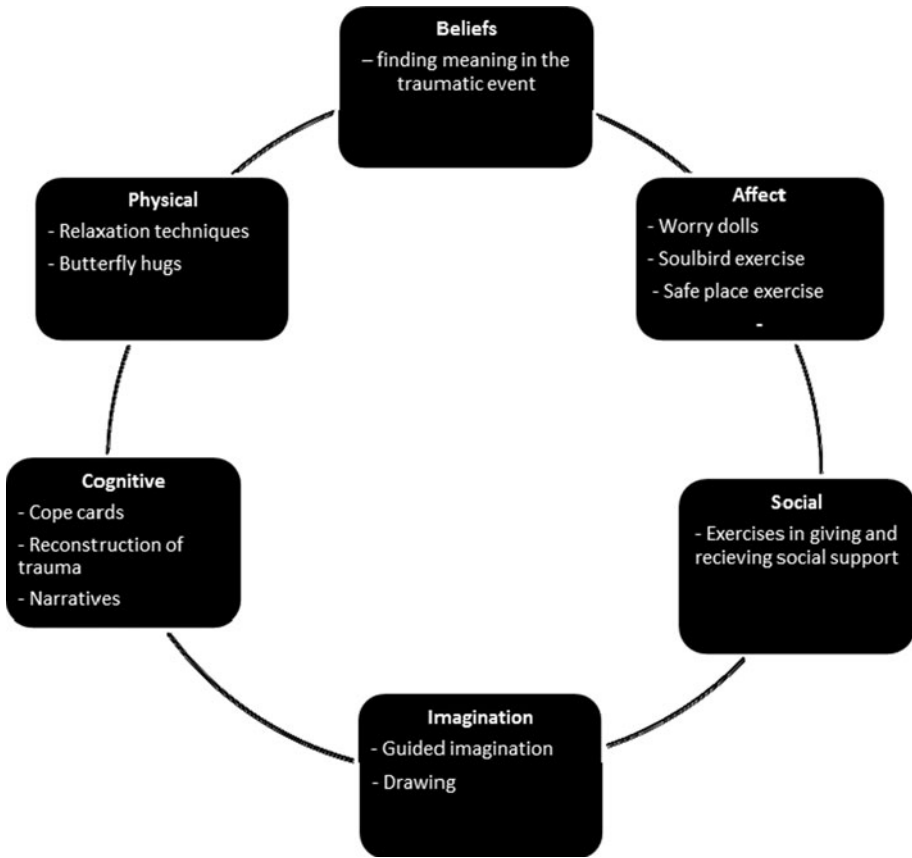


Fig. 1 The BASIC-PH model and examples of treatment elements

Table 1 The intervention program for the youngest children

Day 1	Day 2	Day 3	Day 4	Follow up
Welcome	Welcome	Welcome	Welcome	Welcome
Presentation	Follow-up from yesterday	Follow-up from yesterday	Follow-up from yesterday	Intro
Rules	Rules	Rules	Rules	Rules
Contact information	Physical exercises	Physical exercises	Physical exercises	Repetition of exercises
Physical exercise	Thoughts, feelings, body	Empowerment debriefing	Relaxation techniques	Darryl
Intro	Soulbird exercise	Strength stones	Choose your dream	Me and my life
Name game	Cope cards	Butterfly hugs	Evaluation	Butterfly hugs
Darryl	Butterfly hugs		Butterfly hugs	
Animal cards				
Safe place				
Butterfly hugs				
Round-off	Round-off	Round-off	Round-off	Round-off
Battle cry	Battle cry	Battle cry	Battle cry	Battle cry

during the 3 h sessions. This was done in order to secure an optimal level of arousal. Examples of the different activities are presented in Fig. 1.

In order to ensure that the children would be able to remember and use their newly acquired abilities and insights upon treatment termination, they were provided with a bag/box containing the objects used during the different sessions. Objects included: drawings, beach stones, candles, worry dolls, notebooks, selected COPE cards that had been enlarged and laminated etc. COPE cards are cards that symbolically illustrate the coping mechanisms that are typically applied by children (Ayalon and Ayalon 1993).

A more detailed description of the intervention program can be found in Elklit et al. 2009. Interested readers are also welcome to contact the Danish national center of Psychotraumatology.²

Community Focus

The treatment program was community-based meaning that it involved the whole school system. All of the teachers as well as the non-participating students and the parents were invited to listen to an introduction about traumatic exposure and trauma reactions. Community-based programs represent an alternative to most of the methods that are used in therapy, trauma therapy in particular. Community-based programs focus on the empowerment of the client as opposed to treating traumatized individuals in a clinical setting using preconceived diagnostic and therapeutic procedures. Community-based programs emphasize resilience, coping, and the salutary effects of intervention in the natural life space (Ayalon 1998).

Treatment Fidelity

In order to ensure that the sessions were as uniform as possible and to address any problems, the psychologists had one joint supervision session during the intervention period, and an end-of-the-day evaluation after each day of intervention.

Results

Of the 108 children in this study, 69 (63, 9 %) were female and 39 (36.1 %) were male. The children attended school grades ranging from 1 to 9. All of the children completed the treatment program and most of them attended all of the sessions featured in the intervention program. The exact number of sessions that were missed was not recorded. Fourteen children (13 %) did not complete the post assessment due to being absent on the day or having changed school.

A paired-samples *t* test was conducted to assess the impact of the treatment program. A statistically significant reduction was observed from pre-treatment to post-treatment in 2 of the 3 symptom categories (re-experiencing: $t(94) = 4.12, p < .001$; avoidance: $t(96) = 2.50, p < .02$; arousal: $t(96) = 1.73, p < .087$) and in the total number of PTSD symptoms (symptom total: $t(94) = 3.76, p < .001$). The results of the paired-samples *t* test are presented in Table 2. Prior to the treatment program, a total of 34 children fulfilled the criteria corresponding to a full DSM-IV PTSD diagnosis. Upon termination of treatment, only 19 children met the criteria for a probable PTSD diagnosis. An overview of the development of PTSD

² www.psykotraume.dk.

Table 2 PTSD symptoms pre- and post-treatment

PTSD symptom category	Mean	SD	<i>d</i>
Re-experiencing			
Pre	2.45	2.18	.31
Post	1.78	2.20	
Avoidance			
Pre	2.88	2.57	.20
Post	2.36	2.61	
Hyperarousal			
Pre	1.98	1.74	.14
Post	1.72	1.94	
Symptoms total			
Pre	7.32	5.67	.25
Post	5.87	6.15	

over time is presented in Table 3. There was a significant reduction in the number of children with a full PTSD diagnosis from pre-treatment to post-treatment, however, the effect size was small ($\chi^2 = 43.36$, $p < .001$, $d = .28$). According to the Reliable Change Index (RCI), the overall level of symptom improvement was not reliable (.59): from pretreatment to post-treatment 49 % ($n = 46$) of the children improved, 37 % (35) were stable and 14 % ($n = 13$) deteriorated.

Significantly more girls than boys fulfilled the criteria for a probable PTSD diagnosis. This difference was maintained at post-treatment. Prior to treatment, 29 girls and 5 boys obtained a PTSD diagnosis ($r = .21$, $p < .05$). At post-treatment, 17 girls and 2 boys still obtained a PTSD diagnosis ($r = .27$, $p < .05$). The size of the treatment group and the effect of the therapist dyads conducting the treatment were not associated with treatment effect.

A logistic regression analysis was performed to assess whether gender, age, and pre-treatment levels of PTSD impacted the likelihood that children still obtained a PTSD diagnosis at post-treatment. The results of the logistic regression are presented in Table 4. Being female predicted PTSD diagnosis at post-treatment; an odds ratio of 7.25 was recorded. Thus, the girls in this sample were over 7 times more likely than the boys to fulfill a PTSD diagnosis upon treatment termination. However, the difference in PTSD levels at post-treatment between boys and girls is due to girls being more likely to fulfill a PTSD diagnosis at pre-treatment. Age also had a significant impact on post-treatment diagnosis. The younger the child was, the higher the risk of fulfilling a PTSD diagnosis at post-treatment (OR = .62). Finally, high PTSD scores at pre-treatment also predicted PTSD diagnosis at post treatment; an Odds Ratio of 1.34 was recorded.

Discussion

This study evaluated a school-based group treatment of chronic PTSD symptoms in children after a firework factory explosion in a large Danish city. The results revealed a significant reduction in PTSD symptoms among children upon treatment termination. This is in spite of the fact that the intervention was carried out 4 years after the explosion. More

Table 3 Development of PTSD symptoms over time

No. of symptom clusters	Pre-treatment	Attrition	Post-treatment	Recovery	Stable	Deterioration
3 = PTSD	34 (32 %)	2	19 (20 %)	18	13	6
2 = Subclinical PTSD	24 (22 %)	3	20 (21 %)	16	3	4
1	32 (30 %)	4	25 (27 %)	12	8	3
0	18 (17 %)	5	30 (32 %)	NA	11	NA
Total	108	14 (13 %)	94	46 (49 %)	35 (37 %)	13 (14 %)

The Table shows the numbers of PTSD cases and levels of PTSD severity (fulfilling 3, 2, 1 or 0 of the symptom clusters in the PTSD diagnosis) before and after the intervention. The table also includes information about attrition in relation to PTSD severity and how many from each group that have recovered (now belonging to a group with fewer symptoms), remained stable or have deteriorated (moved from a group with fewer symptom to a group with more symptoms)

Table 4 Logistic regression predicting likelihood of post-treatment PTSD diagnosis

	B	SE	Wald	df	p	Odds ratio
Sex	1.98	.99	4.01	1	.05	7.25
Age	-.47	.18	7.02	1	.01	.62
Pre-treatment PTSD score	.29	.07	16.93	1	.00	1.34

than 25 % of the children attending a local school in the area where the explosion occurred screened positive for PTSD or subclinical PTSD 4 years after the explosion. These children were included in the treatment program. The results of the present study highlight the importance of conducting long-term screening assessments in children who have been exposed to traumatic events and providing them with appropriate treatment for mental health problems. Many of the children who were exposed to the firework factory explosion still suffered from a clinically significant level of PTSD 4 years after the accident and this is likely to have serious consequences regarding the affected children's mental health and scholastic performance (Beers and DeBellis 2002; Chu and Lieberman 2010).

Regarding the Daryl measure, the results showed a significant reduction in both the re-experiencing and avoidance categories of PTSD from pre-treatment to post-treatment. However, symptom reduction in the arousal category did not reach statistical significance. Two episodes observed at the local school illustrate the persistence of arousal symptoms among the children. After a short lecture about PTSD, which took place during a parents meeting, the head teacher stated that he now understood why so many of the children had reacted the way they did when a controlled chimney explosion was carried out in the neighborhood 3 weeks earlier. Indeed, a number the children started to cry when the first warning siren was sent out. The second episode occurred on the day that Dr. Ayalon arrived for the first training day at the local school. A fire engine was parked outside. Some of the classes had been invited to come and see the truck. Out of courtesy, one of the firemen switched on the siren. However, the result was that many of the children started to cry. This was witnessed by the whole group of psychologists.

The persistence of arousal symptoms following traumatic exposure is a tendency that has been observed in a number of other post trauma intervention studies involving children (Salloum 2008; Salloum et al. 2001). These studies provide evidence to suggest that the

chronicity of arousal symptoms among children may be due to continuous exposure to potentially traumatizing experiences (PTEs). However, this does not appear to be the case regarding the children in the present study given that they lived in a very secure and quiet area in Denmark. Therefore, it is likely that the majority of these children were not exposed to further PTEs following the firework explosion. One explanation for the persistence of arousal symptoms among children following traumatic exposure is that the interventions employed in the present- and above mentioned studies may not have adequately targeted the arousal symptom cluster. Another explanation could be that arousal symptoms are more recalcitrant than symptoms from the other two symptom clusters, and that this may be especially true in children. Finally, the Darryl instrument did not screen for PTSD symptoms associated with other traumatic events besides the explosion, hence, it may be that the children who showed less or no symptom reduction had been exposed to multiple traumatic events prior to the explosion. Thus, interventions designed to target the avoidance symptom cluster (e.g. by using exercises that focus on targeting desensitization, self-calming skills, and a sense of safety) as well as prior victimization experiences may be advantageous when it comes to treating children post disaster. Additional studies are needed before anything concrete can be concluded regarding this matter.

According to the Reliable Change Index (RCI) the overall level of symptom improvement in the present study was not reliable. Moreover, the effect size for the reduction in the number of children with a full PTSD diagnosis from pretreatment to post treatment was relatively small ($d = .28$). These findings are in contrast with those of similar post disaster intervention studies involving children (Chemtob et al. 2002; Salloum and Overstreet 2012), indicating that the change observed in PTSD symptomatology after the present intervention may not be statistically significant. However, given that one of the above mentioned studies examined a very thorough 11 session intervention (Salloum and Overstreet 2012) and that the other study was conducted only 2 years after a disaster (Chemtob et al. 2002), the lower effect size observed in the present study may be due to the fairly short intervention period combined with a longer period of time prior to intervention. Although the present intervention is short, comprised of only four sessions, and was carried out three and a half years after the explosion, it still resulted in the reduction of PTSD symptoms in 49 % of the implicated children. Thus, the present intervention may still be a promising tool for treating children post disaster. Given that there were only 1 month between pre and post-assessments and that they were conducted 4 years after the explosion, it seems unlikely that so many of the children would have recovered spontaneously in this short period of time. Research has consistently suggested that class-based interventions such as cognitive behavioral therapies and manualized teacher interventions are promising for symptom reduction in traumatized children Baum et al. 2013; Taylor and Weems 2011). The intervention in the present study included several CBT components, but did not adhere entirely to a CBT manual. Since the majority of intervention studies that has been conducted has used different methods and intervention components, it is hard to make conclusions about what works and what does not, why it has worked and in some cases, why it has not. It may be that only some of the elements in the present intervention (i.e. CBT elements) has had an impact on PTSD symptoms while others, such as the imagination exercises, had no impact and that this is the reason why the overall effect size is so low compared to more stringent CBT interventions. Also, we did not measure social desirability among the implicated children or the test–retest reliability of Darryl, and this leaves many uncertainties regarding this study. Additional intervention studies using the same methodology, some of which should be conducted shortly after the occurrence of a disaster, are therefore warranted.

The results indicate that being female, being young, and having a high PTSD symptom score at pre-treatment predicts post-treatment PTSD. In the present study, girls reported significantly higher PTSD scores at both pre-treatment and post-treatment compared to boys. The majority of studies that have evaluated interventions designed to treat children after disasters have found being female to be a risk factor in terms of developing higher PTSD scores immediately after the disaster and having higher PTSD scores upon termination of the treatment (Chemtob et al. 2002; Goenjian et al. 1995, 2001, 2005; Vernberg et al. 1996). Other studies have reported no differences between the genders (Salloum and Overstreet 2012). In general, it has been consistently found that girls exhibit more PTSD symptoms than boys (Bal 2008; Goenjian et al. 2001). This may be due to girls being more willing to report psychological distress or having a greater tendency to internalize their symptoms in response to traumatizing events (Vogel and Vernberg 1993). Furthermore, the baseline level of PTSD has been shown to predict PTSD at post-treatment (Jaycox et al. 2010). In line with this, the results of the present study indicate that girls and boys benefited equally from the treatment program but that girls were at higher risk of fulfilling a PTSD diagnosis at post-treatment because they had high PTSD scores at pre-treatment. As reported in the present study, low age has previously been found to predict PTSD after interventions (Chemtob et al. 2002). Other studies have found no age differences (Salloum and Overstreet 2008; Jaycox et al. 2010). Given the sparse data regarding the extent to which gender, age, and baseline PTSD predict post-treatment PTSD, researchers should continue to explore these variables. However, given that these variables cannot be changed, it may be more profitable to focus on variables that are more changeable; variables that we know are related to PTSD symptom levels and treatment effect such as social support, coping strategies, and the therapeutic alliance.

Given that 25 % of the children involved in this study reported PTSD symptoms as long as 4 years after exposure to the factory explosion, this study highlights the importance of screening repeatedly for PTSD symptoms among children exposed to disasters. The Darryl instrument was easy to administer and proved to be a very useful screening tool in this sample of Danish children.

Whereas previous studies have documented that conducting interventions in the immediate aftermath of traumatic exposure is effective when it comes to reducing PTSD symptoms among children (Berkowitz 2003), the present study provides preliminary evidence for the efficacy of a classroom-based treatment program that was conducted several years after traumatic exposure. This is promising, given that communities vulnerable to natural and technical disasters, often lack the financial and practical means to carry out effective treatment during the immediate aftermath of a disaster (World Health Organization 2007).

The results of the present study should be interpreted in light of several limitations. Firstly, this study did not include a control group. Second, although a validated screening measure—the Darryl—was employed to assess pre- and post-treatment PTSD symptoms, this relies on self-report, measures which may be biased. However, previous studies (Roeholt et al. 2013) have shown that the Darryl corresponds very well with thorough diagnostic interviews such as the CAPS-CA. Thirdly, this study included only pre and post-assessments and did not allow for the assessment of the long-term treatment effects. Fourthly, only one outcome measure was used. To examine the full impact of post-disaster experiences as well as the following course of development, treatment studies need to go beyond just measuring PTSD. Finally, it is a limitation that therapists' adherence to the therapeutic guidelines specific for this intervention was not secured more extensively. The strengths of this study include: the use of a validated assessment instrument, the

manualized treatment program, and the use of experienced psychologists who were trained specifically to use the treatment manual.

Conclusion

When children develop PTSD symptoms after traumatic exposure, these symptoms are often chronic in nature and have serious psychological, behavioral, and academic consequences for the affected children. The present study, which involved Danish school children who had been exposed to a firework factory explosion, showed that the treatment program developed by Dr. Ayalon was successful in alleviating PTSD symptoms among this group of children with chronic PTSD symptoms. Furthermore, the results indicated that the Darryl instrument was a useful screening tool for assessing PTSD symptom levels and treatment effect in this sample of school children.

Conflict of interest The authors declare that they have no conflict of interest.

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