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Application of Life's Essential 8 to assess cardiovascular health during early childhood

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Abstract

Objectives: Assess cardiovascular health (CVH) during early childhood using the American Heart Association's recently-updated construct, Life's Essential 8 (LE8); examine concordance in CVH status per LE8 vs. Life's Simple 7 (LS7); and identify perinatal correlates of high CVH per LE8.

Methods: We applied LE8 and LS7 to data from 305 children aged 4–7 years in Denver, CO; estimated % low, moderate, high, and optimal CVH; assessed concordance in CVH status based on LE8 and LS7 using contingency tables; and used multivariable logistic regression to identify early-life correlates of high CVH per LE8.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Results: Average age of children was 4.7±0.6 years; 44.6% were female. No participants had low or optimal CVH; 43.9% had high and 56.1% had moderate CVH per LE8, whereas 33.4% had high and 66.6% had moderate CVH per LS7. Twenty-two percent had high CVH based on both constructs. Correlates of high CVH were maternal prenatal diet quality ($OR_{\text{Healthy Eating Index score} > \text{vs.} \leq 57}$ =1.90 [1.12, 3.21]) and child age ($OR_{\text{per 1 year}}$=1.58 [1.04. 2.42]).

Conclusions: LE8 yielded higher prevalence of high CVH than LS7 during early childhood, though there is modest concordance between the two constructs. Maternal diet is a potential modifiable target to optimize early-life CVH.

Keywords

cardiovascular health; pediatrics; prenatal correlates; epidemiology; optimal cardiovascular health; ideal cardiovascular health; primordial prevention

INTRODUCTION

Ten years ago, the American Heart Association (AHA) put forth a cardiovascular health (CVH) construct known as Life's Simple 7 (LS7) [1,2] to facilitate primordial prevention of cardiovascular disease (CVD). LS7 comprises three behavioral (no cigarette smoking, healthy diet, physical activity) and four health factors (normal body mass index [BMI], blood pressure, cholesterol, and glucose) that predict lower risk of CVD [3,4], longer life span [5], and better quality of life [6]. Each LS7 metric comprises strata of poor, intermediate, and ideal CVH and the composite score ranges from 0 to 14, with 14 indicating "ideal" CVH. Studies from the last decade revealed low prevalence (%) of ideal CVH in adults (<1%) [3,7] and children (<2%) [4,8–19]. In 2022, the AHA introduced Life's Essential 8 (LE8) [20], an updated construct that includes an eight metric of sleep and holds promise to enhance CVH assessment across the lifespan. One advantage of LE8 over LS7 is the method of calculating the composite CVH score, which ranges from 0 to 100 regardless of the number of available metrics. This scoring system facilitates comparisons of CVH across populations and enables assessment of change in CVH at the individual and population levels. Moreover, the distinction between high vs. optimal CVH per LE8, as opposed to a single category of ideal CVH per LS7, may allow for greater sensitivity in assessing differences in CVH that are especially relevant during early-life.

At present, we are aware of only one study that assessed CVH in children using LE8. Leveraging data from 9,888 children and adolescents ages 2–19 years in the National Health and Nutrition Examination Survey (NHANES) 2013–2018, Lloyd-Jones et al. [21] found that 2.2% of youth had optimal CVH and 29.1% had high CVH. Importantly, prevalence of high CVH declined with age, emphasizing a need to identify determinants of early-life CVH to home in on opportunities for primordial prevention of CVD.

Here, we sought to assess and describe CVH status at ages 4–7 years based on LE8 and LS7, evaluate concordance in CVH status across the two constructs, and identify perinatal correlates of high CVH per LE8. Given the relatively scant literature on this topic, the data science tasks [22] of interest in this analysis are: (1) description – that is, describing and comparing CVH status based on LE8 and LS7; and (2) prediction, referring to the

identification of perinatal factors that are independently associated with high early-life CVH – findings that will inform future studies investigating causal determinants of CVH in young children.

METHODS

Study population.

Study participants were from the Healthy Start Study, a prospective cohort of 1,410 racially/ethnically diverse pregnant women enrolled at ≤24 gestational weeks from prenatal clinics at the University of Colorado Hospital from 2009–2014 [23,24]. Women were excluded if they were expecting multiple births; had a previous stillbirth or delivery <25 gestational weeks; had pre-existing diabetes, asthma managed with steroids, cancer, or psychiatric illness; were younger than 16 y of age; or had already completed 24 gestational weeks. Of the 1,410 women enrolled, 907 mother-offspring pairs returned for the early childhood at ages 4–7 years. Of them, the analytical sample comprised 305 mother-child pairs with complete data on LE8 metrics.

As shown in Supplemental Table 1, participants included in this analysis are similar to those not included, except for slightly older maternal age (~2 years), higher prevalence of non-Hispanic White women (62.0% vs. 51.0%), higher maternal education (30.2% vs. 19.2% college graduates), and higher household income (26.1% vs. 39.6% with ≤$40,000). All mothers provided written informed consent. The study protocol was approved by the Colorado Multiple Institutional Review Board.

Assessment of Life's Essential 8

BMI and blood pressure assessment—Research assistants (RAs) measured the children's weight on an electronic scale and height via a stadiometer. We calculated BMI as weight(kg)/height(m)^2 and standardized values as percentiles using the World Health Organization (WHO) growth reference [25,26].

We measured systolic (SBP) and diastolic blood pressure (DBP) twice in the seated position using an oscillometric monitor (Dinamap V100, GE Carescape; Waukesha, WI) using an appropriately-sized cuff. For the analysis, we took the average across the two measures and converted values to age, sex, and height-specific z-scores [27].

Fasting glucose and lipid profile—We assayed fasting glucose using an enzymatic approach (Olympus America, Center Valley, PA). Serum concentrations of total cholesterol, high-density lipoprotein (HDL), and triglycerides were measured via a radioimmunoassay (Millipore Corporation, Burlington, MA). We calculated non-HDL cholesterol as (total cholesterol–HDL).

Physical activity—After the research visit, the children wore a waist-worn accelerometer (ActiGraph wGT3X-BT, ActiGraph, Pensacola, FL) for seven days. For each child, we used data from the four days with the longest wear-time, with a minimum of 8 hours/day, to derive intensity of physical activity and defined moderate-to-vigorous physical activity

(MVPA) as a vector count ≥3908 [28]. These data were used to estimate minutes of MVPA/day.

Diet quality, sleep duration, and nicotine exposure—Mothers reported their child's dietary intake via two Automated Self-Administered 24-hour Dietary Recalls (ASA24). We used the USDA Food and Nutrient Database to extract nutrient and caloric intake, and calculated the Healthy Eating Index (HEI)-2015 score [29], an assessment of diet quality [30] used in LE8. Mothers also reported on their child's usual sleep duration via questionnaire.

LE8's metric for nicotine exposure comprises first- and secondhand exposure. Given the young age of the participants, we assumed that none had ever smoked a cigarette. Exposure to secondhand smoke was assessed via a questionnaire inquiring on whether an adult in the household smoked.

Perinatal characteristics.

At enrollment, we administered a questionnaire inquiring on the women's birthdate, reproductive history, educational attainment, and annual household income. We also inquired on the women's self-identified race and ethnicity, for which we provided the options of American Indian or Alaska Native; Asian, Native Hawaiian or Pacific Islander; non-Hispanic Black or African American; non-Hispanic White, and >1 race. Due to small cell sizes for some of the categories, we combined American Indian or Alaska Native, Asian, Native Hawaiian or Pacific Islander and >1 race into a single category of "non-Hispanic other." We view race and ethnicity as social constructs that reflect the effects of lived experiences on health.

We obtained information on the women's diet via two ASA24s administered across pregnancy and used the same procedure as for the children to calculate prenatal HEI score [29], which we dichotomized as >57 vs. ≤57 [29,31]. We derived the women's pre-pregnancy BMI based on weight and height, and dichotomized values as < vs. ≥25 kg/m^2. Medical records provided information on gestational diabetes mellitus diagnoses during the index pregnancy. The women reported on cigarette smoking via questionnaires during pregnancy and at delivery.

We abstracted data on offspring sex, gestational age at delivery, and birthweight from medical records. We dichotomized gestational age at delivery as <37 vs. ≥37 gestational weeks as an indicator of preterm birth, which is associated with poor CVH [32]. We calculated birthweight-for-gestational-age z-scores using the WHO standard [25] and categorized values as small (<10th), appropriate (10th-90th), and large (>90th percentile) for gestational age to reflect the U-shaped relationship between birth size and CVH [33,34]. Finally, we created a breastmilk-months variable reflecting duration and exclusivity of breastfeeding [35], dichotomized as ≥6 vs. <6 months.

Data analysis

Step 1: Derive CVH score and assess CVH status per LE8—We applied the LE8 scoring system to data on individual CVH metrics using weights proposed by Lloyd-Jones et al. [20] (Supplemental Table 2). We then calculated a composite CVH score as the average

value across all metrics and created separate scores for the health and behavioral factors. We assessed the overall composite CVH score continuously, and as low (<50), moderate (50-<80), high (80-<100), and optimal (100) [21].

Step 2: Assess concordance in CVH status per LE8 vs. LS7—We derived LS7 metrics as previously described [19]. Each metric comprises strata of poor (0 points), intermediate (1 point), and ideal (2 points) based on clinically-accepted thresholds. We took the sum across all seven metrics and derived CVH status categories based on thresholds suggested by Perak et al. for CVH assessment in children [36]: <7 of 14 points (0%-<50%) as low CVH; 7-<10.5 (50%-<75%) as moderate CVH; 10.5-<14 (75%-<100%) as high CVH; and 14 (100%) as ideal CVH. We then evaluated concordance in CVH status based on LE8 vs. LS7 via contingency tables and assessed Pearson's correlation between the continuous scores. We also repeated the above steps after removing sleep from LE8.

Step 3: Perinatal correlates of high CVH per LE8—We examined bivariate associations of the perinatal characteristics with prevalence (%) of LE8's definition of high CVH, using alpha=0.10 as the threshold for statistical significance. We entered statistically significance correlates identified in the prior step, plus child age and sex, as predictors into a logistic regression model where high CVH was the outcome. We tested for an interaction between all characteristics and child sex to assess need for sex-stratified models (*P*-interaction<0.10). In sensitivity analyses, we re-ran all models with the addition of characteristics that were marginally significant in bivariate analyses (*P*=0.10-<0.15) and assessed whether their inclusion altered the estimates. We carried out all analyses using SAS 9.4 (Cary, NC, USA).

RESULTS

Average age of the children was 4.7±0.6 years; 45% were female. The majority (62%) of mothers identified as non-Hispanic White, 23.3% as Hispanic, 11.8% as non-Hispanic Black, and 2.9% were classified as non-Hispanic Other. Table 1 shows additional mother-child characteristics.

No children had low or optimal CVH; 43.9% had high CVH and 56.1% had moderate CVH. Average CVH score was 78.2±6.7. Boys had higher prevalence of high CVH than girls (46.8% vs. 40.4%) and, accordingly, higher average CVH score (Table 2). When assessing individual metrics, boys had higher scores for diet and physical activity, but a lower score for BMI (Table 2). Generally, children had high scores for the health factors, and low-to-moderate scores for the behavioral factors, except for nicotine which ranged from 80 (high) to 100 (optimal).

Table 3 shows the % of participants categorized as having moderate and high CVH based on LE8 and LS7. LE8 yielded greater % high CVH than LS7 (43.9% vs. 33.4%). The Wald chi-square test indicated a difference in the proportion of participants in each category based on LE8 and LS7, with 22.3% of children categorized as high and 44.9% categorized as moderate CVH based on both definitions. Pearson's R^2 for continuous CVH scores was 0.56. After removing sleep from LE8, 4.3% of participants classified as high CVH were

re-classified as moderate CVH. The % of participants categorized as high CVH based on both definitions increased to 26.6% and Pearson's R^2 increased to 0.67.

Table 4 shows crude associations of perinatal characteristics with % high CVH per LE8. Older maternal age, non-Hispanic White maternal ethnicity, higher maternal education and household income, maternal BMI <25 kg/m^2, maternal HEI score >57, and older child age were each associated with high CVH. We noted marginal associations of lower parity (0 or 1–2 prior births), household income (≥$40,000), and breastfeeding duration (≥6 months) with high CVH.

We did not find evidence of an interaction between any perinatal characteristics and child sex, so the multivariable model included all children. Table 5 shows odds ratios (ORs) and 95% confidence intervals (CI) from a multivariable logistic regression model in which maternal age, race/ethnicity, education, BMI, and HEI score; and child age and sex were predictors; and high CVH was the outcome. Children whose mothers had HEI score >57 vs. ≤57 during pregnancy had nearly twice the odds of high CVH (OR: 1.90, [95% CI: 1.12, 3.20]), and each 1-year increment in child age corresponded with 1.58 (95% CI: 1.04, 2.42) times greater odds of high CVH.

Figure 2 shows β (95% CI) for associations of the same predictors described above with continuous CVH scores. Maternal education, BMI, and HEI score; and child age were each positively associated with the overall CVH score, whereas children with mothers of non-Hispanic Black race/ethnicity had lower CVH scores. These associations were driven by associations with the behavioral factors, though we noted that Hispanic maternal race/ethnicity corresponded with a lower health factor score (−2.96 [95% CI: −5.75, −0.17]). Including parity, breastfeeding duration, and household income in the model did not appreciably change results (data available upon request).

DISCUSSION

In this study of 305 diverse children, we compared early-life CVH status based on Life's Essential 8 (LE8) vs. Life's Simple 7 (LS7); and identified perinatal correlates of high CVH per LE8. None of the participants had low or optimal CVH according to LE8, though 43.9% had high CVH. We observed modest concordance in % high CVH based LE8 and LS7, with 22.3% classified as high CVH based on both definitions. Maternal diet quality and older child age were the strongest correlates of high CVH at age 4–7 years. When we assessed CVH continuously, higher maternal educational attainment and prenatal diet quality, and lower pre-pregnancy BMI predicted high CVH in offspring; these findings were driven by behavioral, rather than biological, CVH components.

CVH status in children per LE8

To date, we are aware of seven studies that assessed CVH in youth, six of which applied LS7. These studies include 8-to-17 year-olds in Minnesota (n=300) [15]; youth in China (n=5,596 youth ages 6–18 years in Beijing [14]; n ~15,000 youth ages 6–16 years in Beijing [37]; n=12,618 youth ages 6–18 years in northern and southern provinces [17]); 2-to-11-year-olds in NHANES (n=8,946) [16]; 12-to-15-year-olds in the Cardiovascular Risk in Young

Finns Study (n=856) [4]; and Finnish adolescents in the STRIP trial followed at ages 15–19 years [38]. Our finding of 0% optimal CVH aligns with very low prevalence of ideal CVH (0% to 1.7%) reported in the above earlier studies based on LS7 [13,15–17,38].

We know of only one paper that applied LE8 in youth, in which Lloyd-Jones et al. [21] reported an average CVH score of 65.5 of 100 points among 2-to-19-year-olds in NHANES. In this analysis, 2.2% and 29.1% of youth had optimal and high CVH, respectively. Prevalence of high CVH declined with age. Scores were lowest for diet (unitless CVH component score = 40.6) and physical activity (75.1); and highest for blood pressure (96.0), glucose (92.2), and nicotine exposure (85.6).

In the present study, average CVH score (78.2) was higher than in NHANES. This may be due to the younger and narrower age range of Healthy Start participants given that cardiometabolic profile typically worsens with age. As in NHANES, we found a low average score for diet (47.6) – though in our study sample, physical activity was the lowest-scoring metric (34.3); and high scores for blood pressure (99.8), glucose (99.6), and nicotine exposure (97.4). When assessing CVH by sex, we noted higher scores for physical activity in boys than girls (37.8 vs. 30.0), as was the case in NHANES [21]. However, contrary to Lloyd-Jones et al.'s findings of a higher diet score in girls, boys had a higher diet score than girls (49.1 vs. 45.8) – a pattern that may reverse later in life [39–41].

We observed a modest correlation (Pearson's R^2=0.56) between LE8 and LS7 CVH scores, which was lower than in NHANES (R^2=0.88). After removing sleep from LE8, the correlation increased to 0.67. When comparing CVH status with vs. without inclusion of sleep in the LE8 definition, 4.3% of children were reclassified from high to moderate CVH after including sleep, whereas both upward (7.9%) and downward reclassification (8.4%) across quartiles of LE8 score occurred in NHANES [21]. The downward reclassification of CVH status in this study highlights the impact of sleep on CVH in young children, though we note that beyond the inclusion of sleep, other differences in LS7 [1,2] vs. LE8 [20] may influence concordance in CVH status. Specifically, the LS7 diet metric was based on AHA's recommendations for a healthy diet [1,2] whereas LE8 employs HEI 2015 [20]. Additionally, LS7 focused on firsthand cigarette smoking as an indicator for nicotine exposure whereas LE8 considers first and secondhand cigarette smoke exposure [1,2].

Perinatal correlates of high CVH during early childhood per LE8

A key finding of this analysis is that children whose mothers had an HEI score >57 vs. ≤57 during pregnancy had nearly twice the odds of having high CVH. Additionally, each 1-year increment in child age corresponded with ~60% greater odds of high CVH. The association of higher prenatal diet quality with offspring CVH aligns with a growing literature [31,42,43], but the positive association between age and CVH was unexpected in light of findings of Lloyd-Jones et al. [21] and others [38]. However, within the narrow age range of our study sample, the older children (6–7 years) may exhibit healthier behaviors than younger ones (4–5 years), such as higher diet diversity and quality [44], which may then drive the overall CVH score. Indeed, disaggregation into the behavioral and health components of CVH revealed that the above associations are driven by the relationship between perinatal characteristics and the behavioral factors. We also noted that children born to non-Hispanic Black women

had the lowest behavioral score – an association that reflects myriad social determinants of health, including but not limited access to healthful foods, built environment characteristics, and cultural differences in health behaviors. Regardless, these results indicate that improving children's diet and physical activity may be key to optimizing early-life CVH.

Strengths & limitations

Strengths of this study include use of the most updated construct to assess CVH in early childhood, a sensitive period for development of cardiovascular risk [45–47]; ability to compare concordance between LE8 and LS7; and the rich prospective data.

A key limitation of this study is that only 22% of the mother-offspring dyads enrolled during pregnancy had complete data on early childhood CVH components. Because mothers included in this study were more likely to be White, college-educated, and with higher annual income than those not included, our findings may not be generalizable to the overall cohort.

Future studies in larger, representative cohorts are warranted to investigate the extent to which the perinatal correlates identified herein are causally involved in shaping early-life CVH.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations:

CVH	cardiovascular health
HEI	healthy eating index
BMI	body mass index
CVD	cardiovascular disease
LE8	Life's Essential 8
LS7	Life's Simple 7
SBP	systolic blood pressure
DBP	diastolic blood pressure

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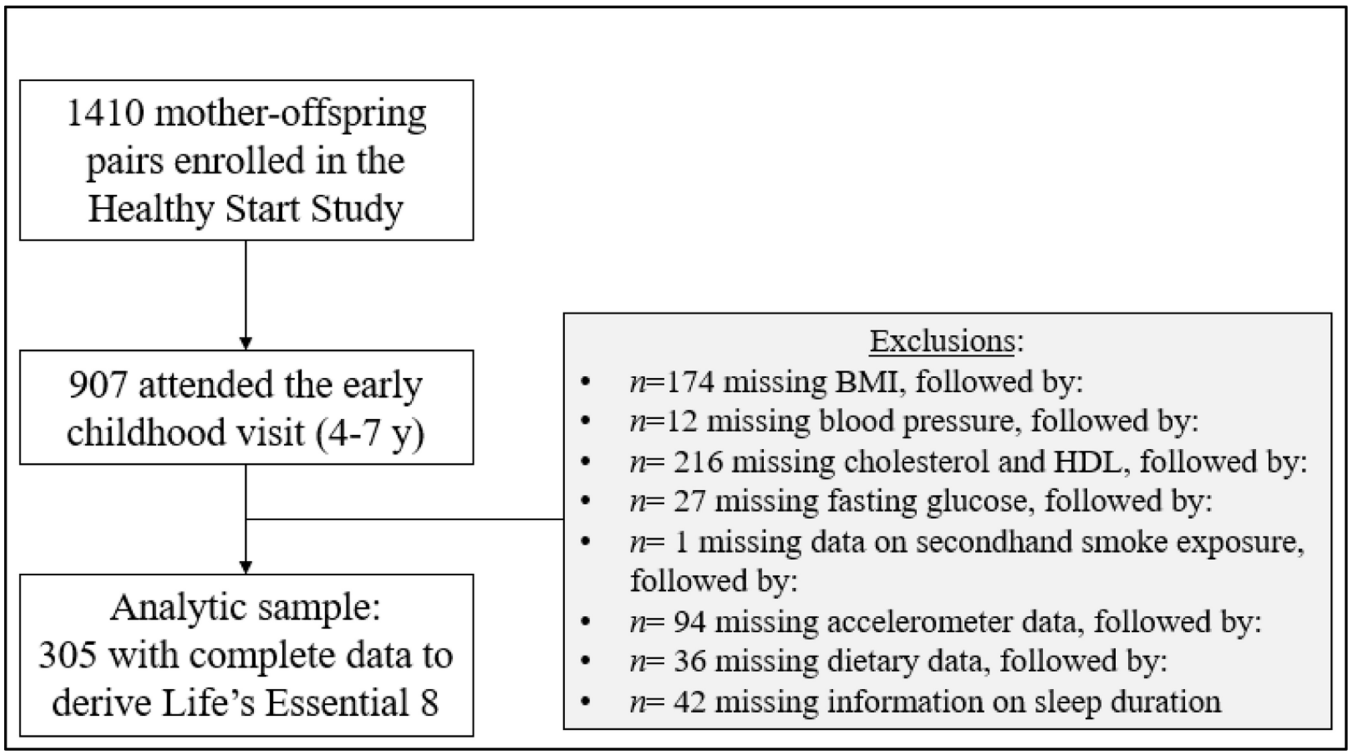

Figure 1.
shows the study participant flow.

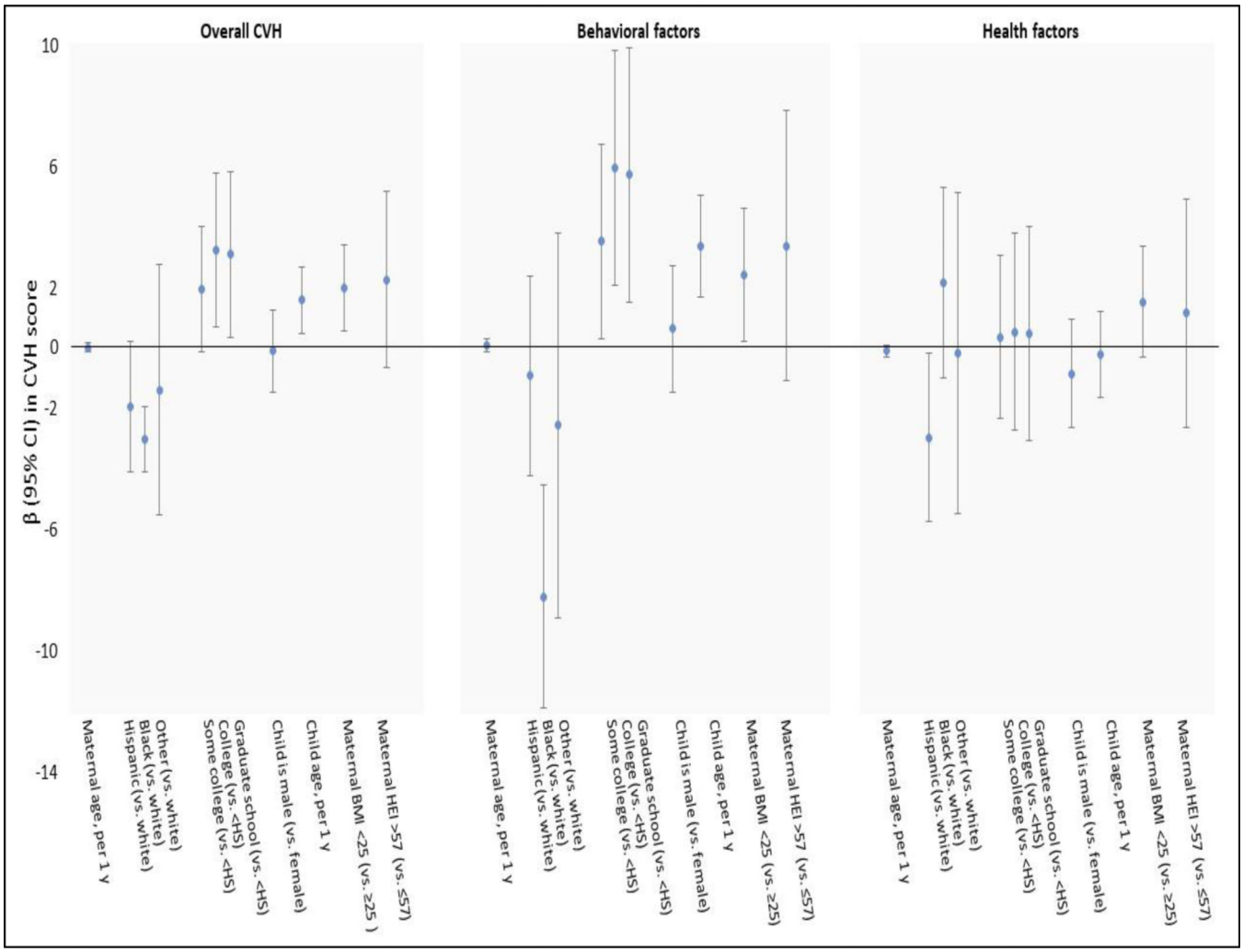

Figure 2.

Associations (β[95% CI]) of perinatal characteristics with overall cardiovascular health (CVH), behavioral factors, and health factors scores based on Life's Essential 8 among 305 children aged 4–7 years in the Healthy Start pre-birth cohort. Estimates are from a multivariable logistic regression model that included all variables shown in the figure.

Abbreviations: CVH – cardiovascular health; HS – high school; BMI – body mass index; HEI – Healthy Eating Index

Table 1

Background characteristics of 305 mother-offspring pairs in the Healthy Start pre-birth cohort.

	Mean ± SD or % (N)
Maternal and child sociodemographic characteristics	
Maternal age at delivery, years	29.4 ± 5.7
Maternal race/ethnicity	
Hispanic	23.3% (71)
Non-Hispanic White	62.0% (189)
Non-Hispanic Black	11.8% (36)
Non-Hispanic Other	2.9% (9)
Parity (not including index)	
0	42.6% (130)
1 to 2	52.8% (161)
≥3	4.6% (14)
Preterm delivery	6.2% (19)
Birth size	
Small-for-gestational age	11.6% (34)
Appropriate-for-gestational age	80.5% (235)
Large-for-gestational age	7.9% (23)
Maternal education level	
Less than high school	22.0% (67)
Some college/associate degree	23.3% (71)
College graduate	24.6% (75)
Graduate degree	30.2% (92)
Annual household income <$40,000	26.1% (68)
Child is female	44.6% (136)
Child's age at the early childhood visit, years	4.7 ± 0.6
Maternal perinatal metabolic characteristics	
Pre-pregnancy BMI[a]	
BMI <25 kg/m2	55.1% (168)
BMI ≥25 kg/m2	44.9% (137)
Pre-pregnancy BMI, kg/m^2	25.7 ± 6.4
Gestational weight gain[b]	
Inadequate	23.9% (73)
Adequate	29.2% (89)
Excessive	46.9% (143)
Gestational diabetes mellitus (GDM dx)	4.9% (14)
Maternal and infant behaviors	
Cigarette smoking during pregnancy	5.3% (16)

	Mean ± SD or % (N)
High diet quality during pregnancy (HEI >57)	45.3% (136)
≥150 min/week of MVPA during pregnancy	61.0% (186)
Child was breastfed for ≥6 months	15.8% (38)

Abbreviations: BMI: body mass index; HEI: Healthy Eating Index-2010; MVPA: moderate-to-vigorous physical activity

[a] Includes 6 women classified as underweight (BMI <18.5 kg/m^2).

[b] According to Institute of Medicine 2009 guidelines.

Table 2

Mean ± SD scores and % of cardiovascular health (CVH) status categories based on Life's Essential 8 among 305 children aged 4–7 years in the Healthy Start pre-birth cohort.

	All children *n* = 305	Girls *n* = 136	Boys *n* = 169	*P* [a]
Behavioral factor scores				
Nicotine exposure				
Mean ± SD	97.4 ± 6.8	97.6 ± 6.6	97.3 ± 6.9	0.78
Min, Max	80, 100	80, 100	80, 100	
Diet quality				
Mean ± SD	47.6 ± 15.3	45.8 ± 14.5	49.1 ± 15.8	0.05
Min, Max	25, 100	25, 80	25, 100	
Physical activity				
Mean ± SD	34.3 ± 15.4	30.0 ± 11.0	37.8 ± 17.5	<0.0001
Min, Max	0, 80	25, 70	0, 80	
Sleep duration				
Mean ± SD	73.7 ± 34.0	74.2 ± 34.6	73.3 ± 33.6	0.81
Min, Max	0, 100	0, 100	0, 100	
Biological factor scores				
Body mass index				0.08
Mean ± SD	92.3 ± 22.3	94.8 ± 18.2	90.3 ± 25.0	
Min, Max	0, 100	0, 100	0, 100	
Blood pressure				0.11
Mean ± SD	99.8 ± 2.0	99.6 ± 3.0	100	
Min, Max	75, 100	75, 100	100, 100	
Non-HDL cholesterol				0.67
Mean ± SD	81.0 ± 23.2	81.6 ± 22.7	80.5 ± 23.7	
Min, Max	0, 100	0, 100	20, 100	
Fasting glucose				0.69
Mean ± SD	99.6 ± 4.0	99.7 ± 3.4	99.5 ± 4.3	
Min, Max	60, 100	60, 100	60, 100	
Overall CVH score [b]				
Mean ± SD	78.2 ± 6.7	77.9 ± 6.4	78.5 ± 6.9	0.46
Min, Max	54.4, 93.8	54.4, 88.1	58.8, 93.8	
CVH status				0.27
Low (score <50)	0% (0)	0% (0)	0% (0)	
Moderate (score: 50-<80)	56.1% (171)	59.6% (81)	53.3% (90)	
High (score: 80-<100)	43.9% (134)	40.4% (55)	46.8% (79)	
Optimal (score = 100)	0% (0)	0% (0)	0% (0)	

[a] From a Wald test for continuous variables; from the Chi-squared test for % participants by CVH status.

[b]Average of score across the eight Life's Essential 8 components: nicotine exposure, physical activity, healthy diet, sleep duration, body mass index, non-HDL cholesterol, blood pressure, and fasting glucose.

Table 3

Concordance (% [N]) of cardiovascular health (CVH) status and correlation between CVH scores based on Life's Essential 8 vs. Life's Simple 7 definitions among 305 children aged 4–7 years in the Healthy Start pre-birth cohort.

	Life's Essential 8 (LE8)			
Life's Simple 7 (LS7)	Low	Moderate	High	Ideal/Optimal
Low	0% (0)	0% (0)	0% (0)	0% (0)
Moderate	0% (0)	44.9% (137)	21.6% (66)	0% (0)
High	0% (0)	11.2% (34)	22.3% (68)	0% (0)
Ideal/Optimal	0% (0)	0% (0)	0% (0)	0% (0)
	Wald chi-square test statistic:32.2; P <0.0001			
	Pearson's R^2 for continuous CVH scores = 0.56; P <0.0001			
	LE8 without sleep			
LS7	Low	Moderate	High	Ideal/Optimal
Low	0% (0)	0% (0)	0% (0)	0% (0)
Moderate	0% (0)	44.9% (137)	21.6% (66)	0% (0)
High	0% (0)	6.9% (21)	26.6% (81)	0% (0)
Ideal/Optimal	0% (0)	0% (0)	0% (0)	0% (0)
	Wald chi-square test statistic: 59.8; P <0.0001			
	Pearson's R^2 for continuous CVH scores = 0.67; P <0.0001			

Table 4

Percentage (% [N]) of participants with high cardiovascular health (CVH) according to Life's Essential 8 criteria across categories of perinatal characteristics among 305 children aged 4–7 years in the Healthy Start pre-birth cohort.

	N [a]	% (N) with high CVH	*P* [c]
	305	**43.9% (134)**	
Maternal and child sociodemographic characteristics			
Maternal age at delivery			0.002
16–24 y	65	24.6% (16)	
25–29 y	79	43.0% (34)	
30–34 y	101	54.5% (55)	
≥35 y	60	48.3% (29)	
Maternal education level			0.003
Less than high school	27	33.3% (9)	
High school graduate	40	22.5% (9)	
Some college/associate degree	71	38.0% (27)	
College graduate	75	50.7% (38)	
Graduate degree	92	55.4% (51)	
Annual household income			0.08
<$40,000	68	36.8% (25)	
≥$40,000	193	49.2% (95)	
Maternal race/ethnicity			0.002
Hispanic	71	31.0% (22)	
Non-Hispanic White	189	52.4% (99)	
Non-Hispanic Black	36	27.8% (10)	
Non-Hispanic Other	9	33.3% (3)	
Parity (not including index)			0.12
0	130	41.5% (54)	
1 to 2	161	47.8% (77)	
≥3	14	21.4% (3)	
Child's sex			0.27
Female	136	40.4% (55)	
Male	169	46.8% (79)	
Preterm delivery			0.76
No (≥37 weeks)	286	43.7% (125)	
Yes (<37 weeks)	19	47.4% (9)	
Birth size			0.58
Small-for-gestational age	34	38.2% (13)	
Appropriate-for-gestational age	235	45.1% (106)	
Large-for-gestational age	23	52.2% (12)	
Child's age at the time of CVH assessment			0.04

	N [a]	% (N) with high CVH	P [c]
	305	**43.9% (134)**	
Q1 (median: 4.1 y)	50	35.1% (27)	
Q2 (median: 4.5 y)	45	40.8% (31)	
Q3 (median: 4.6 y)	37	51.3% (39)	
Q4 (median: 5.3 y)	39	48.7% (37)	
Maternal prenatal metabolic characteristics			
Pre-pregnancy BMI [a]			0.06
BMI <25 kg/m^2	168	48.4% (82)	
BMI ≥25 kg/m^2	137	38.0% (52)	
Gestational weight gain [b]			0.28
Inadequate	73	49.3% (36)	
Adequate	89	47.2% (42)	
Excessive	143	39.2% (45)	
Gestational diabetes			0.12
No	271	43.2% (117)	
Yes	14	64.3% (9)	
Maternal and infant behaviors			
Cigarette smoking during pregnancy			0.29
No	289	44.6% (129)	
Yes	16	31.3% (5)	
Maternal diet quality during pregnancy			0.0003
Low quality (HEI ≤57)	164	34.2% (56)	
High quality (HEI >57)	136	55.2% (75)	
Maternal MVPA during pregnancy			0.68
<150 min/week	119	45.4% (54)	
≥150 min/week	186	43.0% (80)	
Infant feeding practices			0.09
<6 breastmilk months	202	43.1% (87)	
≥6 breastmilk months	38	57.9% (22)	

Abbreviations: HEI: Healthy Eating Index-2010; MVPA: moderate-to-vigorous physical activity

[a] Includes 6 women who are underweight (n = 3 each when stratified by sex).

[b] According to Institute of Medicine 2009 guidelines.

[c] P-value represents a Wald chi-squared test with the exception of ordinal variables (age, education level, and pre-pregnancy weight status) where the P-value represents a test for linear trend.

Table 5

Odds ratios (OR [95% CI]) of having high cardiovascular health (CVH) based on Life's Essential 8 with respect to perinatal characteristics among 305 children aged 4–7 years in the Healthy Start pre-birth cohort.

	OR (95% CI)[a] of having high CVH during early childhood[b]
Maternal and child sociodemographic characteristics	
Maternal age, per 1 year	1.02 (0.96, 1.07)
Race/ethnicity	
Non-Hispanic White	1.00 (Reference)
Hispanic	0.72 (0.33, 1.59)
Non-Hispanic Black	0.65 (0.26, 1.62)
Non-Hispanic Other	0.62 (0.14, 2.83)
Type 3 *P*-value[b]	0.69
Maternal education level	
Less than high school	1.00 (Reference)
Some college/associate degree	1.51 (0.68, 3.35)
College	1.62 (0.64, 4.12)
Graduate school	1.62 (0.60, 4.38)
P-trend	0.48
Child sex	
Female	1.00 (Reference)
Male	1.14 (0.69, 1.88)
Child's age, per 1 year	1.58 (1.04, 2.42)
Maternal perinatal characteristics	
Maternal pre-pregnancy weight status	
BMI <25 kg/m^2	1.41 (0.83, 2.37)
BMI ≥25 kg/m^2	1.00 (Reference)
Maternal prenatal behaviors	
Maternal diet quality during pregnancy	
Low quality (HEI ≤57)	1.00 (Reference)
High quality (HEI >57)	1.90 (1.12, 3.21)

Abbreviations: BMI: body mass index; HEI: healthy eating index; OR: odds ratio; CI: confidence interval

[a] From a multivariable logistic regression model comprising for all variables in table as predictors.

[b] CVH score of 80 to <100.