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Early growth trajectory is associated with psychological stress in parents of infants with congenital heart disease, but moderated by quality of partner relationship

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ABSTRACT

Purpose: To explore the relationships between growth trajectory, parenting stress and parent post-traumatic stress (PTS), in infants with congenital heart disease, and the moderating role of parents' dyadic adjustment on those associations.

Design and methods: A secondary analysis of data from the REACH Telehealth home monitoring multi-site randomized clinical trial. Parents completed the Parenting Stress Index (PSI), Post-traumatic diagnostic scale, and the Dyadic Adjustment Scale. Multivariate logistic regression models were used to examine the associations of interest.

Results: During 4-month follow-up after hospital discharge, parents of infants with 'Never recovered' and 'Partially recovered' growth trajectories had 2–5 times higher odds of experiencing higher stress on the Parent Domain (OR = 4.8, CI = 1.3–18.0; OR = 2.5, CI = 1.0–5.9, respectively) than those with stably grown infants. Parents of "Never recovered" infants had 4 times higher odds of PTS symptoms (OR = 3.9; CI = 1.6–9.9). Parental dyadic adjustment moderated the relationships. Parents of 'Partially recovered' infants and having low dyadic adjustment had 3–5 times higher odds of high stress on all PSI domains, while parents with high dyadic adjustment did not have increased stress due to poor infant growth. Parents of "Never recovered" infants had four times higher odds of PTS symptom, even with high dyadic adjustment.

Conclusions: Infant growth trajectory over the first four months is associated with parenting stress and PTS. Quality of partner relationship moderates some of these associations.

Practice implications: Infant growth should serve as a screening aid for identifying parents at psychological risk. Interventions targeting the quality of partner relationship may support parental coping and mitigate stress.

Clinical Trial Registration: NCT01941667

Introduction

Growth is a crucial aspect in the longitudinal assessment of overall health in pediatrics. Infants with congenital heart disease (CHD) have increased risk for poor growth and often struggle with oral feeding problems (Costello et al., 2015) that require the use of an enteral feeding tube for supplemental nutrition (Di Maria et al., 2013; Hsieh et al., 2019; Steward et al., 2020). Poor infant growth in CHD, defined by declining weight-for-age Z-scores (WAZ) according to the World Health Organization (de Onis et al., 2009) over time, has been attributed to physiologic factors such as suppression of insulin-like growth factors (Avitabile et al., 2015; Chung et al., 2017; Surmeli-Onay et al., 2011), alterations in resting energy expenditure (Nydegger et al., 2009; van der Kuip et al., 2007), or pathophysiologic feeding difficulties (Costello et al., 2015). Poor growth may be associated with delays in the provision of postoperative nutrition (Anderson et al., 2011; Hansson et al., 2016), the use of enteral feeding tubes (Di Maria et al., 2013; Steward et al., 2020), and with other severity of illness indicators such as longer hospital stays (Costello et al., 2015; Hapuoja et al., 2021), reintubations after

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surgery (Anderson et al., 2011), and neurodevelopmental delays (Ravishankar et al., 2013).

Deficits in growth trajectory compared to healthy controls have been demonstrated in children with CHD (Daymont et al., 2013). Our team (Lisanti et al., 2022) recently defined four distinct classes of weight-for-age Z-score growth trajectories (WAZ-GT) over the 4-month period following discharge from the hospital after neonatal cardiac surgery. These WAZ-GT classes identified two healthy growth patterns ("stable around WAZ = 0" and "maintaining WAZ > 0") and two classes of poor growth ("partially-recovered" and "never-recovered"), and infants were evenly split between healthy and poor WAZ-GTs (Lisanti et al., 2022). Parents of infants with CHD have described their substantial worry over infant growth and the stressful demands of enteral feeding (Hartman & Medoff-Cooper, 2012). Having an infant with persistent poor growth may be very stressful for parents during the critical early infancy period, resulting in psychological and emotional distress.

Parents of children born with congenital heart disease (CHD) experience high rates of psychological and emotional distress, with up to 80% demonstrating clinically significant symptoms of traumatic stress (Woolf-King et al., 2017). The early infancy period, during which infants undergo a major surgery requiring cardiopulmonary bypass with subsequent recovery in the cardiac intensive care unit (CICU), is arguably the most stressful for parents. Post-surgery and over the following months, infants are at increased risk for mortality and morbidities, demonstrate numerous heath issues, and increased healthcare needs (Rudd et al., 2020). Both parenting stress and post-traumatic stress (PTS) symptoms can develop during the hospitalization for neonatal cardiac surgery (Cantwell-Bartl & Tibballs, 2013) or after hospital discharge (Franich-Ray et al., 2013; Golfenshtein et al., 2017; Torowicz et al., 2010), negatively influencing parental quality of life (Denniss et al., 2019; Ernst et al., 2018; Lisanti et al., 2022) and child neurodevelopment (Roberts et al., 2021).

The Parental Stress and Resilience in CHD (PSRCHD) Model describes a relationship between child, parent, and environmental factors with psychological stress in parents of children with CHD (Lisanti, 2018). Psychological stress may be exhibited by increased parenting stress or PTS (Golfenshtein, Lisanti, et al., 2022). According to the PSRCHD Model, the support parents receive from close social networks, and for coupled parents- the quality of the partner relationship, may moderate the relationships between child, parent, and environmental factors and psychological stress. While some of these relationships have been supported in recent research (Golfenshtein et al., 2020; Golfenshtein, Lisanti, et al., 2022), one child factor that has not been closely examined as potentially influencing psychological stress in parents is their infant's growth over time. This is surprising due to the extent of growth problems in infants with CHD and the potential implications of long-term psychological stress of their parents. The purpose of this study was to explore the relationships of growth trajectory in infants with CHD on the psychological stress of parents:

Aim 1. To compare the effect of infant WAZ-GT class on the psychological stress of parents, as measured by parenting stress and PTS.

Aim 2. Examine the moderating role of the quality of the partner relationship on the associations of infant WAZ-GT and parent psychological stress. We hypothesized that the parents of infants in the poor growth trajectory classes, and with lower quality of partner relationship, will experience greater psychological stress as measured by parenting stress and PTS.

Methods

This prospective, observational study used data from a previously described multi-site randomized clinical trial of the REACH telehealth home monitoring protocol that was conducted from 2012 to 2017 (Medoff-Cooper et al., 2020). The REACH trial tested whether a telehealth intervention would reduce stress in parents whose infants with CHD required neonatal cardiac surgery. Infant-parent dyads were recruited from three children's hospitals in the US. Infants were included if they underwent cardiac surgery for CHD by three weeks of age with a Risk Adjustment in Congenital Heart Surgery (RACHS-1) category of 2 or greater, and if at birth they were at least 37 weeks and at least 2500 g. Parents <18 years of age or who did not speak or read English were excluded from the study, along with infants diagnosed with genetic disorders and other syndromes (except for non-syndromic appearing DiGeorge syndrome), cardiomyopathy, and those awaiting heart transplant. The ethics review boards from each of the pediatric hospitals approved this study and all parents provided informed consent. Infant clinical and demographic data were collected from medical records during the hospitalization. According to the REACH protocol, both intervention and control groups were discharged with a digital scale to record infant weights daily, which the parents were trained to use prior to discharge (Medoff-Cooper et al., 2020). Infants' parents completed stress and other self-report surveys prior to hospital discharge and at an average of 4 months post-discharge. Final analytic sample from the main trial included 178 infant-parent dyads. The sample for the current study included 136 parent-infant dyads having either parenting stress or PTS measures at discharge and study end with infant growth measures across the study period. We included both intervention and control subjects, as no significant differences were found between groups on any of the current study's variables of interest. We also examined whether significant differences existed in our subset of subjects versus the final analytic sample of the main trial and found no differences in infant or parent characteristics.

Empirical measures and covariates

Infant WAZ-GT

We included weekly infant weights from birth to 4 months (20 weeks) post-discharge. To characterize our independent variable of WAZ-GT, infant weights were converted to WAZ using the World Health Organization's standards (de Onis et al., 2009). Infant distinct WAZ-GT classes were further identified by using latent class growth modeling (see Analysis and Results sections).

Parent psychological stress

Two forms of psychological stress reported by parents were examined as outcome variables for this secondary analysis: parenting stress and post-traumatic stress (PTS).

Parenting stress

The outcome variable of parenting stress was assessed via the Parenting Stress Index (PSI-Long Form) (Abidin, 1995), a 101-item self-report questionnaire for parents containing three subscales (Child Domain, Parent Domain, Total Stress) that provides ratings for each item on a 5-point Likert scale. The Child Domain reflects stress evoked by factors related to the child's characteristics and parental perceptions of and expectations from the child. The Parent Domain reflects stress resulting from parental personal characteristics, the relationship with the child, the parenting role, and the coping process. The Domains' scores are summed into a Total Stress score, and further transformed into percentiles representing normal distribution of the general population. Higher percentiles indicate more stress. For this analysis, we further dichotomized this variable into low and high stress levels, according to the fiftieth (50th) percentile, as represented by the PSI standardized z-scores (Abidin, 1995). Reliability for the total score has a Cronbach's alpha of 0.91 and ranges from 0.80 to 0.87 for the subscales.

Parental post-traumatic stress

The outcome variable of PTS was assessed via the Post-traumatic Diagnostic Scale (PTDS)- a self-report measure that screens for post-traumatic stress diagnosis (PTSD) and PTS number of symptoms and

severity of symptoms (Foa et al., 1997). Originally created according to the DSM-IV criteria, the forty-nine item instrument measures the number, type and severity of PTS, which correspond to most of the current DSM-V criteria (Association, A. P, 2013). The Number of Symptoms subscale, with higher scores indicating more symptoms, was dichotomized using the median, between <6 symptoms and 6 or greater symptoms. The Total Symptom Severity subscale categorizes scores for severity of symptoms as none, mild, moderate, moderate to severe, and severe, per the instrument manual. For this study we dichotomized total symptom severity of none to mild versus moderate or greater. The PTDS has high internal consistency ($\alpha = 0.92$) and test retest reliability ($r = 0.74$) (Foa et al., 1997). Parents were instructed to complete the PTDS with respect to their infant's CHD as the traumatic event.

Quality of the partner relationship

The quality of partner relationship was considered as a moderator in our analyses and was measured by the Dyadic Adjustment Scale (DAS) (Spanier, 1989). The instrument consists of 32 items across four domains (satisfaction, cohesion, consensus, and expression) that make up the total score that can range from 0 to 151. Answers are rated on a Likert scale and summed to a total score, with higher score representing higher adjustment (better quality of the partner relationship). We further dichotomized the partner's support into low and high according to the median value.

Study covariates

In our previous work (Lisanti et al., 2022), we demonstrated significant predictors of class membership for WAZ-GT, including class of CHD (single vs two ventricles), hospital length of stay, feeding mode at discharge, parent report of infant appetite, number of children, and parental education. Therefore, these cannot be adjusted for in the current multivariate analyses. We included seven other demographic variables that may influence parental stress according to the Parental Stress and Resilience in CHD Model, including: parental age, race, ethnicity, insurance type, timing of diagnosis (prenatal vs postnatal), and parental social support. Specifically, parental social support was measured using the ENRICHED Social Support Index (ESSI), a self-report instrument that assesses social support (Mitchell et al., 2003). Its 7-items are summed for a total score, with higher scores suggestive of greater social support. The ESSI defines low social support as total scores less than or equal to 18 and having at least two items with a score of 3 or less. The reliability and validity of the ESSI have been demonstrated in several cardiac populations (Berkman et al., 2003; Husak et al., 2004; Lee et al., 2003; Vaglio Jr. et al., 2004).

Analysis

Descriptive statistics summarized the characteristics of infants and their families. Latent class growth modeling (LCGM) was used to characterize distinct infant growth trajectories from birth over a period of 20 weeks (Andruff et al., 2009; Becnel & Williams, 2019; Mattsson et al., 2019). The LCGM is a semi-parametric technique to classify individuals following a similar pattern of WAZ change over time. A model with four trajectories of infant WAZ during the first 4 months demonstrated the best fit (Bayesian Information Criterion, BIC = −1280.15). The mean of posterior probability in each trajectory was high for all classes (range: 0.88–0.99) and above the suggested threshold of 0.8 (Wang & Bodner, 2007).

To examine the associations between infant growth trajectories and parental stress at 4 months after discharge, we used a multivariate logistic regression model. To compare parental stress level during hospital discharge and 4 months follow-up across the infant growth patterns, we used generalized estimating equation (GEE) model accounting for repeated measures of parental stress, while adjusting for covariates. Parental race and ethnicity were dropped from the analyses as most subjects were non-Hispanic and White. All statistical analyses were done using Stata 16 (StataCorp LLC, College Station, TX) and SAS 9.4 (SAS Institute, Inc., Cary, NC).

Results

All but one parent ($n = 135$) reported being a mother, with more than two-thirds (68%) completing a college education and almost three-quarters (74%) having private insurance (Table 1). Mothers' infants were mostly White (82%), non-Hispanic (93%), and prenatally diagnosed with the CHD (81%). Approximately half (54%) were diagnosed with single ventricle physiology. Three-quarters (74%) of the infants had a hospital length of stay of at least 14 days and half of the infants (49%) were discharged on oral feeds only, without feeding tube supplementation. More than one-quarter of parents ($n = 37$, 28%) demonstrated at least moderate PTS symptom severity at discharge and almost one-third at study end ($n = 40$, 31%). Parents were relatively split between experiencing 0–5 PTS symptoms ($n = 69$, 53%) and 6 or more PTS symptoms ($n = 61$, 47%) at discharge, with a growing number of parents experiencing 6 or more symptoms by study end ($n = 71$, 55%). At discharge, 8.5% of parents ($n = 11$) met criteria for PTSD diagnosis, with the percentage increased to 13.1 ($n = 17$) by study end. Regarding parenting stress, 59 (63%) parents had high stress levels (above the 50th percentile) on the Child Domain, 40 (36%) on the Parent domain, and 40 (46%) on the Total Stress scale, at the time of discharge. At the study end, 61 parents (65%) had parenting stress levels above the 50th percentile on the Child Domain, 43 parents (39%) on the Parent Domain, and 32 parents (36%) on the Total Stress scale. The LCGM identified four classes of distinct WAZ trajectories in our sample, very similar to the previously reported trajectories (Fig. 1) (Lisanti et al., 2022). Among the identified trajectories, two are considered healthy growth patterns: "stable around WAZ=0" ($n = 51$, 37.5%) and "maintaining WAZ > 0" ($n = 12$, 8.8%). Therefore, these two patterns were collapsed into one group to serve as the reference group for the analysis, which we named "Stable and maintaining WAZ ≥0." Two additional WAZ-GT classes were identified that reflected poor growth: "partially-recovered" ($n = 44$, 32.4%) and "never-recovered" ($n = 29$, 21.3%).

Table 2 presents the risk of high parenting stress and PTS after 4 months following discharge across infants' growth trajectories. Findings demonstrate that parents of infants in the "Never recovered" group had four to five times higher odds of experiencing high parenting stress (above 50th percentile; OR = 4.14, 95% CI = 1.04–16.54) on the Child Domain and at least moderate to severe PTS symptom severity (OR = 4.58, 95% CI = 1.54–13.64) compared to those in the reference group. A stratified analysis by parental dyadic adjustment showed a moderation effect on several associations of interest, such that parents of infants with poor growth trajectories, who also had poor dyadic adjustment were generally at a greatest risk to experience higher stress. Specifically, parents of infants in the "Never recovered", and in the "Partially recovered" groups, who had low dyadic adjustment, had five to nine times higher odds of experiencing high parenting stress levels (OR = 9.17, 95% CI = 1.20–70.02; and OR = 5.88, 95% CI = 1.28–26.99, respectively) compared to the reference group, whereas parents with high dyadic adjustment did not demonstrate such associations. However, parents of infants in the "Never recovered" group had five to eight times higher odds of experiencing at least moderate to severe PTS symptom severity, regardless of whether they had low (OR = 5.18, 95% CI = 1.01–26.71) or high (OR = 7.90, 95% CI = 1.20–52.23) dyadic adjustment. Additionally, parents of infants in the "Never recovered" group who had low dyadic adjustment had a greater risk of PTSD diagnosis (OR = 17.65, 95% CI = 1.09–286.39).

Table 3 presents the associations between infant growth trajectories and parental stress levels over time (during hospital discharge and 4-month follow-up). Findings show that parents of infants both in the 'Never recovered' and the 'Partially recovered' groups had two to five times higher odds of experiencing higher parenting stress levels on the Parent Domain over time compared to the reference group

Table 1
Infant and parent demographics, $n = 136$.

Characteristics	N(%) or mean(SD)
I. Infant	
Received intervention	75 (55.1)
Sex: female	62 (45.6)
Race	
White	111 (81.6)
Black	13 (9.6)
Other	12 (8.8)
Ethnicity- Hispanic or Latino	10 (7.4)
Gestational age (weeks, n = 135)	38.9 (0.9)
Birthweight (g, n = 135)	3356.6 (443.0)
Prenatal cardiac diagnosis	110 (80.9)
Single ventricle	74 (54.4)
RACHS-1 Mortality Category	
2	11 (8.1)
3	46 (33.8)
4	25 (18.4)
5	2 (1.5)
6	52 (38.2)
Feeding mode at discharge	
Oral feeding only	67 (49.3)
Tube + oral feeding	57 (41.9)
Tube feeding only	12 (8.8)
Length of initial hospitalization (days)	22.4 (14.1)
Number of rehospitalization	0.7 (1.0)
Ever re-hospitalized	61 (44.9)
Age at end of study (weeks)	22.0 (4.2)
II. Parent and household	
Sex (n = 135): female	130 (96.3)
Race: white	115 (84.6)
Ethnicity: Hispanic	129 (94.9)
Age (years, $n = 125$)	30.5 (5.5)
Education ($n = 118$)	
Partial/graduated from high school/partial college	38 (32.2)
Graduated college	80 (67.8)
Insurance Type	
Private	100 (73.5)
Non-private/government founded	36 (26.5)
Household Income ($n = 108$)	
$0–49,999	35 (32.4)
$50,000-99,999	35 (32.4)
$100,000+	38 (35.2)
Number of Children in Household	
1	52 (38.2)
2+	84 (61.8)
III. Parent Psychosocial Measures	
PTDS Scores at discharge	
Total Symptom Severity ($n = 130$)	
None to mild	93 (71.5)
Moderate or greater	37 (28.5)
Number of Symptoms (n = 130)	
0–5	69 (53.1)
6 or more	61 (46.9)
PTSD diagnosis (n = 130)	11 (8.5)
PTDS Scores at study end	
Total Symptom Severity (n = 130)	
None to mild	90 (69.2)
Moderate or greater	40 (30.8)
Number of Symptoms (n = 130)	
0–5	59 (45.4)
6 or more	71 (54.6)
PTSD diagnosis (n = 130)	17 (13.1)
PSI at discharge*	
Child domain ($n = 93$)	
<50th percentile	34 (36.6)
≥50th percentile	59 (63.4)
Parents domain ($n = 110$)	
<50th percentile	70 (63.6)
≥50th percentile	40 (36.4)
Total stress ($n = 88$)	
<50th percentile	48 (54.5)
≥50th percentile	40 (45.5)
PSI at study end	
Child domain ($n = 94$)	
<50th percentile	61 (64.9)
≥50th percentile	33 (35.1)
Parents domain ($n = 111$)	
<50th percentile	68 (61.3)
≥50th percentile	43 (38.7)
Total stress ($n = 89$)	
<50th percentile	57 (64.0)
≥50th percentile	32 (36.0)
Social Support	30.7 (3.7)
Dyadic adjustment	120.1 (14.9)

* We excluded one subject's PSI scores at discharge as an extreme outlier since the total and domain scores were all over 99th percentile.

(OR = 4.78, 95% CI = 1.27–17.96; and OR = 2.47, 95% CI = 1.04–5.85, respectively). Parents of infants in the "Never recovered" group had four times higher odds of experiencing moderate to severe PTS symptom severity over time (OR = 3.91, 95% CI = 1.60–9.86). A stratified analysis to examine the moderating effect of parental dyadic adjustment on the associations of interest revealed significant moderation effects. Parents with low dyadic adjustment, and whose infants were in the 'Partially recovered' group had three to five times higher odds of experiencing high level parenting stress on the Child Domain (OR = 5.45, 95% CI = 1.75–16.92), on the Parent Domain (OR = 2.88, 95% CI = 1.10–7.51), and on the Total Stress Domain (OR = 2.63, 95% CI = 1.00–6.88), over time compared to the reference group. Parents with low dyadic adjustment whose infants were in the 'Never recovered' or the 'Partially recovered' groups had four to five times higher odds of experiencing at least moderate to severe PTS symptoms over time (OR = 5.31, 95% CI = 1.87–15.05; and OR = 4.32, 95% CI = 1.47–12.71, respectively). Lastly, parents of infants in the "Never recovered" group had four times higher odds of experiencing at least moderate to severe PTS symptom severity over time, even with high (OR = 4.14, 95% CI = 1.16–14.77) dyadic adjustment.

Discussion

The current study aimed to examine the associations between infant growth, parental quality of partner relationship, and parental psychological stress over the critical period during the early months post-neonatal cardiac surgery. Our findings indicate that infant growth trajectory over the first few months is associated with both parenting stress and PTS. The results generally demonstrate that parents of infants with poorer growth trajectories (the 'Partially recovered' and the 'Never Recovered') experience higher psychological stress levels than parents of infants with stable growth. Our findings indicated that most parents experienced higher stress levels (above 50th percentile) on the Child Domain and lower levels on the Parent domain at the time of discharge. Almost half of parents were experiencing 6 or more PTS symptoms, with a smaller portion of parents reporting at least moderate symptom severity and 8.5% reaching diagnosis threshold. After four months, most parents experienced lower levels of parenting stress (below 50th percentile) across all domains while PTS symptoms increased, with more than half of parents reporting 6 or more PTS symptoms and almost one-third experiencing at least moderate symptom severity. These trends align with previous reports on decreasing parenting stress levels in parents of CHD infants over infancy (Golfenshtein, Hanlon, et al., 2022), as parents are most stressed around the initial hospital discharge following the cardiac surgery due to their expected loss of healthcare providers' support as they go home and expected caretaking burden of their fragile infant (Golfenshtein et al., 2017; Lisanti, Golfenshtein, & Medoff-Cooper, 2017). As time progresses, and infants become more stable, and parents learn how to take care of the infant along with the infant's medical needs, the stress may decrease. However, symptoms of PTS arise from a traumatic event, in this case the infant's

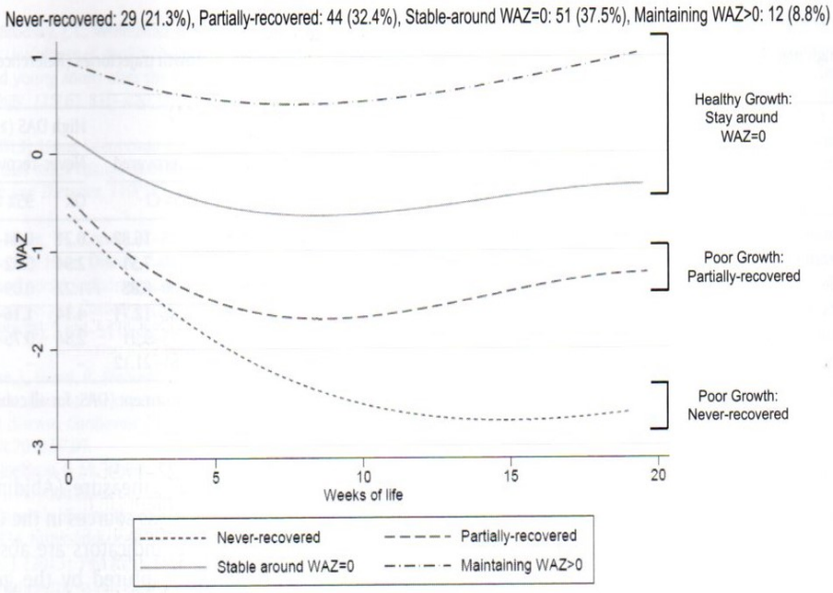

Fig. 1. Infant growth trajectories, n = 136.
Never-recovered: 29 (21.3%), Partially-recovered: 44 (32.4%), Stable-around WAZ = 0: 51 (37.5%), Maintaining WAZ > 0: 12 (8.8%).

hospitalization for CHD, and may not reduce over time as the infant stabilizes or parents become more accustomed to caregiving.

The associations of infant growth trajectory and parenting stress varied across the parent and child domains, according to the inspected time points. Parents of infants in the "Never Recovered" group had a greater risk to experience stress on the Child Domain at the study end, whereas when accounting for both time points, their risk referred to stress on the Parent domain. These differences may indicate the dynamic nature of parenting stress as parents respond to the ever-changing caretaking demands of infants with CHD, which may impact the way parents perceive the CHD and their parental competence to take care of their infant (Biber et al., 2019; Soulvie et al., 2012). Parents of infants in the "Partially Recovered" also experienced greater odds of higher stress in the Parent domain. Over time, if their infants are experiencing poor growth, parents may perceive stress from their parental roles as primary caregivers of infants with medically complex needs and may attribute poor infant growth to issues of parental competence rather than to the illness itself.

Parents of infants in the "Never Recovered" group had significantly greater odds of experiencing at least moderate symptom severity of PTS at study end and over time from discharge to study end. Past research has not found clinical factors associated with PTS symptom severity (Helfricht et al., 2008). Our previous growth trajectory analyses have identified that infants in the "Never Recovered" group had significantly greater odds of having prolonged length of stay >30 days, requiring a feeding tube, and demonstrating low appetite, indicating that these infants may have had worse severity of illness and complicated postoperative recovery (Lisanti et al., 2022). Parents of infants in this poorest growth trajectory class may have been experiencing significantly worse PTS symptom severity due to the complicated clinical course of their infants. Nevertheless, growth trajectory may be an important clinical indicator to examine and screen for PTS in parents.

When examining the role of parental quality of partner relationship as measured by dyadic adjustment, findings indicate that it has a moderating effect on our associations of interest. After stratification, the associations of interest generally remained significant only for parents with low dyadic adjustment, except for parents with infants in the "Never Recovered" group, which remained at high risk for at least moderate PTSD symptom severity regardless of their relationship quality. This may indicate that parents with low quality of partner relationship do not receive the stress-mitigating support from their partners as they experience the adversities posed by their infant's illness as indicated by poor growth trajectory whereas parents with a greater quality of partner relationship are more protected from the illness adversities potentially threatening their wellbeing. Indeed, social networks and well-adjusted partner relationship have been repeatedly reported to be protective factors aiding parents in their coping process with severe pediatric illness, including parents of infants and children born with heart defects (Bratt et al., 2019). Both studies of Lisanti et al. (Lisanti et al., 2021), and Rychik et al. (Rychik et al., 2013), for instance, reported on the protective role couple's cohesion has against parental anxiety and depression. The protective effect of higher quality of partner

Table 2
Comparing the risk of having high parental stress after 4-months following discharge across three infant growth trajectories (Reference: Stay around WAZ ≥ 0), and by quality of partner relationship.

	All				Low DAS (< median)				High DAS (≥ median)			
	Never-recovered		Partially-recovered		Never-recovered		Partially-recovered		Never-recovered		Partially-recovered	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
PSI-Child domain ≥50percentile	**4.14**	**1.04–16.54**	2.08	0.64–6.72	**9.17**	**1.20–70.02**	**5.88**	**1.28–26.99**	1.06	0.07–16.25	0.22	0.02–2.81
PSI-Parent domain ≥50percentile	2.47	0.67–9.14	1.76	0.60–5.21	2.91	0.46–18.43	2.24	0.51–9.81	2.53	0.31–20.88	1.68	0.28–9.97
PSI-Total stress ≥50percentile	2.06	0.46–9.30	1.27	0.36–4.45	3.55	0.50–25.25	2.30	0.50–10.50	0.54	0.01–63.72	0.18	0.01–6.41
PTSD-Total symptom severity ≥ moderate	**4.58**	**1.54–13.64**	1.35	0.48–3.75	**5.18**	**1.01–26.71**	3.26	0.73–14.68	**7.90**	**1.20–52.23**	0.49	0.10–2.44
PTSD-Number of symptoms≥6	2.22	0.76–6.53	1.41	0.58–3.44	1.58	0.33–7.63	3.02	0.67–13.65	4.31	0.82–22.60	0.84	0.24–2.97
PTSD diagnosis	3.17	0.75–13.42	1.13	0.26–4.87	**17.65**	**1.09–286.39**	14.38	0.99–207.84	–	–	–	–

Logistic regression analyses after adjusting for parental age, time of diagnosis, insurance type (private vs. others), social support (ESSI) and dyadic adjustment (DAS; for all column only).
Bold text = $p < 0.05$.

Table 3
Comparing the risk of having high parental stress during hospital discharge and 4-months follow-up across three infant growth trajectories (Reference: Stay around WAZ ≥ 0), and by quality of partner relationship.

	All				Low DAS (< median)				High DAS (≥ median)			
	Never-recovered		Partially-recovered		Never-recovered		Partially-recovered		Never-recovered		Partially-recovered	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
PSI-Child domain ≥50percentile	1.52	0.45–5.11	2.06	0.91–4.67	5.51	0.61–49.82	**5.45**	**1.75–16.92**	0.21	0.04–1.19	0.40	0.09–1.85
PSI-Parent domain ≥50percentile	**4.78**	**1.27–17.96**	**2.47**	**1.04–5.85**	4.91	0.63–38.48	**2.88**	**1.10–7.51**	2.94	0.62–13.88	1.74	0.33–9.14
PSI-Total stress ≥50percentile	1.87	0.41–8.48	2.22	0.89–5.54	4.00	0.40–39.66	**2.63**	**1.00–6.88**	1.22	0.09–16.89	2.89	0.22–25.54
PTSD-Total symptom severity ≥ moderate	**3.91**	**1.60–9.86**	2.23	0.97–5.12	**5.31**	**1.87–15.05**	**4.32**	**1.47–12.71**	**4.14**	**1.16–14.77**	0.58	0.11–3.10
PTSD-Number of symptoms≥6	2.46	0.91–6.62	1.42	0.66–3.06	2.42	0.80–7.39	1.79	0.75–9.91	2.84	0.75–10.72	0.64	0.21–1.93
PTSD diagnosis	2.32	0.62–8.62	1.40	0.39–4.97	3.35	0.60–18.71	4.13	0.81–21.12	–	–	–	–

GEE after adjusting for parental age, time of diagnosis, insurance type (private vs. others), social support (ESSI) and dyadic adjustment (DAS; for all column only). Bold text = $p < 0.05$.

relationship on PTS, however, was not demonstrated in the "Never Recovered" group. It may be that no matter how strong the partner relationship may be, the trauma experienced by parents who have such a medically fragile infant requires additional support, coping or other resilience factors not measured in this study.

Research and practice implications

The findings have important research and clinical implications. Findings provide additional support for the Parental Stress and Resilience in CHD (PSRCHD) Model, which innovatively incorporates the child's heath condition into the parent-child system stressors. Adding to the other central sources of stress in the CHD population (e.g. condition severity, medical procedures, the CICU environment, caretaking burden) (Lisanti, Allen, et al., 2017; Sarajuuri et al., 2012; Torowicz et al., 2010), findings suggest that infant growth may be a strong health indicator which cannot be ignored and should be further incorporated in condition/illness-specific stress models, such as the PSRCHD, and routinely assessed. As such, infant growth checks can serve as screening aids for identifying parents at risk for mental health problems, specifically psychological stress. Next, our findings also show that the relationship between infant growth and parental stress evolves with time, as demonstrated by the change in the various parenting stress domains and the gradual increase of PTS symptoms and diagnosis. These findings may suggest that the dynamic nature of the illness, and the ever-changing illness demands over time, may affect the parental perceptions regarding their infant's condition, and potentially require adjustment of their coping strategies over time. Future research is needed regarding parental coping over the illness trajectories, to gain insight into the parental coping process over time. Finally, findings indicate that parents with lower partner's support are at a greater risk to be negatively affected by their infant's distressful condition and exhibit psychological distress. Dyadic adjustment may serve as a screening indicator for parents at risk, as well as an interventional target for parents whose infant has been diagnosed with CHD.

Study limitations and directions for future research

The current study has several limitations resulting from the secondary nature of the analysis. The fixed sample limited our sample size and the ability to include additional variables and measurement points. Participating parents were relatively homogeneous, with a majority reporting female, White race, non-Hispanic, with private insurance and at least a college education. Future studies should strategically enroll parents representing more diverse populations. Additionally, we had only data available through the first 4 months post-surgical discharge. Infant's growth trajectories and parental stress measures of parenting stress and PTS, accordingly, may continue to evolve throughout early childhood. Future research should be targeted towards identification of longitudinal, and perhaps the unique outcomes of the identified trajectories. Lastly, while Abidin's parenting stress model informed the general PSI measure (Abidin, 1995) which captures many of the parenting stress sources in the CHD pediatric population, the child's health/illness indicators are absent from the model and therefore could not be captured by the general PSI measure. The PSRCHD model can guide a future development of a condition-specific stress measure, which would more accurately reflect parenting stress in the CHD population. The PSRCHD model can also guide future research to test additional relationships influencing the psychological stress of parents beyond those explored in this study.

Conclusions

This study examined the associations between distinct growth trajectories identified in infants with complex CHD, and parental stress over the first 4 months of infants' life. Findings show that parents of infants with poorer growth trajectories are at a greater risk to experience psychological stress. That is especially true for parents with poorer dyadic adjustment. Findings can be used in the screening process of families at potential risk of poor illness adaptation and in the design of interventions to target parental stress and mental health in this vulnerable patient population.

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CRediT authorship contribution statement

Amy Jo Lisanti: Conceptualization, Methodology, Data curation, Writing – original draft. **Nadya Golfenshtein:** Conceptualization, Methodology, Data curation, Writing – original draft. **Jungwon Min:** Formal analysis, Methodology, Writing – review & editing. **Barbara Medoff-Cooper:** Funding acquisition, Writing – review & editing.

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