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Children's Sedentary Activity After Hurricane Exposure

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The current study examined the potential impact of a natural disaster, Hurricane Ike, on children's levels of sedentary activity. Sedentary activity is a health risk behavior associated with poor chronic health outcomes. Hurricane exposure (perceived and actual life threat) and recovery stressors (hurricane-related and major life events) were expected to be associated with posttraumatic stress (PTS) symptoms and sedentary activity. Children (n = 204; 51% girls; M age = 9.23 years; 73% ethnic minorities) from Galveston, Texas, were evaluated 8 months posthurricane. Child-report measures of traumatic experiences, major life events, PTS symptoms, height and weight, and sedentary activity were collected; actual height and weight measurements were collected for a subset of 53 children. Consistent with expectations, hurricane exposure and recovery stressors were significantly associated with PTS symptoms and sedentary activity. Findings also suggest that PTS symptoms may mediate the relationship between stressors and sedentary activity. Implications for schools, families, and future research are discussed.

Keywords: disaster, physical health, structural equation modeling, children

This study examined the potential impact of a natural disaster on children's sedentary activity, defined as engaging in low-energy activities such as watching TV or using computers (Myers, Strikmiller, & Webber, 1996). Children's sedentary activity is a key health risk behavior highlighted by the Centers for Disease Control and Prevention (2013). Sedentary activities and lifestyles among children are associated with increased energy intake (Temple, Giacomelli, Kent, Roemmich, & Epstein, 2007), as well as poor chronic health outcomes such as obesity, heart disease, high blood pressure, and Type 2 diabetes (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998; Goldfield et al., 2007; Hu, Li, Colditz, Willett, & Manson, 2003; Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Martinez-Gomez, Tucker, Heelan, Welk, & Eisenmann, 2009). No known research has examined children's sedentary activity levels postdisaster. This is an important gap in the literature, given the health risks associated with sedentary activity.

Disasters are likely to be associated with increased sedentary activity among children for several reasons. First, numerous stressors are present postdisaster (Ekşi et al., 2007; La Greca et al., in press; La Greca, Silverman, Lai, & Jaccard, 2010; Lai, La Greca, Auslander, & Short, 2013), and research suggests that stressors are associated with increased sedentary activity among children (Hamer, Stamatakis, & Mishra, 2009; Roemmich, Gugrol, & Epstein, 2003). Second, it is well established that many children display elevated symptoms of posttraumatic stress (PTS) after disasters (Kolaitis et al., 2003; Scheeringa & Zeanah, 2008; Yelland et al., 2010), and psychological distress symptoms are also associated with higher levels of sedentary activity among youth (Brodersen, Steptoe, Williamson, & Wardle, 2005; Johnson et al., 2008; Page, Cooper, Griew, & Jago, 2010). Third, disasters may destroy playgrounds and gymnasiums, which are primary areas for school-aged children's physical activities (Farley et al., 2007). Fourth, parents may have safety concerns about outdoor spaces postdisaster, due to debris and other vestiges of the event (Hall, 2008), and thus they may encourage children to stay indoors. Finally, stressors that occur during the recovery period (e.g., parental job loss, changing schools) might also limit children's playtime, after-school activities, and friendships (Silverman & La Greca, 2002).

Reducing children's sedentary activity and increasing their physical activity might be an important intervention to consider postdisaster. Children's sedentary activity is associated with poorer self-esteem, decreased academic achievement, and lower commitment to physical activity (Holder, Coleman, & Sehn, 2009; Russ, Larson, Franke, & Halfon, 2009; see Tremblay et al., 2011, for a systematic review). These findings have been demonstrated among youth of all ethnic backgrounds, including predominantly minority samples (Racine, DeBate, Gabriel, & High, 2011), Asian youth (Chen, Liou, & Wu, 2008), and African American girls (Robinson et al., 2003). Decreasing children's sedentary activity is associated with decreased energy intake (Epstein, Roemmich, Paluch, & Raynor, 2005), increased aerobic fitness (Epstein, Paluch, Gordy, & Dorn, 2000) and activity (Epstein & Roemmich, 2001), and improved academic achievement (Robinson et al., 2003). At the same time, increasing children's physical activity is associated with both physical health benefits (e.g., reduced risk for obesity; Epstein et al., 2000), reduced levels of sedentary activity (Robinson et al., 2003), and improved mental health outcomes (Annesi, 2004; Diaz & Motta, 2008; for reviews see Ahn & Fedewa, 2011; Biddle & Asare, 2011; Ekeland, Heian, & Hagan, 2005).

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Currently, postdisaster interventions rarely consider children's activity levels (La Greca & Silverman, 2009). However, activity interventions have been successfully implemented in schools (Kriemler et al., 2010) by school personnel (Walters & Martin, 2000; for a review, see Ahn & Fedewa, 2011). Such evidence suggests that activity interventions are a lower-cost intervention that could be broadly implemented by adults to help youth in disaster-affected areas. In particular, activity interventions might be able to address many of the challenges that arise in implementing services postdisaster, such as difficulties engaging children, high cost, and lack of clinical workforce skills and capacity (CATS Consortium, 2007; Jaycox et al., 2010). In contrast, postdisaster psychological interventions are costly to administer and may be less feasible to implement because they require the expertise of highly trained psychologists or mental health personnel (La Greca & Silverman, 2009).

In this study, an existing conceptual model of children's postdisaster functioning (e.g., La Greca et al., 2010; La Greca, Silverman, Vernberg, & Prinstein, 1996) was extended to examine children's sedentary activity after a destructive hurricane, Hurricane Ike. Hurricane Ike was a Category 2 hurricane that struck Texas in September 2008 and was one of the most costly hurricanes in U.S. history (Blake, Landsea, & Gibney, 2007). This conceptual model was originally developed to better understand children's *psychological functioning* postdisaster (Silverman & La Greca, 2002), and it has not yet been extended to health behavior outcomes. We built on an existing conceptual model because it is well established and has been replicated for numerous postdisaster psychological outcomes (e.g., PTS symptoms, depression, and anxiety). Moreover, this model emphasizes the influence of stressors on children's postdisaster functioning, which parallels the linkage between stressors and sedentary activity in the broader literature on children's health behaviors (e.g., Pugliese & Tinsley, 2007; Stice, Shaw, & Marti, 2006).

The existing model hypothesizes that children's postdisaster outcomes would be predicted by stressors and child characteristics. Regarding stressors, two types of stressors are conceptualized to play a role in children's functioning postdisasters: hurricane *exposure* and *recovery* stressors (La Greca et al., in press; Norris et al., 2002; Silverman & La Greca, 2002). Hurricane exposure includes children's perception of life threat (i.e., thinking they might die) and actual life-threatening events that occur during the disaster. Recovery stressors include initial and ongoing disaster-related loss and disruption (e.g., damage to homes, changing schools, moving away from friends), as well as other stressful events that occur during the postdisaster recovery period (e.g., family illness, parental divorce) that may or may not be disaster related. Recovery stressors have been found to mediate the relationship between hurricane exposure and children's postdisaster outcomes, and also contribute to the maintenance or persistence of postdisaster psychological reactions (e.g., La Greca et al., 2010). Thus, in this study, we expected that hurricane exposure and recovery stressors would be positively associated with children's levels of sedentary activity, and that hurricane exposure would be associated with children's sedentary activity through recovery stressors (a potential mediating pathway).

Additionally, child characteristics are emphasized in the model as important for understanding postdisaster reactions (Vernberg, La Greca, Silverman, & Prinstein, 1996; Weems et al., 2007). For example, higher PTS symptoms have been reported among girls (Agustini, Asniar, & Matsuo, 2011; McDermott, Cobham, Berry, & Stallman, 2010) and minority youth (La Greca et al., 1996). Thus, we incorporated child characteristics into our adapted conceptual model for examining children's sedentary activity levels. Specifically, we focused on the child characteristics of gender, ethnicity, and weight—factors that have been related to children's sedentary activity (Andersen et al., 1998; Berkey et al., 2000). With respect to the relationship between children's gender and sedentary activity, findings are mixed. Some studies report that boys and girls engage in roughly the same amounts of sedentary activity (Andersen et al., 1998), others report that boys engage in more sedentary behavior than girls (Berkey et al., 2000; Colley et al., 2011), and still other studies report higher levels of sedentary activity in girls (Matthews et al., 2008). Regarding ethnicity, African American and Hispanic children reportedly engage in more sedentary activity than White children (Andersen et al., 1998; Crespo et al., 2001; Matthews et al., 2008). Finally, with respect to weight, children who engage in higher amounts of sedentary activity tend to be heavier (Andersen et al., 1998; Eisenmann, Bartee, & Wang, 2002). Thus, these child characteristics were examined as potential covariates of children's postdisaster sedentary activity.

Further, we extended the conceptual model to examine whether stressors could be viewed as indirectly related to sedentary activity through the potential mediating pathway of PTS symptoms. Associations between stressors and children's PTS symptoms postdisaster are well established (Blaze & Shwalb, 2009; La Greca et al., 2010; Norris et al., 2002; Yelland et al., 2010; Weems et al., 2007), and psychological distress is associated with higher levels of sedentary activity among children (Brodersen et al., 2005; Hamer et al., 2009; Page et al., 2010) and adults (Hamer, Stamatakis, & Mishra, 2010). Thus, PTS symptoms were expected to act as a potential mediator of the relationship between stressors and sedentary activity.

In summary, this article is the first to systematically examine children's sedentary behaviors postdisaster. Based on a conceptual model, we examined potential predictors (i.e., exposure and recovery stressors, PTS symptoms, and child characteristics) of postdisaster sedentary behavior. Understanding variables that contribute to children's postdisaster sedentary behavior may help identify children who might benefit from postdisaster interventions to improve health behaviors and might suggest specific targets for interventions.

Method

Participants

Participants were 204 third (49%) and fourth graders (51%). Children were recruited from all elementary schools in Galveston, Texas, that were in operation post-Hurricane Ike. The Galveston area was in the direct path of Hurricane Ike (McKinley & Krauss, 2008). Children (51% female) ranged in age from 7 to 11 years ($M = 9.23$, $SD = .79$) and came from diverse ethnic backgrounds (35% Hispanic, 27% White, 22% African American, 4% Asian, 13% "Mixed" or "Other"). Most children (57%) lived in two-parent homes, 41% lived with only one parent, and 2% lived with another caretaker.

Procedures

Study approval was obtained from the institutional review boards of the University of Texas Medical Branch, the University of Miami, and the Galveston Independent School District (GISD). This study was part of a larger investigation of children's reactions to Hurricane Ike that included children in Grades 2 to 4. Only children in Grades 3 and 4 were included in the current study, due to cognitive demands of reporting height, weight, and sedentary activities.

Regarding participation rates for our study, letters describing the overall study and parental consent forms were distributed to 1,594 second, third, and fourth graders enrolled in elementary schools in the GISD in April of 2009. Thirty-one percent of these children returned consent forms to their homeroom teachers. Of the consent forms returned, 68% indicated parental permission to participate. Thus, our overall response rate was 21%.

Parental consent was provided for 212 third- and fourth-grade children. Of these children, 204 (96%) provided written assent to participate in the study and completed assessments. The primary reason for nonparticipation was absence (i.e., eight children with parental consent to participate were absent on the days of testing).

Children participated in May 2009 (8 months postdisaster). Children completed measures in a group setting of 25 to 40 children, with five to eight researchers present, during a 60-min period. Items were read aloud to ensure that children understood items; individual assistance was provided as needed.

As part of the consent process, parents were contacted if their child reported high levels of distress. Of the participating children, 40 (20%) met criteria for clinically elevated PTS symptoms; their parents were sent letters providing referral information for local community psychological services.

After completing questionnaires, children were given parental consent forms requesting children's participation in a follow-up assessment (2 weeks later) to evaluate the validity of self-reported height and weight. Fifty-five (27%) children returned the forms, and of those, 53 (96%) children had permission to participate. Participating children's actual height and weight were measured individually. Children who participated at both Time 1 and Time 2 did not differ from those who participated only at Time 1 on any study variables.

Measures

Child demographics. A background information questionnaire assessed children's demographic characteristics. Three dummy codes were created for ethnicity, with White children serving as the reference group, and African American, Hispanic, and "Other" ethnicities as identified groups.

Exposure stressors. Exposure stressors were assessed using the Hurricane Related Traumatic Experiences–Revised (HURTE-R; Vernberg et al., 1996). Exposure stressors included life threat (perceived and actual) during the hurricane. *Perceived life threat* is assessed by the question, "At any time during the hurricane, did you think you might die?" (0 = no, 1 = yes). *Actual life threat* is assessed by six items (0 = no, 1 = yes) related to objective, potentially life-threatening events occurring during the hurricane (e.g., "Did windows or doors break in the place you stayed during the hurricane?"). Items were summed to create a total score. Previous research supports the validity of the HURTE-R (La Greca et al., 1996, 2010; Yelland et al., 2010).

Recovery stressors. Hurricane-related recovery stressors, *initial* and *ongoing loss/disruption*, were assessed using two subscales of the HURTE-R. Initial loss/disruption was measured from 10 yes/no items (0 = no, 1 = yes) related to loss/disruption in the first 2 months postdisaster (e.g., "Was your home damaged badly or destroyed by the hurricane?"); items were summed to create a total score. *Ongoing loss/disruption* was measured from six items pertaining to continuing loss/disruption (e.g., "Are you living in a house that still has damage because of the hurricane?"); items were summed to create a total score.

In addition, *major life events* (e.g., parental divorce or separation; illness in the family) occurring during the recovery period were assessed using a 14-item (coded 0 = no, 1 = yes) form of the Life Events Checklist (LEC; Johnson & McCutcheon, 1980). Major life events are not conceptualized as directly related to the hurricane, although some events may have been hurricane-related (e.g., illness, hospitalization). Items are summed to create a total score. Past test–retest reliability of the LEC over a 2-week interval is .72 (Greenberg, Siegle, & Leitch, 1983). The LEC has been used with youth postdisasters (La Greca et al., 2010; Weems et al., 2007).

Posttraumatic stress symptoms. The Posttraumatic Stress Disorder–Reaction Index, Revision 1 (PTSD-RI-R1; Steinberg, Brymer, Decker, & Pynoos, 2004) is a 22-item questionnaire that assesses 17 PTS symptoms, yielding a total PTS severity score ranging from 0 to 68. The PTSD-RI-R1 has been used with children postdisaster (e.g., La Greca et al., 2010), and has good reliability and validity (Steinberg et al., 2004) and internal consistency (i.e., .83 to .86 in La Greca et al., 2010). In this study, internal consistency was .87.

Sedentary activity. Sedentary activity was assessed through a three-item questionnaire adapted from the Child and Adolescent Trial for Cardiovascular Health (CATCH) (Nader et al., 1999). Children rated average daily sedentary activity spent on watching TV or movies, playing video games, or time spent on the computer (e.g., "How many hours per day do you usually spend on the computer away from school?"). Questions were rated on a scale ranging from "0" to "6 or more hours." A total score for sedentary activity was calculated (range = 0 to 18). Self-reported activity measures have been used with school-age children (Myers et al., 1996). Cronbach's alpha for sedentary activity was .65 in this study.

Height and weight. Height and weight was assessed by asking children to report their height (feet and inches) and weight (pounds). A subsample of 53 children participated in a validity assessment of self-reported height and weight measures, a methodology used in past research (e.g., Ezzati, Martin, Skjold, Hoorn, & Murray, 2006). For actual height and weight measurements, children were asked to remove shoes, sweaters, and outerwear. Height was measured to the nearest .1 in. on a portable stadiometer. Weight was measured to the nearest .1 pound on a digital scale. Past research with youth aged 12 to 16 years has shown that correlations between actual and self-reported height ranged from .82 to .91. Correlations between actual and self-reported weight ranged from .87 to .94 in the same study (Strauss, 1999).

Results

Preliminary Analyses

Validation of self-reported height and weight. Self-reported height and weight measurements were inspected for validity among the 53 children with actual height and weight measurements. Self-reported height showed low criterion validity, as it was not significantly correlated with actual height, $r = .23$, $p = .15$. Thus, self-reported height was not used in study analyses. Children's self-reported weight showed good criterion validity and was highly correlated with actual weight, $r = .82$, $p = < .001$. Self-reported weight was used in all study analyses, with nine outliers removed due to likely inaccurate reporting. Specifically, children whose self-reported weight fell below 40 pounds were eliminated, as this weight represents the 5th percentile or less for 7-year-old boys and girls (Chronic Disease Prevention and Health Promotion, 2000) and thus was unrealistically low for our sample of children aged 7 to 11 years.

Descriptive statistics. Means and standard deviations for continuous study variables were computed by gender and for the total sample (see Table 1). In this sample, 31% of children reported thinking they might die during the hurricane (i.e., perceived life threat), and the average number of reported actual life-threatening events during the hurricane was less than 1 ($M = .72$). Perceived life threat levels in this sample were lower than levels reported in other postdisaster samples. For example, 9 months after Hurricane Charley, 59% of children (Grades 2 to 4) reported perceived life threat (La Greca et al., 2010). Lower levels of perceived life threat may have been reported in our sample because of high evacuation rates during Hurricane Ike (84% of participants evacuated). Other hurricane samples have reported lower evacuation rates: 65% of people evacuated during Hurricane Floyd (Dow & Cutter, 2002) and 26% evacuated during Hurricane Bonnie (Whitehead et al., 2000).

On average, children's PTSD-RI total scores fell in the mild to moderate range of PTS symptoms ($M = 22.97$, $SD = 14.31$; Steinberg et al., 2004). However, 20% ($n = 40$) reported clinically elevated PTS symptoms (scores equal to or greater than 38; Steinberg et al., 2004). In the current study, girls reported higher levels of PTS symptoms than boys, $t(201) = 2.21$, $p = .03$. Postdisaster research has generally found that girls report higher PTS levels than boys, when gender differences are observed (Silverman & La Greca, 2002).

Overall, children reported an average of 5.91 hr a day engaged in sedentary activity, or approximately 41.37 hr per week. Boys ($M = 7.04$, $SD = 4.87$) reported higher levels of sedentary activity than girls ($M = 4.92$, $SD = 4.12$), $t(199) = -3.53$, $p = .001$.

Covariates. Based on gender differences in study variables, discussed earlier, gender was included as a covariate in all analyses. There were no ethnic differences in PTS symptoms, but differences emerged for sedentary activity, $F(3, 192) = 6.82$, $p < .001$. Specifically, African American ($M = 7.86$, $SD = 4.71$) and Hispanic children ($M = 6.54$, $SD = 4.97$) reported higher levels of sedentary activity than White children ($M = 4.06$, $SD = 3.66$). Thus, ethnicity was controlled for in study analyses. Finally, although no study variable was significantly correlated with self-reported weight, children's weight was included as a covariate of sedentary activity, consistent with the literature on health behaviors (Andersen et al., 1998; Eisenmann et al., 2002).

Stressors, Child Characteristics, and Sedentary Activity

A structural equation model (see Figure 1) was tested in Mplus (version 6.11), examining associations between hurricane exposure and recovery stressors and children's sedentary activity. It was expected that hurricane exposure would be associated with children's sedentary activity through recovery stressors. The model fit the data well: χ^2 (17) = 9.32, $p = .93$, CFI = 1.00, RMSEA < 0.001, and SRMR = 0.02, explaining 22% of the variance in sedentary activity. Recovery stressors were directly related to children's sedentary activity, $b = 0.83$, $SE = .30$, $p < .01$. For every additional loss and disruption event, children reported engaging in 0.83 more hours of sedentary activity per day.

Table 1
Means and Standard Deviations of Study Variables

Variables (possible scores)	Boys ($n = 96$)	Girls ($n = 108$)	Total ($n = 204$)
Demographics			
Age	9.24 (.84)	9.22 (.74)	9.23 (.79)
Self-reported weight (pounds)*	73.82 (22.20)	82.12 (26.78)	78.43 (25.12)
Self-reported weight (no outliers)*	77.50 (17.80)	84.59 (24.52)	81.48 (22.04)
Hurricane exposure stressors			
Perceived life threat (0–1)	.31 (.47)	.30 (.46)	.31 (.46)
Actual life threat (0–6)	.73 (.88)	.72 (.86)	.72 (.86)
Recovery stressors			
Initial loss/disruption (0–10)**	3.07 (2.06)	3.87 (2.07)	3.49 (2.10)
Ongoing loss/disruption (0–6)	1.41 (1.33)	1.76 (1.98)	1.60 (1.70)
Life events (0–14)	1.38 (1.33)	1.75 (1.82)	1.57 (1.62)
Outcomes			
Sedentary activity (0–18)***	7.04 (4.87)	4.92 (4.12)	5.91 (4.60)
PTS symptoms (0–68)*	20.65 (13.88)	25.05 (14.43)	22.97 (14.31)

Note. Significant gender differences are noted.
* $p < .05$. ** $p < .01$. *** $p < .001$.

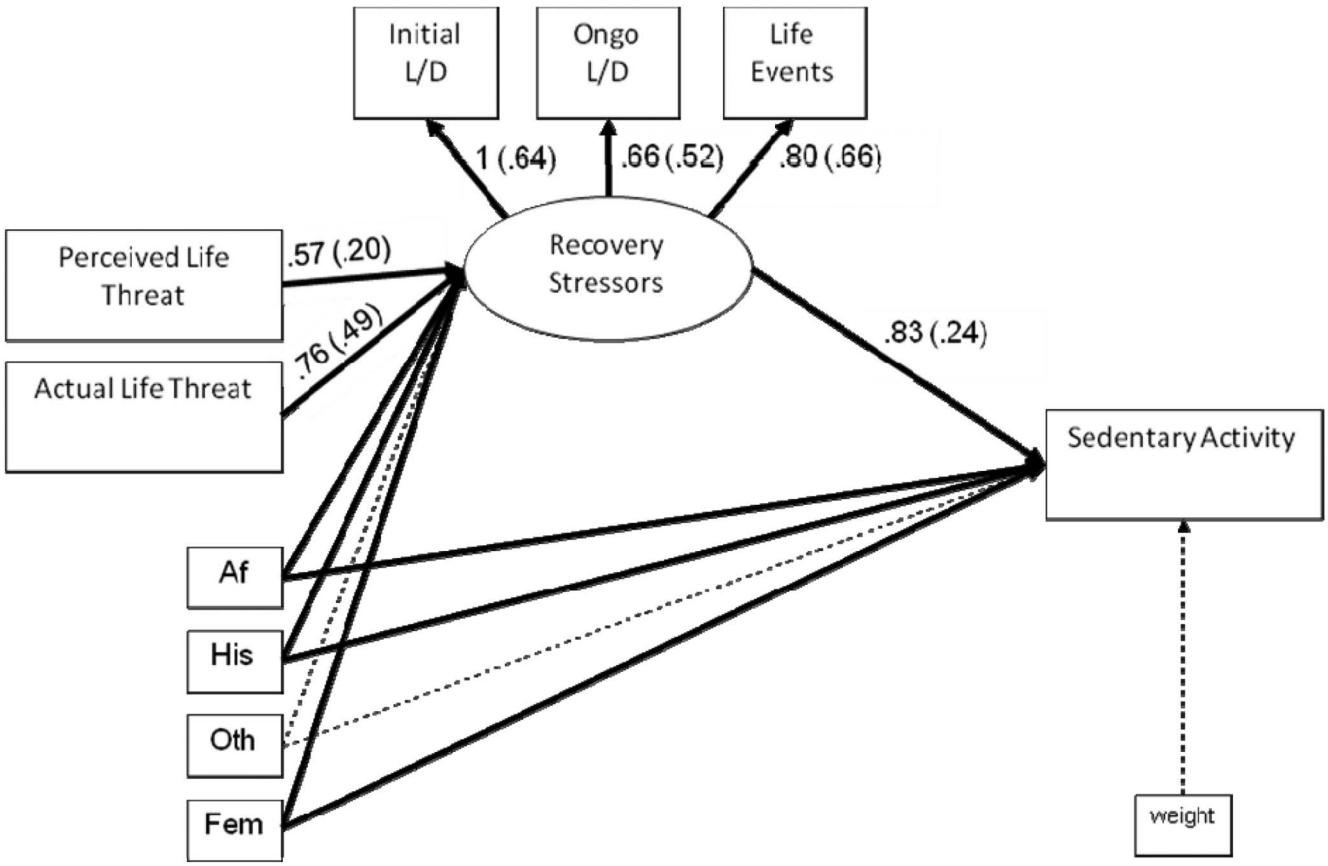

Figure 1. Stressors and sedentary activity. Significant paths and loadings ($p < .05$) are denoted by bold lines. Unstandardized path coefficients are listed, followed by standardized path coefficients in parentheses. Exogenous variables were assumed to be correlated and covariates are described in the results section in order to reduce clutter. L/D = Loss/Disruption; Af = African American; His = Hispanic; Oth = Other Ethnicity (i.e., children who did not identify as Caucasian, African American, or Hispanic); Fem = Female.

The model path for the indirect effect of perceived life threat on sedentary activity was significant, $b = 0.47$, $SE = .24$, $p = .05$, as was the indirect effect of actual life threat to sedentary activity, $b = .63$, $SE = .23$, $p < .01$. These indirect effects are consistent with mediation; that is, hurricane exposure and sedentary activity may be associated via their relationships with recovery stressors.

In terms of child characteristics, boys engaged in approximately 2.86 more hours per day of sedentary activity than girls ($b = -2.86$, $SE = .61$, $p < .001$). African American children engaged in roughly 2.86 hours more of sedentary activity than White children ($b = 2.86$, $SE = .92$, $p < .01$), and Hispanic children engaged in 1.81 more hours of sedentary activity than White children ($b = 1.81$, $SE = .79$, $p = .02$). Children of "Other" ethnicity did not differ from White children in levels of sedentary activity. Levels of sedentary activity also did not differ by child weight.

PTS Symptoms and Sedentary Activity

Building upon the previous model (see Figure 1), an additional pathway was added, examining PTS symptoms as a potential mediator of the relationship between stressors and sedentary activity. The hypothesized model (see Figure 2) fit the data, χ^2 (33) = 33.96, $p = .42$, CFI = 1.00, RMSEA = 0.01, and SRMR = 0.05, and explained 26.4% of the variance in sedentary activity. As expected, the paths between exposure stressors to recovery stressors were significant, $b = .57$, $SE = .20$, $p < .01$, and $b = .69$, $SE = .44$, $p < .001$, respectively. Further, the path between recovery stressors and PTS symptoms was significant, $b = 7.18$, $SE = .67$, $p < .001$. PTS symptoms were significantly related to sedentary activity, $b = .10$, $SE = .30$, $p < .001$. For every one-point increase in PTS symptoms, children engaged in .10 more hours of sedentary activities per day.

Also as expected, the total indirect effect from perceived life threat to sedentary activity was significant, $b = .48$, $SE = .13$, $p = .02$. The specific indirect effect of actual life threat to sedentary activity through recovery stressors and PTS symptoms was significant, $b = .48$, $SE = .13$, $p < .001$. Results are consistent with PTS symptoms as a mediator of the relationship between stressors and sedentary activity. These findings also replicate previous studies of children's postdisaster psychological reactions (e.g., La Greca et al., 1996, 2010), in finding that hurricane exposure and recovery stressors are predictors of children's postdisaster PTS symptoms.

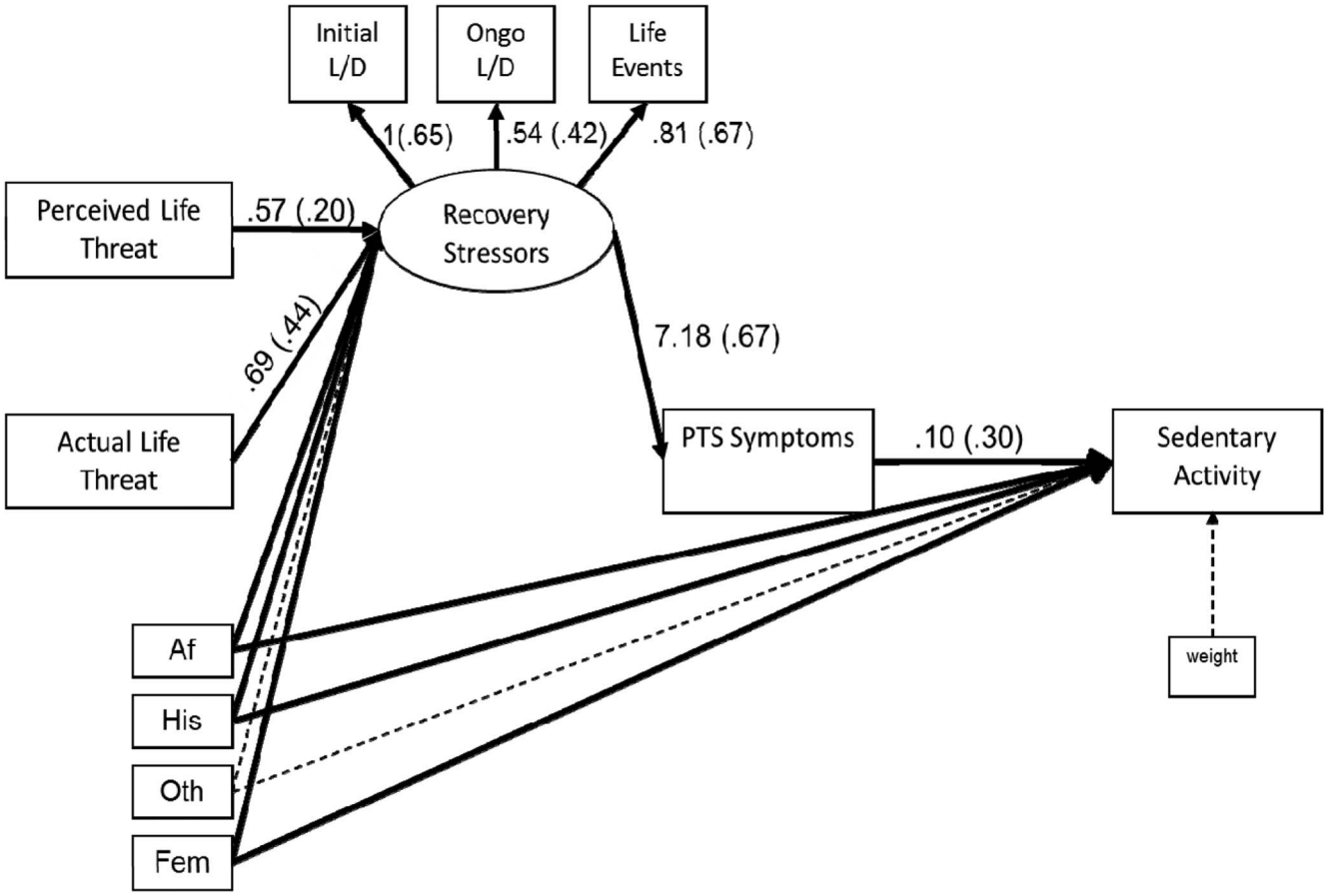

Figure 2. PTS symptoms and sedentary activity. Significant paths and loadings ($p < .05$) are denoted by bold lines. Unstandardized path coefficients are listed, followed by standardized path coefficients in parentheses. Exogenous variables were assumed to be correlated. L/D = Loss/Disruption; Af = African American; His = Hispanic; Oth = Other Ethnicity (i.e., children who did not identify as Caucasian, African American, or Hispanic); Fem = Female.

Discussion

The current study represents the first systematic investigation of children's sedentary activity levels postdisaster. Findings revealed that higher levels of exposure and recovery stressors were associated with higher levels of sedentary activity. Further, PTS symptoms may play a role in the relationship between stressors and sedentary activity. Key findings are discussed in this section.

This study demonstrates that children's sedentary activity is important to examine postdisaster. Children's average sedentary activity levels in this study, 41.37 hr per week or 5.91 hr per day, were much higher than levels reported in nondisaster samples. Berkey and colleagues (2000) found that a national sample of 9-year-old boys and girls reported an average of 29.05 and 23.94 hr per week of sedentary activity, respectively. A study by Matthews and colleagues (2008) assessed 6,329 participants with activity monitors worn for at least 10 hr. In that study, the subset of participants aged 6 to 11 years reported engaging an average of 6.0 hr to 6.1 hr per day in sedentary activity. Although this number may initially seem higher than the 5.91 hr reported per day by our participants, the study by Matthews and colleagues assessed children over the course of the day, and in our study, we only assessed children's after school sedentary activity levels. Our findings suggest that postdisaster, children may be at risk for elevated sedentary activity levels. If our findings are replicated in studies utilizing a longitudinal design, it suggests that children with high levels of disaster exposure and postdisaster stressors may be at risk for the chronic health problems associated with sedentary activity (e.g., obesity, heart disease, Type 2 diabetes; Andersen et al., 1998; Marshall et al., 2004).

Current postdisaster interventions for children rarely consider health behaviors (La Greca & Silverman, 2009). Although our empirical findings do not speak to activity interventions per se, activity interventions may be an appealing option to consider as part of a "stepped care" model for postdisaster intervention. Postdisaster, it is often necessary to triage children according to the severity of their needs, due to limited resources (Jaycox et al., 2010). Activity interventions could be implemented as part of a "first line" intervention for all exposed children, freeing resources for children who experience more severe distress. This approach has important advantages. Activity interventions that focus on

decreasing sedentary activity are associated with increased aerobic fitness (Epstein et al., 2000) and improved academic achievement (Robinson et al., 2003). Interventions to increase children's physical activity reduce obesity (Epstein et al., 2000, 2005), decrease levels of sedentary activity (O'Dwyer, Fairclough, Knowles, & Stratton, 2012; Robinson et al., 2003), have positive effects on self-esteem (Ekeland et al., 2005), and reduce mental health symptoms (Ahn & Fedewa, 2011; Annesi, 2004; Biddle & Asare, 2011; Ekeland et al., 2005), including PTS symptoms (Diaz & Motta, 2008; Motl, Birnbaum, Kubik, & Dishman, 2004). In addition, activity interventions may reach children with limited access to medical or mental health care who might otherwise receive no intervention. Teachers or other school personnel could be trained quickly and at low cost to deliver activity interventions. Good evidence already exists for the feasibility of conducting activity interventions with school personnel (Kriemler et al., 2010; Walters & Martin, 2000; see Ahn & Fedewa, 2011). Further, these types of interventions might be especially important for ethnic minority youth, as Black and Hispanic youth in this study reported significantly higher levels of sedentary activity. In addition, Black and Hispanic youth have higher rates of obesity (Saab, Fitzpatrick, Lai, & McCalla, 2011) and other related health problems (Dietz, 1998; Fitzpatrick, Lai, Brancati, Golden, & Hill-Briggs, 2013), which further enhances the importance of exercise/activity interventions for these ethnic/cultural groups.

Findings also provide support for applying an existing conceptual model of children's postdisaster psychological reactions to understanding postdisaster sedentary behavior. Of note, all proposed risk factors were related to sedentary activity in expected directions. Both hurricane exposure and recovery stressors were associated with higher levels of sedentary activity. It may be that stressors and the destruction associated with disasters limit resources (e.g., playgrounds, availability of friends) for children to engage in play. Further, children may use sedentary activities to cope with stressors. Recovery stressors may magnify existing relationships between exposure stressors and sedentary activity. This is consistent with research demonstrating that stressors are associated with increased sedentary activity (Hamer et al., 2009; Roemmich et al., 2003), and that recovery stressors may amplify effects of hurricane-related exposure stressors (La Greca et al., 2010).

In line with the conceptual model that guided this research, child characteristics were also associated with sedentary activity. Boys reported higher levels of sedentary activity postdisaster; this is consistent with findings that boys engage in more sedentary activity than girls (Berkey et al., 2000; Colley et al., 2011), although some studies have found higher rates of sedentary activity among girls (Matthews et al., 2008) or no differences between boys and girls (Andersen et al., 1998). In addition, African American and Hispanic children engaged in more sedentary activity than White children, consistent with research on sedentary behavior (Andersen et al., 1998; Crespo et al., 2001; Matthews et al., 2008). For example, Saab and colleagues (2011) examined trends in rates of sedentary activity among a sample of 77,050 youth. In that study, Black youth reported the highest rates of sedentary activity, and Hispanic youth reported higher rates of sedentary activity than non-Hispanic White children. Similarly, Li, Treuth, and Wang (2010) examined trends in the nationally representative Youth Risk Behavior Surveillance Surveys from 1991 to 2007. Minority youth, especially Black youth, engaged in more sedentary activity than White youth. Since boys, African American, and Hispanic children are at risk for engaging in sedentary activity generally, particularly those with high levels of disaster exposure and recovery stress, tailoring sedentary activity interventions for these groups may be warranted and should be considered if postdisaster activity interventions are developed.

Further, children's PTS symptoms may be a mechanism underlying the relationship between stressors and sedentary activity. Such findings are consistent with research demonstrating positive associations between PTS symptoms and sedentary activity (e.g., Hamer et al., 2009; Page et al., 2010). If our findings are replicated in longitudinal studies, they would suggest that postdisaster interventions might target children's PTS symptoms to help decrease their sedentary activity. PTS symptoms include problems sleeping and concentrating, which may contribute to fatigue and serve to increase sedentary activities. Alternatively, it is also possible that high levels of sedentary activity may prolong PTS reactions, and this notion needs further examination. Among youth, exercise interventions have been shown to attenuate PTS symptoms (Diaz & Motta, 2008; Motl et al., 2004) and may be useful to assist children with elevated PTS symptoms postdisasters.

In addition to longitudinal studies, future investigations should examine other factors that also may contribute to children's sedentary behaviors postdisasters, such friends moving away or parents' decreased support for physical activity. For example, potential parental factors to examine would include parent activity levels (McMinn, Griffin, Jones, & van Sluijs, 2013; O'Dwyer et al., 2012) and family support for physical activity (McMinn et al., 2013), both of which are generally associated with higher levels of physical activity and lower levels of sedentary activity among children. These two parental factors might be affected by disasters, because parents report numerous stressors and psychological distress postdisaster (Kelley et al., 2010; Scheeringa & Zeanah, 2008; Spell et al., 2008), and this may limit parents' ability to engage in physical activity (Hamer et al., 2010) or provide instrumental support for their children's activities. Clinicians and health care providers may want to encourage parents to take care of themselves by engaging in physical activity, and to prioritize opportunities to help children engage in physical activity, when possible.

This study had numerous strengths, including the recruitment of diverse children from an area heavily impacted by a natural disaster. In this study, we recruited children from all open public schools within an area that was heavily affected by Hurricane Ike. To our knowledge, this study is one of the first to be able to conduct assessments within all open public schools within a geographic area hit by a natural disaster. In addition, our study design, which included school samples, provided a unique opportunity to obtain community estimates of the effects of disasters on children (La Greca, 2006).

However, several limitations should be considered. First, this study was cross-sectional. We did not have information about children's prior sedentary activity, which is likely to be related to their current sedentary activity. Children's predisaster functioning is difficult to obtain, as natural disasters strike suddenly and unexpectedly. Our cross-sectional study design also precluded an examination of reciprocal influences of sedentary activity and PTS symptoms. It is possible that sedentary activity contributes to and prolongs PTS symptoms. Future research should consider longi-

tudinal designs to elucidate potential causal and bidirectional pathways. Second, this study relied on child-report measures, with the exception of measured height and weight data. Although youth are considered the best informants of their PTS symptoms (Ng & Jeffrey, 2003), shared method variance may have contributed to the associations. Future research should consider using other informants (e.g., parents, teachers) and objective measures of activity levels (e.g., accelerometers). Third, given our overall response rate of 21%, this sample may not be representative of the overall population of children in our schools. However, our response rates are similar to those of studies conducted by other research teams with children postdisaster (e.g., after Hurricane Katrina in Kelley et al., 2010); the percentage of minorities participating in this study was high, and the demographic characteristics of children in our study closely matched the demographic characteristics of Galveston public schools (Public Schools Explorer, 2013). It is important that a high proportion of the participants came from racial and ethnic minorities, as these groups appear to be especially vulnerable postdisaster. In addition, our response rates were similar to postdisaster studies conducted by other research teams (e.g., after Hurricane Katrina in Kelley et al., 2010). Finally, although not a focus of the current study, future research may also want to consider assessing other health behaviors (e.g., unhealthy diet), as stressors are associated with increased calorie and fat intake (Roemmich et al., 2003).

Based on study findings, several recommendations are offered for disaster-affected communities. Communities should consider rebuilding gyms and playgrounds quickly. This may help children return to normal roles and routines postdisaster, a practice recommended by the American Psychological Association (2010). In addition, adults should carefully monitor children's stressors and PTS symptoms, as findings indicate that these are risk factors for elevated sedentary activity. These risk factors could easily be assessed with questionnaires. Finally, schools and communities should consider ways to decrease sedentary activity and increase physical activity. This represents a shift in priorities for postdisaster schools and communities, which tend to focus on making up lost academic time postdisaster (Silverman & La Greca, 2002). For example, after Hurricane Ike, schools did not resume gym classes for an entire academic year (S. Howell, personal communication, July, 2009). Academic concerns need to be weighed against the mental and physical health benefits of engaging children in less sedentary activity and more physical activity.

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