Interstage Weight Gain and Social Vulnerability

Rachel Shustak, MD MSCE
CHOP Cardiology 2025
Assistant Professor of Pediatrics
University of Pennsylvania Perelman School of Medicine
Children's Hospital of Philadelphia

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Disclosures

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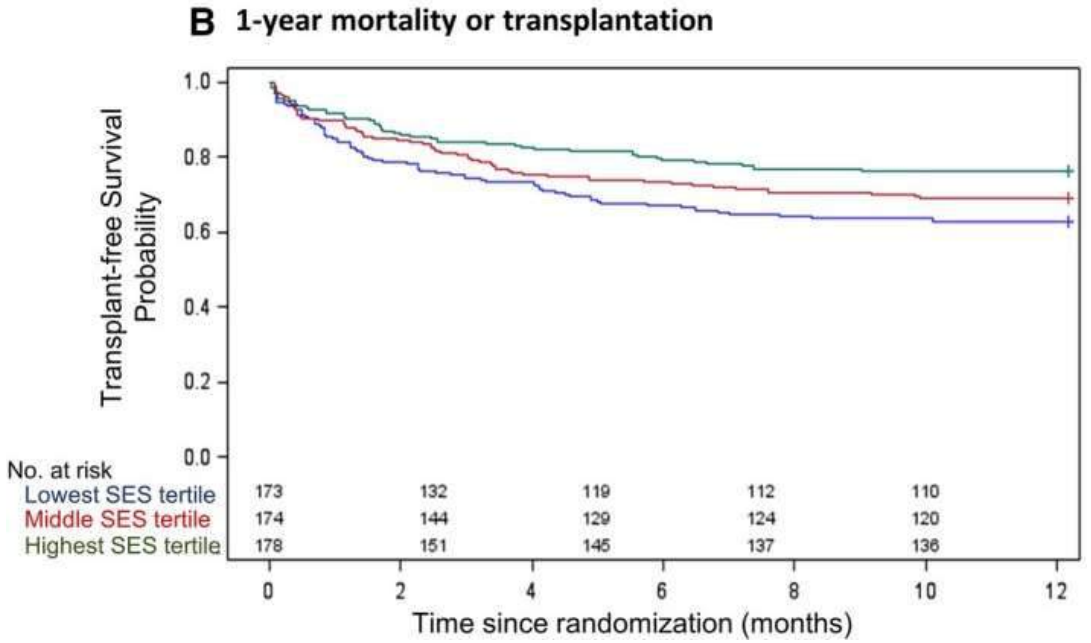
Disparities in Interstage Outcomes

Social determinants of health are risk factors for interstage mortality

- Low neighborhood SES associated with worse 1-year transplant-free survival following S1P
- Birth to a teen mother and single adult caregiver are independent risk factors for interstage mortality



Bucholz, 2018; Taylor, 2016

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Disparities in Interstage Outcomes

- Knowledge gaps exist in our understanding of interstage disparities
  - Role of home monitoring
    - Standard of care
    - Core features:
      - Monitoring of oxygen saturations, enteral intake, and weight change
      - Early notification of the healthcare team
    - Resulted in a significant reduction in interstage mortality
  - Impact on morbidity

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Interstage Growth

- Interstage growth failure is common
- NPC-QIC recommends target growth of 20-30 g/day
- Growth is an indicator of well-being
- Improved interstage weight gain associated with:
  - Shorter length of stay at Stage II surgery
  - Better early developmental outcomes
  - Greater interstage transplant-free survival

Anderson, 2019; Evans, 2017

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Aims

In infants with hypoplastic left heart syndrome, we sought to determine:

1. The association of neighborhood social vulnerability and interstage weight gain
2. If this association is modified by enrollment in the CHOP interstage home monitoring program

Hypothesis

High neighborhood social vulnerability is a risk factor for poor interstage weight gain and home monitoring can decrease disparities

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Interstage Weight Gain

Patient Characteristics:
Prematurity
Genetic Syndrome
Extracardiac anomaly

Hemodynamics:
AVVR
Ventricular function
Qp:Qs balance

Feeds

Social Factors
Health literacy
Supply availability
Caregiver support
Frequent appointments

Home Monitoring
Education
Communication
Access

Volume (titration)

Fortification (mixing)

Mechanism (PO vs NG/GT)

Tolerance

Monitoring

Methods: Study Design

- Single-center retrospective cohort study
- Infants with hypoplastic left heart syndrome who underwent Stage I palliation at CHOP between 2007 - 2020
- Exposure: **CDC Neighborhood Social Vulnerability Index (SVI)**

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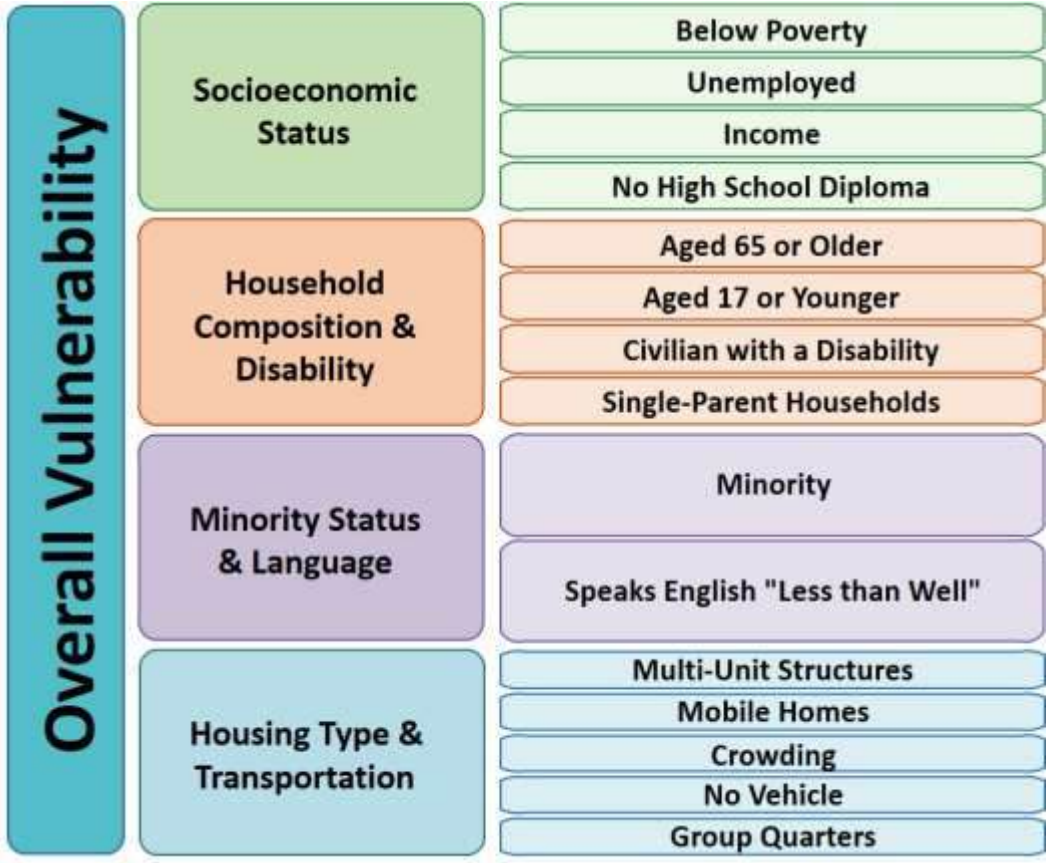
Neighborhood Social Vulnerability Index (SVI)

Social vulnerability is the resilience of an individual or community when confronted by external stresses on human health

CDC Neighborhood SVI

- Range 0 – 1 **Higher SVI = More Vulnerable**
- Geocoded address at Stage 1 discharge
- Vulnerability tertiles – low, middle, high



Methods: Study Design

- Exposure: CDC Neighborhood Social Vulnerability Index (SVI)
- Outcome: **Interstage weight gain**
  - Average daily weight gain
  - Growth failure defined as < 20 g/day
- Effect Modifier: **Home monitoring program**
  - Historical controls (1/1/2007 – 11/30/2010)
  - HMP (12/1/2010 – 12/31/2020)

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Methods: Statistical Analysis

- Multivariable linear and logistic regression models
- Effect modification
- Segmental regression analysis

Adjusted Covariates

Demographic
- Race
- Ethnicity
- Prematurity
- Sex
- Maternal age
- Birth Weight
- Genetic Syndrome

Operative & Post-operative
- Shunt type
- ECMO
- AV valve regurgitation
- Right ventricular function

Discharge
- Feeding mechanism
- Digoxin

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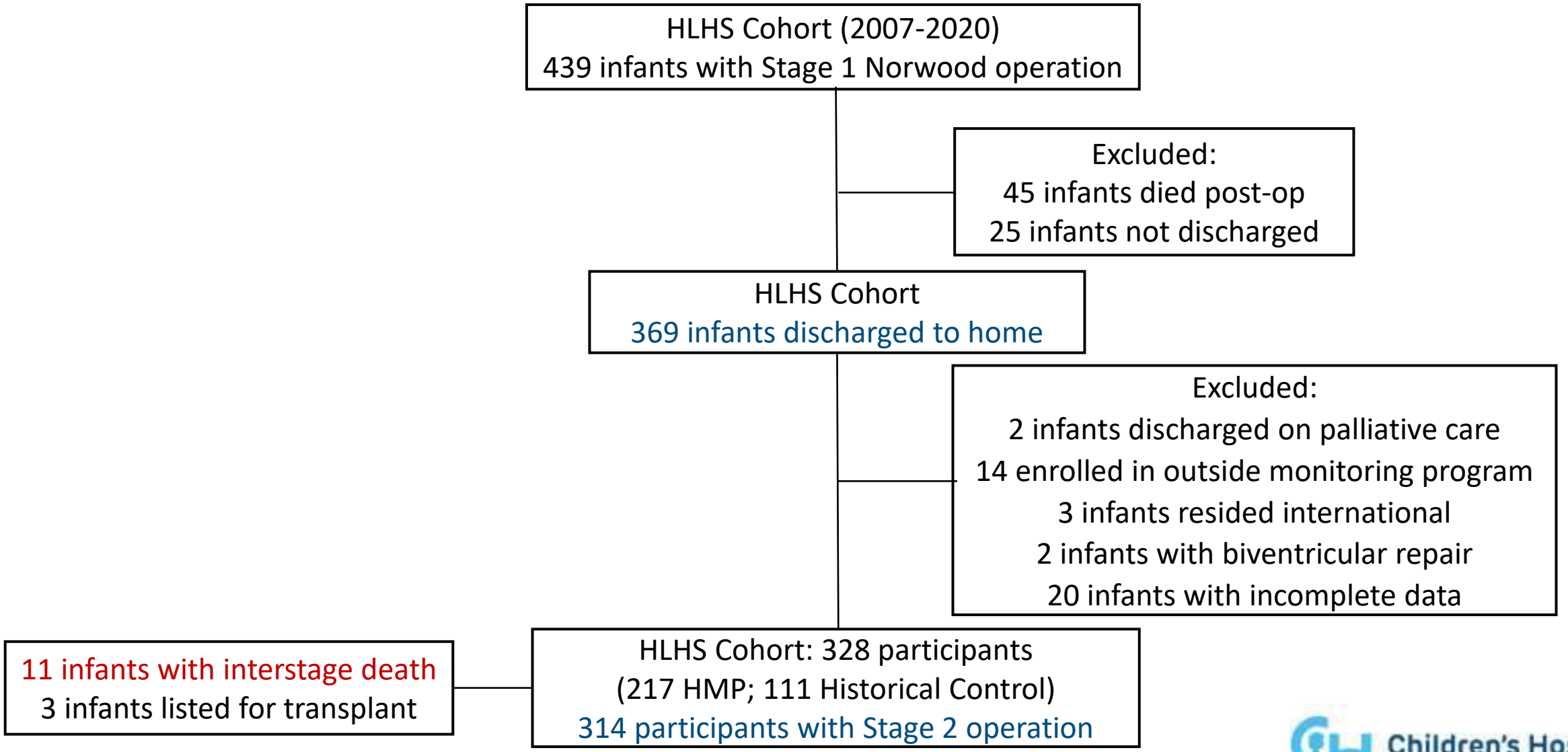
Results



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Demographic and Birth Characteristics

	Total (n=328)	**Low Vulnerability** (n=110)	**Middle Vulnerability** (n=109)	**High Vulnerability** (n=109)	P-value
Male sex (%)	62	67	57	62	
Birth weight, kg	3.25 (2.90, 3.57)	3.26 (2.84, 3.59)	3.27 (3.00, 3.58)	3.22 (2.80, 3.48)	
Birth WHO WAZ	-0.14 (-0.95, 0.57)	-0.11 (-1.02, 0.55)	-0.12 (-0.63, 0.62)	-0.22 (-1.17, 0.47)	
Gestational Age, wks	39 (38, 39)	39 (38, 39)	39 (38, 39)	39 (38, 39)	
Prenatal diagnosis (%)	94	95	93	95	
Maternal Age, yrs	29 (24, 34)	32 (27, 35)	30 (26, 34)	25 (21, 32)	<0.001
Race (%)					
White	70	88	79	42	<0.001
Black	15	5	6	33	
Other	15	7	15	25	
Ethnicity (%)					
Non-Hispanic	86	94	87	76	<0.001
Hispanic	13	4	11	24	
Unknown	1	2	2	0	

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Stage I Operative Characteristics

	Total (n=328)	**Low Vulnerability** (n=110)	**Middle Vulnerability** (n=109)	**High Vulnerability** (n=109)	P-value
Age at Stage I, days	4 (2, 6)	4 (2, 6)	4 (3, 6)	4 (2, 6)	
Stage I operation (n, %)					
BTT shunt	182 (55)	52 (47)	67(62)	63 (58)	
RV-PA conduit	141 (43)	56 (51)	42 (38)	43 (39)	
BTT + RV-PA conduit	5 (2)	2 (2)	0 (0)	3 (3)	
CPB, min	86 (77, 102)	84 (76, 95)	84 (78, 103)	91 (80, 110)	0.007
Mechanical Vent, days	2.5 (1, 5)	3 (1, 5)	2 (1, 5)	3 (1, 5)	
CPR (n, %)	31 (9)	11 (10)	7 (6)	13 (12)	
ECMO (n, %)	18 (5)	4 (4)	6 (5)	8 (7)	

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Stage 1 Discharge Characteristics

	Total (n=328)	**Low Vulnerability** (n=110)	**Middle Vulnerability** (n=109)	**High Vulnerability** (n=109)	P-value
Weight, kg	3.49 (3.16, 3.87)	3.49 (3.11, 3.85)	3.57 (3.24, 3.91)	3.45 (3.15, 3.90)	
WHO WAZ	-1.47 (-2.37, -0.74)	-1.54 (-2.46, -0.82)	-1.44 (-2.04, -0.61)	-1.47 (-2.49, -0.82)	
Length of stay, days	26 (19, 40)	24 (18, 33)	27 (19, 43)	28 (20, 41)	
Prescribed digoxin (%)	48	51	47	46	
Feeding mechanism (%)					
Oral	25	31	33	12	<0.001
Oral + tube feeds	59	53	56	67	
Exclusive tube feeds	16	16	11	21	
Enrolled in ISVMP (%)	66	71	66	62	
Distance from CHOP, miles	52.8 (20.2, 90.6)	57.4 (31.9, 97.7)	57.3 (20.1, 105.9)	46.9 (12.5, 80.7)	0.007

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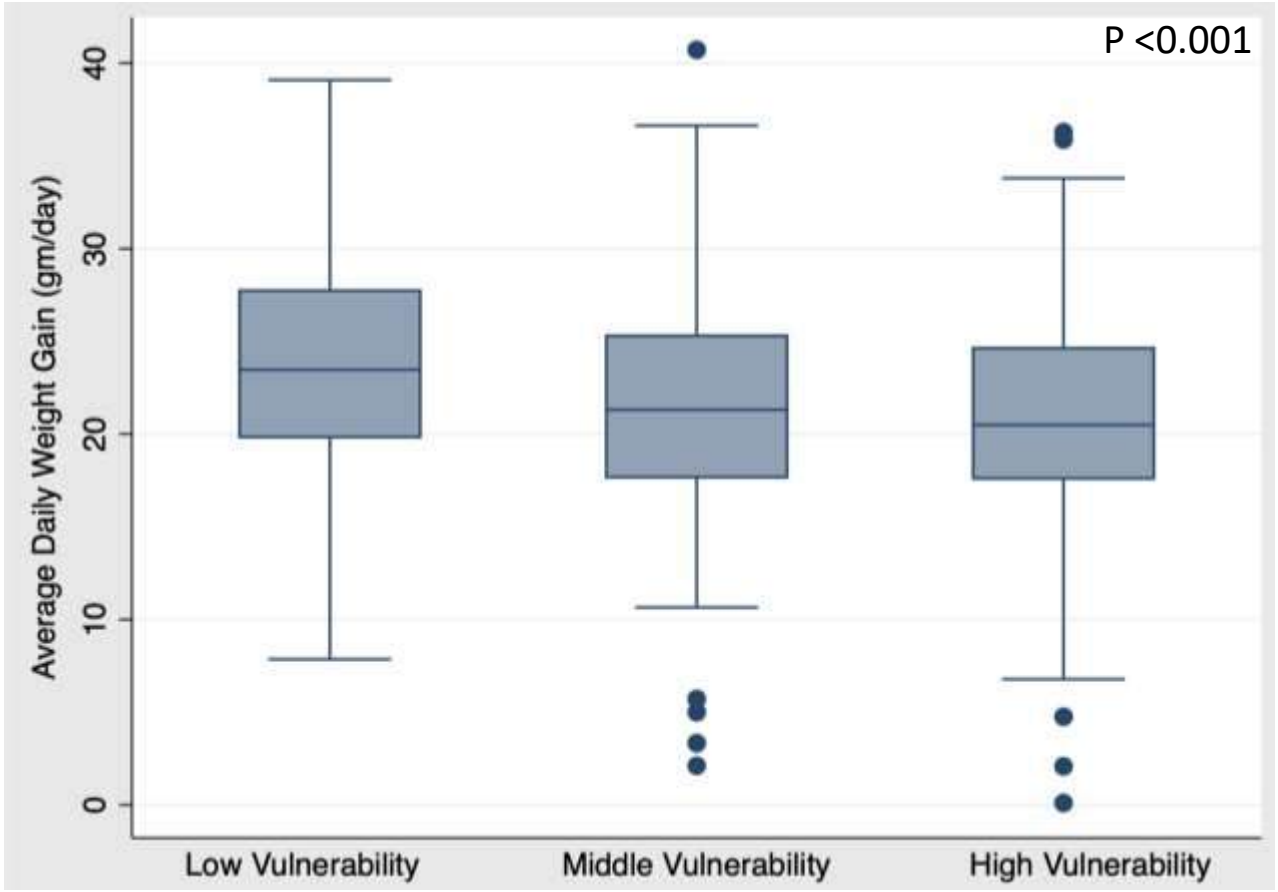
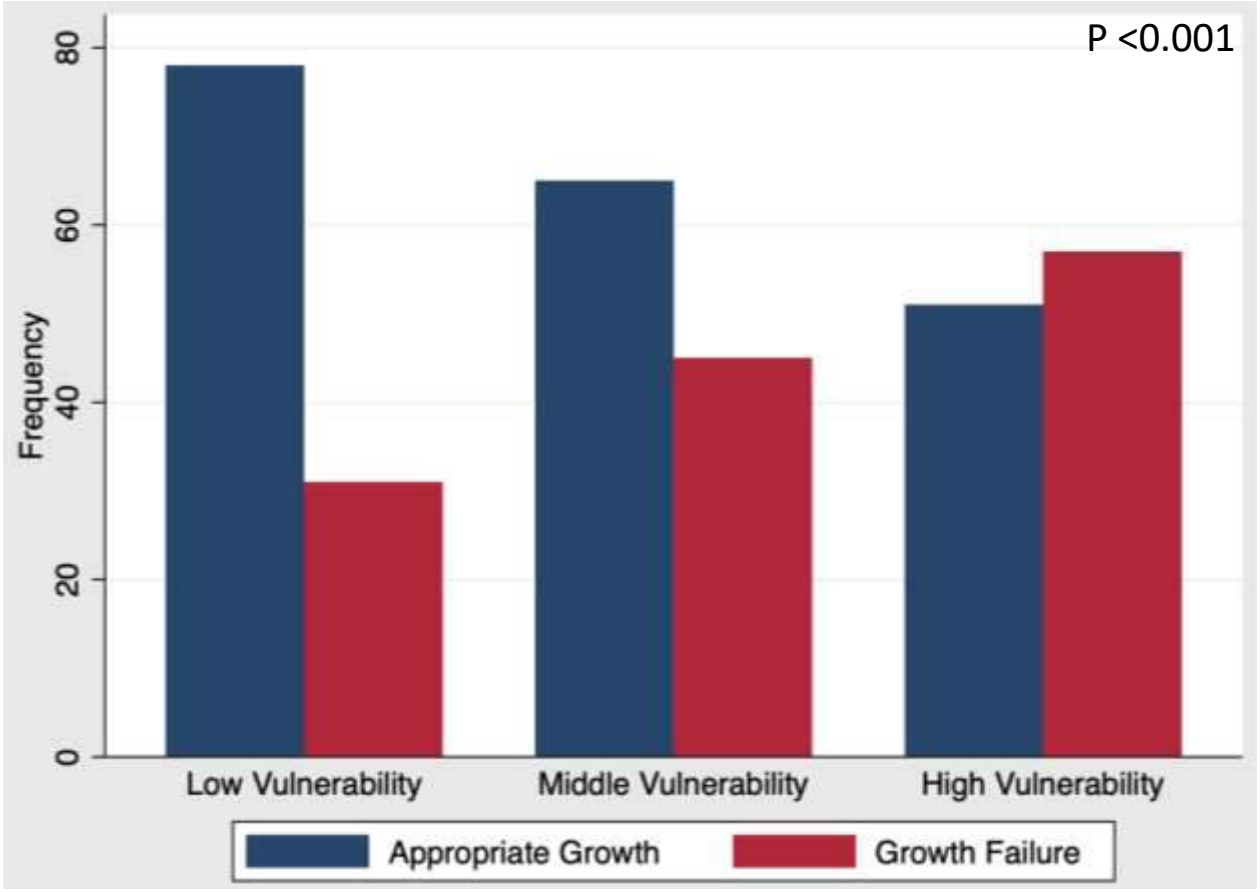
Aim 1

Daily Weight Gain by Vulnerability Tertile



Frequency of Growth Failure by Vulnerability Tertile



Adjusted Analysis: High vulnerability infants gained 3 gm/day less and were > 3 times as likely to experience interstage growth failure compared to low vulnerability infants

Aim 2

ISVMP strongly attenuated the effect of neighborhood social vulnerability on interstage weight gain and growth failure

	Daily Weight Gain (gm/day)		**Growth Failure**	
	Weight Differential (gm/day, 95% CI)	P-value	OR (95% CI)	P-value
Middle vs Low Vulnerability	-4.6 (-7.6, -1.5)	0.004	4.6 (1.5, 14.0)	0.007
High vs Low Vulnerability	-5.3 (-8.4, -2.2)	0.001	7.9 (2.5, 25.1)	0.000
Middle Vulnerability x HMP	4.0 (0.3, 7.7)	0.03	0.2 (0.06, 0.9)	0.039
High Vulnerability x HMP	3.4 (-0.2, 7.1)	0.06	0.3 (0.07, 0.9)	0.042
HMP	-0.79 (-3.56, 1.98)	0.57	1.3 (0.46, 3.68)	0.62

Aim 2

	Historical Control		HMP	
	Daily Weight Gain (gm/day)			
	Weight Differential (95% CI)	P-value	Weight Differential (95% CI)	P-value
Middle vs Low Vulnerability	-4.17 (-7.54, -0.81)	0.016	0.60 (-2.06, 2.18)	0.96
High vs Low Vulnerability	-4.47 (-8.30, -0.65)	0.022	-1.91 (-4.38, 0.56)	0.13
	Growth Failure			
	OR (95% CI)	P-value	OR (95% CI)	P-value
Middle vs Low Vulnerability	7.82 (1.96, 31.22)	0.004	0.59 (0.23, 1.51)	0.28
High vs Low Vulnerability	12.46 (2.49, 62.24)	0.002	1.56 (0.56, 4.36)	0.39

- Of the 4 SVI themes, ”Housing Type & Transportation” had the strongest association with weight gain
- Other identified risk factors were female sex, BTT shunt (compared to RV-PA conduit), and tube feeds

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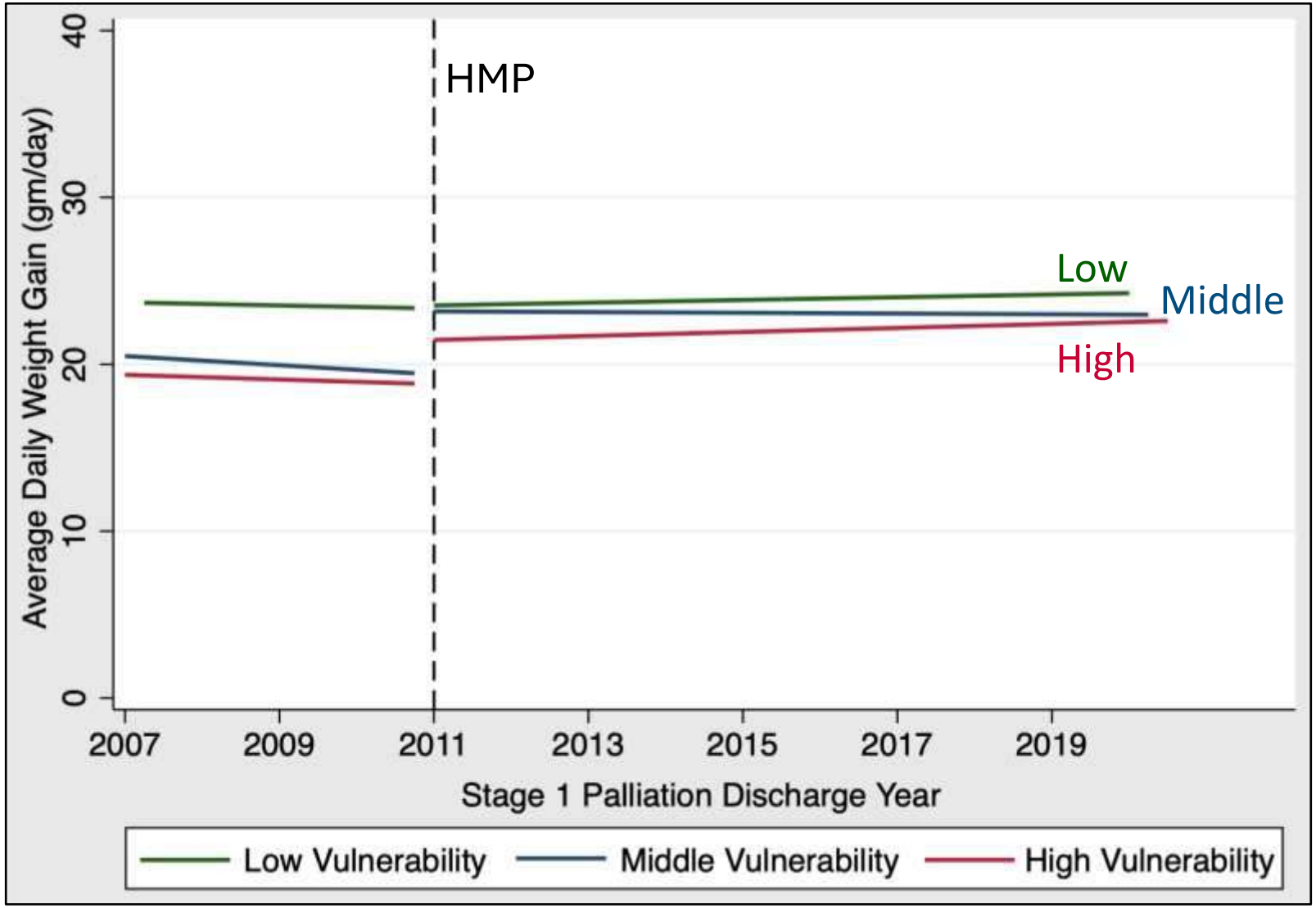
Aim 2


HMP
Low
Middle
High
Average Daily Weight Gain (gm/day)
0
10
20
30
40
2007
2009
2011
2013
2015
2017
2019
Stage 1 Palliation Discharge Year
Low Vulnerability
Middle Vulnerability
High Vulnerability

Conclusions

- High social vulnerability is a risk factor for poor interstage weight gain
- Home monitoring significantly reduces growth disparities
- Potential to be translated to other infants with high-risk physiology
- Future directions
  - Identify other actionable ways to decrease disparities – health literacy
  - Disparities following discontinuation of home monitoring

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Thank you!

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Neighborhood SES Indices

	Social Vulnerability Index	Childhood Opportunity Index	Area Deprivation Index
Components	16 variables (2022) 4 themes: Socioeconomic status Household characteristics Racial and minority status Housing type & transport	44 variables (COI 3.0) 3 domains: Education Health Environment	17 variables Education Employment Housing quality Poverty measure
Geographic Unit	Census Tract	Census Tract, Block, or Zip Code	Census Block
Source Data	American Community Survey (ACS)	ACS, National Center for Health Statistics, Dept of Education, EPA	ACS
Scoring	0 – 1 (Low SVI = Low Vulnerability)	1 – 100 (Low COI = Low Opportunity)	1 – 100 (Low ADI = Low Deprivation)
Other Comments	Includes race, ethnicity, language Composite and theme scores	↑ education and environment No race, ethnicity, language Composite and domain scores	No race, ethnicity, language Only as a composite scale

Effect Modification

- Effect modification is present when the measure of association between X and Y varies across a third variable (Z)