

Ebola Virus Disease and Pediatric Mental Health: Long-Term Mediating Effects of Caregiver Mental Health

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Objective: Previous research suggests that adult survivors of Ebola virus disease (EVD) experience mental health problems following their infection. This study examines long-term mental health consequences of EVD for child survivors, and those affected by EVD but not themselves infected, compared to controls. This study also examines the mediating effects of caregiver mental health on children's mental health outcomes.

Method: Using a case-control study design, we recruited 663 children and adolescents ("children" throughout; aged 10-17 years) and their caregivers at 2 time points, from 6 geographically diverse districts in Sierra Leone. Our analytic sample included 217 EVD-infected children, 206 EVD-affected children (ie, children who were not themselves infected but someone in their household was infected), 230 control children, and 1 caregiver per child (N = 653). Using a structural equation model, we examined the mediating effects of caregiver anxiety and depression at time 1 on the relationship between study condition and children's prosocial behaviors and behavioral difficulties at time 2, controlling for child's age, sex, household wealth, urban vs rural residential environment, and district.

Results: EVD-infected and -affected children were more likely to demonstrate behavioral difficulties compared to controls. Caregiver depression mediated the relationship between being affected by EVD and children's behavioral problems. Caregiver anxiety mediated the relationship between being EVD affected and children's prosocial behaviors.

Conclusion: The mental health consequences of EVD are long-lasting for EVD child survivors and those affected, as well as caregivers. Policy and programmatic responses need to account for the heightened vulnerability introduced not only to survivors after an infectious disease outbreak, but to their families and household members.

Plain language summary: This case-control study in Sierra Leone examined the long-term mental health consequences of Ebola virus disease (EVD) for 217 infected and 206 affected (ie, those not themselves infected but with infected household members) children and adolescents compared to 230 controls, including the mediating effects of caregiver mental health. Results showed that EVD-infected and -affected children were more likely to demonstrate behavioral problems. Caregiver depression mediated the relationship between being affected by EVD and children's behavioral problems. These findings suggest a strong influence of psychosocial factors in the later development of emotional and behavioral issues for EVD-infected or -affected children.

Diversity & Inclusion Statement: We worked to ensure sex and gender balance in the recruitment of human participants. We worked to ensure race, ethnic, and/or other types of diversity in the recruitment of human participants. We worked to ensure that the study questionnaires were prepared in an inclusive way. Diverse cell lines and/or genomic datasets were not available. One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented racial and/or ethnic groups in science. One or more of the authors of this paper self-identifies as a member of one or more historically underrepresented sexual and/or gender groups in science. We actively worked to promote sex and gender balance in our author group. We actively worked to promote inclusion of historically underrepresented racial and/or ethnic groups in science in our author group. While citing references scientifically relevant for this work, we also actively worked to promote sex and gender balance in our reference list. While citing references scientifically relevant for this work, we also actively worked to promote inclusion of historically underrepresented racial and/or ethnic groups in science in our reference list. The author list of this paper includes contributors from the location and/or community where the research was conducted who participated in the data collection, design, analysis, and/or interpretation of the work.

Key words: case-control design; Ebola virus disease; infectious disease; anxiety and depression; children and youth

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The psychological consequences of infectious disease outbreaks can be devastating for child health and development. The 2013 to 2016 Ebola virus disease (EVD) epidemic in West Africa overwhelmed local health systems with more than 28,000 cases, and took the lives of more than 11,000 people.¹ Children accounted for more than one-fifth of EVD cases, and more than 16,000 children lost parents or caregivers to the disease.² Such epidemics can interrupt parent-child relationships and can weaken social structures that support healthy child development and buffer the risk of poor psychosocial outcomes.

Yet, little is currently known about how acute disease exposure influences long-term mental health and psychosocial outcomes in children, or the extent to which this relationship is mediated by caregiver mental health. In relation to COVID-19, a systematic review of 30 studies found that children experienced higher risk of internalizing and externalizing behaviors among lower-income households, and if parents themselves experienced deteriorated mental health and pandemic-related stressors.³ Among adults, limited studies have examined the consequences of acute infections on mental health, such as severe acute respiratory syndrome (SARS) and methicillin-resistant *Staphylococcus aureus* (MRSA). In 1 cohort of SARS survivors, 2 years after infection, more than 40% had at least 1 psychiatric diagnosis (eg, post-traumatic stress disorder [PTSD], depression, panic disorder) that adversely affected social relationships, family dynamics, and work life.⁴ A survey of Dutch MRSA carriers found that more than half reported clear or probable stigma associated with infection that negatively influenced mental health.⁵

The pathophysiology of EVD suggests that it is an inflammatory syndrome characterized by a robust immune response rather than suppression and viral persistence in bodily fluids post-recovery.⁶ A cluster of sequelae termed “post Ebola syndrome” is well documented,⁷ and often includes musculoskeletal pain, fatigue, headaches, hearing loss, numbness of hands or feet, ocular problems, and psychological/neurological problems.⁷⁻⁹ A growing number of studies demonstrate a clear link between EVD and mental health problems among adults. A 2020 systematic review found that EVD survivors and those with close contact with EVD later experienced depression, anxiety, PTSD, and other mental health problems, with 1 in 5 people infected or affected by EVD having been diagnosed with depression¹⁰; later studies confirm these findings.¹⁰⁻¹⁴ Those in rural areas were found to be more likely to experience severe mental distress compared to those in urban areas.^{15,16} A cross-sectional study of adult EVD

survivors found that nearly half suffered EVD-related PTSD, 12.0% reported substance abuse issues, and 3.9% reported major depression.¹⁷ Another cross-sectional study in Sierra Leone found that greater time spent in Ebola treatment units (ETUs) and greater experience of stigma predicted decreased mental health functioning.¹⁸

Fewer quantitative studies to date have focused on children’s mental health in relation to EVD. One study in the Democratic Republic of Congo found that EVD led to greater depression over time and that EVD stigmatization led to greater anxiety among youth,¹⁹ and in another study, EVD orphans and survivors experienced overwhelming rates of depression (87.3%) and PTSD (44.4%).¹² Among adult and child EVD survivors and community members in Sierra Leone, qualitative studies found that EVD-related stigma and social distancing were each a source of distress, as were fears of disclosing EVD infection and loss of property.^{20,21}

To our knowledge, no studies have simultaneously examined both child and caregiver assessments of their mental health in relation to children’s exposure to EVD. Caregiver functioning is a crucial influence of children’s mental health,^{22,23} and the mental health of both caregivers and children may be affected by EVD.^{10,12,19} To our knowledge, few studies examining how infectious diseases are associated with mental health outcomes have recruited a control group. Previous research on children’s exposure to HIV/AIDS, the case-control design of which served as the basis for the current study, found that children affected by HIV (eg, those who had an infected family member or caregiver) experienced more mental distress than controls, and experienced rates similar to those who were actually infected by HIV.²⁴ This finding highlights the increased vulnerability of affected children, given that infected populations tend to receive more medical and psychosocial services and supports. The case-control longitudinal design of this earlier study,²⁴ and the current study, allows for a greater understanding both of the direct link between EVD exposure and infection and mental health risk and the indirect pathways that might further elevate risk.

The purpose of the current study is to examine the direct effects of EVD on children’s mental health, and whether these relationships are mediated by the mental health of children’s current primary caregivers. Our research questions are as follows: (1) How does experience with EVD (actually being infected; or affected, ie not infected oneself but living in the same household as someone who was infected) affect children’s mental health? (2) How is the relationship between EVD and children’s mental health affected by caregivers’ mental health? We hypothesize that EVD-infected and EVD-affected children will show worse mental health

outcomes over time compared to controls. We also hypothesize that caregivers' mental health will mediate the effects of EVD exposure on children's mental health.

METHOD

Population and Study Design

This study was conducted with a number of local governmental and non-governmental organizations. Caritas Freetown is a local humanitarian organization that employed research assistants (RAs) for mental health data collection. Caritas RAs partnered with RAs from Kenema Government Hospital, who collected physical health data. Sustainable Health Systems (SHS) is a local non-governmental organization (NGO) developed to build research capacity in Sierra Leone. The Sierra Leone Association of Ebola Survivors (SLAES) is a local advocacy group who led our recruitment and community sensitization efforts, and organized community advisory boards in each district prior to data collection.

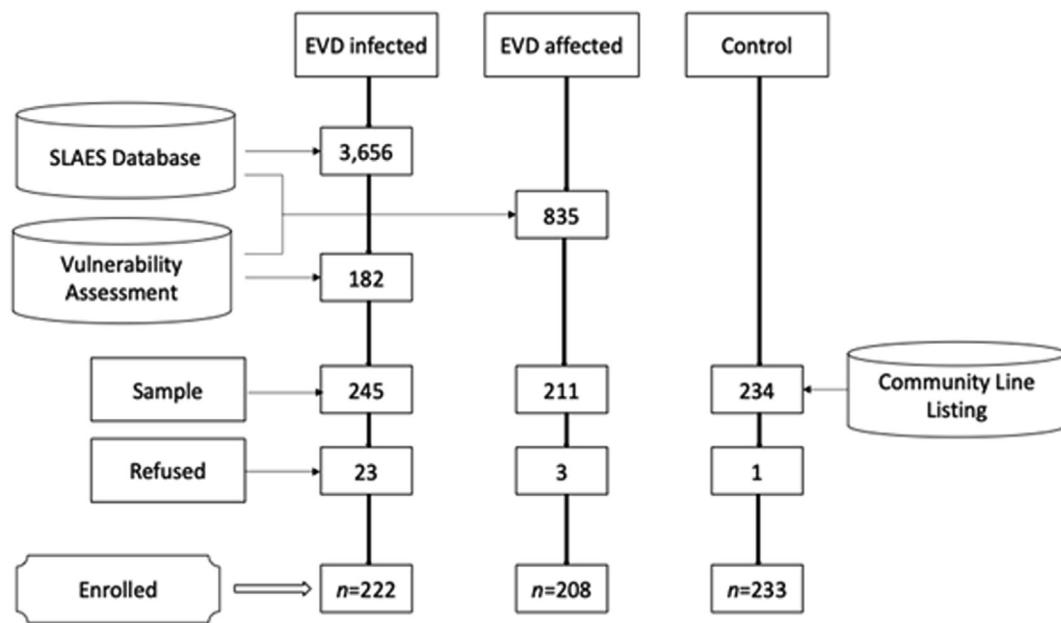
During and after the EVD outbreak, SLAES developed and maintained a list of EVD survivors across the country ($N = 3,656$), which they agreed to share for the purposes of this study. Each EVD survivor was confirmed by laboratory evidence to have had Ebola, admitted to an Ebola Treatment Unit, and discharged with a survivor's certificate. In addition, an EVD survivor vulnerability assessment was conducted by the Government of Sierra Leone as part of the Comprehensive Program for Ebola Survivors in 2017 (CPES).²⁵ Our team harmonized these databases to recruit

and select our sample from 6 geographically diverse districts: Bombali, Kailahun, Kenema, Port Loko, W. Area Urban (Freetown), and W. Area Rural (Freetown).

Using a case-control study design, we recruited 663 children and adolescents ("children" throughout; aged 10–17 years) and their caregivers (aged 21+ years) (Figure 1). We collected data at 2 time points: (1) from November 2021 to July 2022; and (2) from October 2022 to May 2023. Using the harmonized SLAES-CPES database, we recruited 222 child EVD-infected survivors and 208 children affected by EVD but not infected (defined as living in the same household as someone who was infected). If a child was both infected and affected by EVD, we *a priori* assigned the child to the infected group.

To identify control children (who were neither EVD infected nor EVD affected), we used a line listing protocol that involved the following steps: (1) using a geographic information system (GIS) collected for the infected and affected study groups to identify central community locations; (2) spinning a bottle to determine which direction to begin data collection; (3) picking a Leone bill from a bag at random and picking the third serial number on that bill (n) to determine the n^{th} house on a given street to be visited (eg, if the number was "4," the team would visit every fourth house); and (4) interviewing the primary head of household or a representative, and then moving to the next house by counting (n) residences down from the initial residence. This process was repeated until the team completed the assigned number of interviews for the day or

FIGURE 1 Summary of Participants by Study Condition



Note: EVD = Ebola virus disease; SLAES = Sierra Leone Association of Ebola Survivors.

until they ran out of houses. When there were no more houses, the team repeated the process until the required number of interviews was completed. Control children were then matched by age, sex, and district to the group of EVD-infected children ($n = 233$). Our initial study design included a targeted sample of 250 subjects in each study condition ($n = 750$), which would provide 82% power to detect mean differences. Given the lack of EVD survivors remaining in many communities, our sample was reduced to 690. Of these individuals, 663 participated for a response rate of 96.1%, with 76% power to detect mean differences.

One caregiver per child was also surveyed ($n = 663$). Caregivers were defined as adults over 20 years of age at time 1 who lived in the same household as the child and were their main provider of care and support for at least the last 6 months. The definition of “living together” requires that the caregiver and child have been residing in the same household for the past 6 months. The study protocol was approved by the Institutional Review Boards of Boston College and Tulane University, and by the Government of Sierra Leone Ethics and Scientific Review Committee.

Measures

All measures were forward- and back-translated from English to Sierra Leonean Krio, and each underwent a process of cognitive testing in the field, following cultural validation protocols originally established by the World Health Organization (WHO).²⁶ Validation and data collection activities were completed by trained Sierra Leonean research assistants employed by Caritas Freetown. Nearly half of participants reported no formal education, and the rest ranged from primary school to tertiary levels of education. To maintain consistency of data collection across participants, research assistants administered all questions orally and recorded participants’ responses on electronic tablets.

Independent Variables (Time 1). Independent variables at time 1 included child’s EVD infected or affected status (vs control group). Control variables included child’s age (in years), sex (female = 1); district; urban vs rural; and the Brief Sierra Leone Wealth Index (SLWI-S), which our team developed based in part from the Sierra Leone Demographic and Health Survey (DHS)²⁷ and from an asset index previously used in Zimbabwe.²⁸ The SLWI-S is a composite wealth score based on 8 items related to household characteristics: main source of drinking water, type of toilet facility, shared toilet, main source of cooking fuel, household type (wall and roof materials), main flooring material, asset checklist, and land ownership. Composite scores from the SLWI-S are highly correlated with composite scores from the DHS wealth index ($k = 25$ items), with $r =$

0.986. Parallel mediating variables included caregiver anxiety and depression at time 1, measured using the Anxiety ($\alpha = 0.86$) and Depression ($\alpha = 0.88$) raw score subscales of the Hopkins Symptom Checklist (HSCL).²⁹

Dependent Variables (Time 2). Dependent variables at time 2 included the caregiver reported Strengths and Difficulties Questionnaire (SDQ)^{30,31} Prosocial Subscale ($\alpha = 0.72$) and Total Difficulties ($\alpha = 0.75$) scores for children at time 2. Missing data were present for the composite wealth index ($n = 5$), HSCL-Anxiety ($n = 2$), and HSCL-Depression ($n = 3$), and these cases were dropped listwise for a study sample of $N = 653$.

Data Analysis

We used bivariate analyses (eg, χ^2 tests, 1-way analyses of variance with post hoc t tests) to examine differences in sample characteristics, and mediating and dependent variables, by study condition. A structural equation modeling framework³² was used to test the hypothesis that parent mental health mediates the relationship between child EVD status and child behavioral outcomes. Paths were created with caregiver anxiety and depression (HSCL) as the mediator variables and child’s EVD status as the independent variables. For the mediator variables, we controlled for household wealth (SLWI-S). For the dependent variables, we controlled for child’s age, sex, and household wealth (SLWI-S). This model produced the direct, indirect, and total effects among the variables. Afterward, the model was fitted with bootstrap standard errors to account for clustering across districts.³³

RESULTS

Slightly fewer female child participants were represented in the EVD-infected group compared to the overall sample (52.9% vs 54.0%, $p < .001$) (Table 1). Female caregivers were overrepresented in the control group (84.1%, $p < .001$). Control households were significantly wealthier (mean = 0.45, SD = 2.2) than the infected (mean = -0.21, SD = 2.3, $p < .01$) and affected (mean = -0.26, SD = 2.2, $p < .01$) groups ($p < .001$ overall). Significant variability in study groups emerged across districts ($p < .01$). Control households were more likely to be in urban areas (67.1%, $p < .05$) (Table 1). Child SDQ Prosocial scores were higher for the EVD-affected group (mean = 7.6, SD = 2.0, $p < .05$) compared to the EVD-infected group (mean = 7.1, SD = 2.1, $p < .001$), and child SDQ Total Difficulties scores were lower for the control group (mean = 14.5, SD = 4.6, $p < .001$) compared to both the EVD-infected

TABLE 1 Sample Characteristics by Study Group

	Overall N = 653 % or Mean (SD)	EVD infected n = 217 % or Mean (SD)	EVD affected n = 206 % or Mean (SD)	Control n = 230 % or Mean (SD)
Child***				
Sex: female (vs male)	54.4	52.9	56.0	54.3
Age	14.1 (2.5)	14.5 (2.5) ^a	13.6 (2.5)	14.2 (2.3)
Caregiver				
Sex: female (vs male)***	72.7	65.6	67.6	84.1
Age	41.3 (12.6)	41.0 (12.2)	42.1 (11.4)	41.3 (12.6)
Household				
Wealth/asset index***	0.02 (2.3)	-0.21 (2.3)	-0.26 (2.2)	0.45 (2.2) ^b
District**				
Bombali	19.0	16.0	19.5	21.5
Kaihalun	10.1	10.8	9.3	10.3
Kenema	5.5	4.3	5.8	6.4
Port Loko	32.2	36.4	32.3	27.9
W. Area Rural	10.0	10.0	12.8	11.6
W. Area Urban	18.2	18.2	11.9	21.9
Urban (vs rural)*	60.3	58.3	55.1	67.1

Note: ^ap < .001 (infected vs affected; t tests).

^bp < .01 (control vs infected; t tests).

*p < .05; **p < .01; ***p < .001 (across study groups; χ^2 or 1-way analysis of variance).

(mean = 9.4, SD = 4.4, $p < .01$) and EVD-affected (mean = 9.3, SD = 4.1, $p < .01$) groups (see Table 2). Caregiver HSCL Anxiety scores were higher for the EVD-affected group (mean = 16.3, SD = 5.3; $p < .01$) compared to control (mean = 14.5, SD = 16.3), and caregiver HSCL Depression scores were also higher for the EVD-affected group (mean = 23.8, SD = 7.4, $p < .01$) compared to control (mean = 22.2, SD = 6.6).

SDQ Prosocial Behaviors

There was a direct effect on child prosocial behaviors for girls ($z = 2.02$, $b = 0.30$, SE = 0.15, $p < .05$), and an indirect and inverse effect for household wealth on prosocial behaviors ($z = -2.63$, $b = -0.04$, SE = 0.06, $p < .01$). Caregiver anxiety ($z = 5.52$, $b = 1.28$, SE = 0.23, $p < .001$) directly influenced child prosocial behaviors. Caregiver anxiety and depression mediated the relationships

TABLE 2 Results of Bivariate Analyses

	Overall N = 653 Mean (SD)	EVD infected n = 222 Mean (SD)	EVD affected n = 208 Mean (SD)	Control n = 233 Mean (SD)
Child SDQ Prosocial (time 2)*	7.3 (2.0)	7.1 (2.1) ^a	7.6 (2.0)	7.3 (2.0)
Child SDQ Total Difficulties (time 2)**	8.9 (4.1)	9.4 (4.4)	9.3 (4.1)	8.2 (3.6) ^b
Caregiver HSCL Anxiety (time 1)**	15.4 (5.0)	15.4 (5.1)	16.3 (5.3) ^c	14.5 (4.6)
Caregiver HSCL Depression (time 1)*	22.3 (7.1)	22.5 (7.2)	23.8 (7.4) ^c	22.1 (6.6)

Note: HSCL = Hopkins Symptom Checklist; SDQ = Strengths and Difficulties Questionnaire.

^ap < .001 (infected vs affected; t tests).

^bp < .01 (control vs infected; t tests).

^cp < .01 (affected vs control; t tests).

*p < .05; **p < .01; ***p < .001 (across study groups; 1-way analysis of variance).

between EVD affected status on child prosocial behaviors ($b = 0.23$, $SE_{bs} = 0.07$, $p < .01$).

SDQ Total Difficulties

SDQ Total Difficulties were directly and inversely associated with child age ($z = -2.75$, $b = -0.17$, $SE = 0.06$, $p < .01$) and directly and positively associated with household wealth ($z = 2.13$, $b = 0.18$, $SE = 0.08$, $p < .05$). There were direct effects on child total problems by EVD-infected EVD status ($z = 3.13$, $b = 1.16$, $SE_{bs} = 0.36$, $p < .01$) and EVD-affected status ($z = 2.26$, $b = 0.86$, $SE_{bs} = 0.39$, $p < .05$). Caregiver depression ($z = 3.96$, $b = 1.99$, $SE = 0.5$, $p < .001$) directly influenced child total difficulties. Caregiver anxiety and depression mediated the relationships between EVD-affected status on child total problems ($b = 0.26$, $SE_{bs} = 0.13$, $p < .05$). Both EVD-infected and EVD-affected statuses showed significant total effects on child total problems (EVD-infected: $b = 1.20$, $SE_{bs} = 0.36$, $p < .05$; EVD-affected: $b = 1.13$, $SE_{bs} = 0.39$, $p < .01$) (Table 3, Figure 2).

DISCUSSION

In this study, both EVD exposure and caregiver mental health proved to be significant predictors of children's behavioral problems over time. Compared to controls, EVD-infected and -affected children were more likely to demonstrate behavioral difficulties nearly a decade after the EVD outbreak, in both bivariate and multivariate analyses. This finding supports research from the Democratic Republic of Congo that showed that child EVD survivors and orphans experienced high rates of depression and anxiety,^{12,19} and research from Rwanda that showed that HIV-infected and -affected children had elevated mental health symptoms compared to controls.²⁴ It also reinforces earlier qualitative work in Sierra Leone, where EVD exposure in participants was linked to emotional distress.^{20,21} In our study, EVD infection is a long-term predictor of mental health problems in children, whether as a result of the pathophysiology of EVD^{8,9} or the result of social stressors post outbreak.^{20,21}

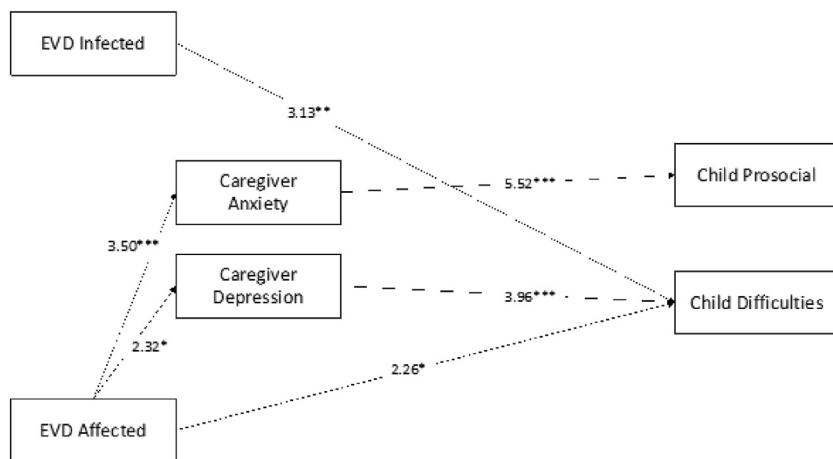
Importantly, however, a child's being in the same household as an EVD survivor, even if the child was not

TABLE 3 Standardized Direct, Indirect, and Total Effects for Endogenous Variables

Endogenous variable	Predictor variables	Direct effects	Indirect effects	Total effects
Child SDQ Prosocial	EVD infected	-1.39	1.51	-0.83
	EVD affected	0.46	3.40**	1.61
	Parent anxiety	5.52***	NA	5.52***
	Parent depression	0.48	NA	0.48
	Child age	1.51	NA	1.51
	Child sex	2.02*	NA	2.02*
	Urban HH	-0.10	0.63	0.10
	HH wealth	1.00	-2.63**	0.07
Child SDQ difficulties	EVD infected	3.13**	0.34	3.13**
	EVD affected	2.26*	2.49*	2.90**
	Parent anxiety	0.67	NA	0.67
	Parent depression	3.96***	NA	3.96***
	Child age	-2.75**	NA	-2.75**
	Child sex	0.17	NA	0.17
	Urban HH	-1.06	-0.33	-1.12
	HH wealth	2.13*	-1.45	1.70
CG HSCL anxiety	EVD infected	1.52	NA	1.56
	EVD affected	3.50***	NA	3.50**
	Urban HH	0.68	NA	0.68
	HH wealth	-2.70**	NA	-2.70**
CG HSCL depression	EVD infected	0.10	NA	0.10
	EVD affected	2.32*	NA	2.32*
	Urban HH	-0.46	NA	-0.46
	HH wealth	-1.18	NA	-1.18

Note: CG = caregiver; HH = household; HSCL = Hopkins Symptom Checklist; SDQ = Strengths and Difficulties Questionnaire.

* $p < .05$; ** $p < .01$; *** $p < .001$.

FIGURE 2 Path Diagram With Standardized Effects

Note: EVD = Ebola virus disease.

* $p < .05$; ** $p < .01$; *** $p < .001$.

infected, has an almost equivalent effect as being infected. Although there are likely neurological sequelae of EVD,^{8,9} this finding suggests a strong influence of psychosocial factors in later emotional and behavioral issues. In some ways, the EVD-affected group may be therefore be more vulnerable; much of the government and humanitarian response to the outbreak focused on survivors themselves, including enhanced access to healthcare and increased financial support. Those children who were not infected received little support in the aftermath of the outbreak, and the infected household member, as well as the noninfected child, may have experienced significant societal stigma related to societal misperceptions of the contagiousness after resolution of initial infection.²⁰ This study shows an equivalent need for mental health supports for those infected and affected by EVD alike.²⁴

In support of existing research, caregiver mental health significantly influenced children's mental health^{22,23} but was more pronounced for affected vs infected children. Caregiver depression mediated the relationship between being affected by EVD and children's behavioral problems, whereas no such mediation emerged for infected children. This finding suggests that the stress of an individual's EVD infection affects the entire household, and plays out in the influence of caregivers' depression on children's mental health.^{22,23} An alternative explanation is that affected children's caregivers were themselves EVD survivors, such that caregiver's infection status influenced their depression. To examine this possibility, we conducted post hoc tests comparing caregivers' anxiety and depression scores, and children's behavioral difficulties scores, by their own EVD infection status. Of the 663 caregivers, 225 (33.9%) were

themselves EVD survivors, and they scored higher on anxiety ($p < .001$), depression ($p < .01$), and children's emotional and behavioral problems ($p < .001$) compared to caregivers who did not contract EVD. It is therefore clear that caregiver mental health is associated both with their own EVD status and with their children's mental health outcomes even when children are not infected by EVD. Future analyses will examine the experiences of adult EVD survivors in relation to their mental health, stigma, and social support.

A curious finding is the mediating relationship between caregiver anxiety and children's prosocial behaviors for the EVD-affected group of children. This finding seems at odds with research on the COVID-19 pandemic, which showed that family chaos³⁴ and parental distress³⁵ contributed to poorer caregiver-child relationships, whereas another study found no link between COVID-related stress and caregiver-child relationships.³⁶ Although our study did not specifically examine caregiver-child relationships, a parent's report of high prosocial behavior for a child might suggest that the relationship was positive. One possible explanation for this finding is that in affected households, noninfected children take on more prosocial behaviors as a way to care for household members, particularly when the caregiver is feeling overwhelmed. This may particularly be the case if caregivers themselves are infected by EVD such that children must take on more household responsibilities. Research on parentification suggests a range of consequences for caregiving children, both negative (eg stress, internalizing problems, poor self-concept) and positive (eg, responsibility, maturity, empathy).³⁷ It is therefore possible that in our sample, EVD-affected children of anxious

parents displayed greater prosocial behaviors as they took on a caregiver role in the household.

Other findings in this study warrant discussion. Our sample represented a geographically diverse population, with 60.3% residing in urban areas. We also controlled for household wealth and assets, which are also correlated with urbanicity. Previous research in the Democratic Republic of Congo¹² found that EVD survivors in rural areas showed worse mental health problems. In our study, urban vs rural residence showed no differences in child prosocial behavior and mental health (Table 3). However, household wealth predicted lower caregiver anxiety and higher children's difficulties. Girls were more likely to have higher prosocial scores, in support of existing research.³⁸

This study's primary limitation is the amount of time that has elapsed since the EVD outbreak of 2013 to 2016. The first wave of data collection occurred in March 2022, over 8 years since the initial EVD outbreak in late 2013. The study began in late 2018, and we had initially planned to begin quantitative data collection in May 2020. However, the COVID-19 pandemic halted all research activities until March 2021, when we began the community line listing for control group recruitment. These lapses of time introduce the possibility of recall bias, such that participants' current functioning may be better or worse than immediately after the outbreak. This concern is somewhat mitigated by the study group designations and longitudinal design. However, it is also possible that these results reflect a persistent effect of Ebola on child wellness in affected areas. Given that data collection occurred during the COVID-19 pandemic, it is possible that participants' responses may have been influenced by the immediate outbreak of COVID-19. Our research assistants followed strict social distancing and protection protocols during data collection. As part of these protocols, RAs asked participants about COVID contact and symptomatology prior to beginning data collection. No participant (0%) reported having any contact with someone symptomatic in the prior 2 weeks. Only 5 persons (0.8%) reported that they or a household member had been experiencing COVID symptoms. We are therefore reasonably confident that COVID did not play a significant role in our findings. Another limitation is that our definition of EVD survivors does not include those who were either infected by EVD but asymptomatic, or who were infected but never sought treatment. Our definition of "caregiver" was related to residing together and does not capture the relation of the affected EVD children's relation to the individual who was infected in their household and defined by current length of time and may not be the child's preferred adult

attachment figure. The caregiver with whom the child is living currently may or may not have been in the household with the child during the Ebola outbreak, and the effect of current caregiver mental health on children's functioning must be considered in that context.

Infectious disease responses typically focus on containing the spread of disease and supporting survivors through clinical care.³⁹ The findings of the current study show that the mental health consequences of EVD are long lasting for both survivors and those indirectly affected. Policy and programmatic responses need to account for the heightened vulnerability introduced not only to survivors after an infectious disease outbreak but to their families and household members as well.

At the conclusion of data collection for this study, the principal investigators worked closely with the local EVD survivors' association to disseminate preliminary findings in each community where we collected data. Community members provided feedback that these findings aligned with their experiences as survivors and community leaders, and expressed support for our future research, which will focus on the following: the relationship between EVD stigma on mental health; the ongoing physical health effects of EVD on children; and how EVD physical and mental health symptoms are related. Community members also reinforced the need to provide ongoing support both to child EVD survivors and children orphaned and otherwise more broadly affected by EVD. Anecdotally, the latter group in particular were the hardest hit socially and economically, with many of them experiencing homelessness and mental illness. It is clear that responding to an infectious disease outbreak such as EVD requires more than immediate containment, but that such a situation introduces an ongoing crisis that demands a dedicated response from humanitarian actors, governments, and the development community. In doing so, actors will move away from instrumental measures of effectiveness⁴⁰ (ie stopping the spread of disease) towards the "moral foundations of foreign aid"⁴¹ (p. 21) where disease containment is the first, not the last, step of the response. In the case of EVD, those affected by the outbreak continue to suffer harm, and need mental health and social services supports that are simply not available.

CRediT authorship contribution statement

Thomas M. Crea: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Oladoyin**

Okunoren: Writing – review & editing, Formal analysis, Data curation. **Elizabeth K. Klein:** Writing – review & editing, Formal analysis, Data curation. **K. Megan Collier:** Writing – review & editing, Project administration, Data curation. **Melissa McTernan:** Writing – review & editing, Writing – original draft, Supervision, Formal analysis. **Stephen Sealive:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Conceptualization. **Bailah Molleh:** Writing – review & editing, Supervision, Project administration, Methodology, Data curation. **Yusuf Kabba:** Writing – review & editing, Supervision, Resources, Project administration, Investigation. **Abdulai Kargbo:** Writing – review & editing, Supervision, Project administration, Investigation. **Joseph Bangura:** Writing – review & editing, Supervision, Project administration, Funding acquisition. **Henry Gbettu:** Writing – original draft, Validation, Supervision, Project administration, Investigation. **Donald S. Grant:** Writing – review & editing, Supervision, Project administration, Investigation. **Robert J. Samuels:** Writing – review & editing, Supervision, Project administration, Investigation. **Stewart Simms:** Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Data curation. **Stacy Drury:** Writing – review & editing, Supervision, Investigation, Conceptualization. **John S. Schieffelin:** Writing – original draft, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Theresa**

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Data Sharing: Data will be available to upon publication to researchers whose proposed use of the data has been approved after a proposal and with a signed data access agreement by contacting creat@bc.edu.

Melissa McTernan, PhD, and Matt Gregas, PhD, of Boston College, served as the statistical experts for this research.

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