Characterizing a "big data" cohort of over 200,000 low-income U.S. infants and children for obesity research: The ADVANCE Early Life Cohort

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Abstract

Introduction—Low-income populations have elevated exposure to early life risk factors for obesity, but are understudied in longitudinal research. Our objective was to assess the utility of a cohort derived from electronic health record data from safety net clinics for investigation of obesity emerging in early life.

Methods—We examined data from the PCORNet ADVANCE Clinical Data Research Network, a national network of Federally-Qualified Health Centers serving >1.7 million safety net patients across the US. This cohort includes patients who, in 2012–2014, had 1 valid Body Mass Index measure when they were 0–5 years of age. We characterized the cohort with respect to factors required for early life obesity research in vulnerable subgroups: sociodemographic diversity, weight status based on World Health Organization (<2 years) or Centers for Disease Control (2 years) growth curves, and data longitudinality.

Results—The cohort includes 216,473 children and is racially/ethnically diverse (e.g., 17.9% Black, 45.4% Hispanic). A majority (56.9%) had family incomes below the Federal Poverty Level (FPL); 32% were <50% of FPL. Among children <2 years, 7.6% and 5.3% had high and low weight-for-length, respectively. Among children 2–5 years, 15.0%, 12.7%, and 2.4% were overweight, obese, and severely obese, respectively; 5.3% were underweight. In the study period,

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79.1% of children had 2 BMI measures. Among 4–5 year olds, 21.9% had >1 BMI measure when they were <2 years.

Discussion—The ADVANCE Early Life cohort offers unique opportunities to investigate early life determinants of obesity in the understudied population of low income and minority children.

Keywords

Obesity; Socioeconomic factors; infant; child; longitudinal

INTRODUCTION

Early life is a critical period in the etiology of obesity and chronic disease (Perez-Escamilla & Kac, 2013). Low-income and racial/ethnic minority children have a high prevalence of adverse prenatal exposures (Taveras, Gillman, Kleinman, Rich-Edwards, & Rifas-Shiman, 2013) and elevated risk of obesity and disease later in life (Rossen & Schoendorf, 2012). Socioeconomically disadvantaged children are among the most vulnerable, yet most understudied populations.

Studying prenatal and early childhood influences on obesity-related health in vulnerable populations presents several challenges. First, recruitment of large numbers of low-income and racial/ethnic minority participants is challenging due to social and economic barriers to study participation (Yancey, Ortega, & Kumanyika, 2006). Second, obesity research requires objectively measured body weight, stature, and clinical outcomes. Third, extensive follow-up is needed to study impacts of early life on health outcomes that develop over long periods.

Electronic health records (EHRs) address these barriers by providing longitudinal clinical data on large populations. Yet the handful of existing EHR-based perinatal and pediatric research datasets (Hillier et al., 2008; Koebnick et al., 2012; Vesco et al., 2011) are comprised predominately of insured health system members, and thus underrepresent socioeconomically disadvantaged populations. The growth of EHR data from community health centers serving safety net (publicly insured and uninsured) patients (DeVoe et al., 2014) thus has great potential for enhancing early life obesity research in socially vulnerable children.

Using retrospective EHR data from safety net clinics, we constructed the Accelerating Data Value Across a National Community Health Center Network (ADVANCE) Early Life Cohort, a cohort of >200,000 low-income children 0–5 years of age from all regions of the U.S. The objective of this paper is to evaluate the utility of our cohort for studying early life determinants of obesity in vulnerable children. Specifically, we characterized the cohort with respect to key factors required for early life obesity research: sociodemographic diversity, obesity burden, and availability of longitudinal data.

METHODS

Study population

ADVANCE is a multi-center collaborative led by the OCHIN, Inc. (not an acronym) health information network in partnership with Health Choice Network (HCN) and Fenway Health. The ADVANCE data warehouse has been described previously (DeVoe et al., 2014). Briefly, these systems have outpatient clinical data from >100 Federally-Qualified Health Center (FQHC) health systems with 974 clinics serving >2 million safety net patients in 22 states (Figure 1). OCHIN and HCN networks provide EHR data infrastructure and technical support that is not typically feasible for a single community health center. ADVANCE includes pediatric and adult OCHIN, HCN, and Fenway patients with at least 1 office visit on or after 1/1/2012. Patients are added to the study population as the ADVANCE data warehouse is refreshed with EHR data on a quarterly basis.

The ADVANCE Early Life Cohort contains ADVANCE patients who, between 1/1/2012 and 12/31/2014 (at the time of data analysis in 2015), had at least one valid BMI measure when they were 0–5 years of age. Fenway Health's pediatric population is small (<1% are <18 years) and therefore excluded. This research was approved by the Western Institutional Review Board.

Data source

We examined outpatient EHR data from the OCHIN and HCN networks. The OCHIN EHR database contains information from the Epic practice management system (e.g., billing and appointments) as well as demographic, utilization, and clinical data from the full Epic EHR (DeVoe et al., 2014). The HCN EHR database contains information from a hosted and centralized EHR platform (Intergy by Greenway Health) and supported by network-wide clinical informatics and analytic tools. Among patients in the ADVANCE Early Life cohort, we extracted EHR data collected at clinical encounters from as early as 1/1/2005 through 12/31/2014. Availability of historical data reflects the dates of EHR implementation by each clinic, which began as early as 2003, although in general EHR implementation occurred earlier for OCHIN clinics than HCN clinics.

Study variables

Body Mass Index (BMI) and weight-for-length percentiles—Body weight and concurrently measured length or height were ascertained from clinical encounter records. Length and height are recorded in a single field and assumed to represent length for children <24 months, and height for children 24 months.

Among encounters at which the child was <24 months of age, weight-for-length (WFL) was calculated and converted to age- and sex-specific WFL percentiles relative to the World Health Organization (WHO) standard growth curve (WHO, 2006). Low and high WFL were defined as <2.3rd and >97.7th percentiles, respectively, which are comparable to the CDC 5th and 95th percentiles (Grummer-Strawn, Reinold, & Krebs, 2010).

Among encounters at which the child was 24 months of age, BMI was calculated and converted to age- and sex-specific BMI percentiles using the CDC 2000 growth curves (Kuczmarski et al., 2002). BMI percentiles were classified into underweight (<5th percentile), normal weight (5th to <85th), overweight (85th to <95th), obese (95th to <20% higher than the 95th percentile), and severe obese (20% higher than the 95th percentile) (Flegal et al., 2009).

Valid WFL and BMI measures were limited to biologically plausible measures (CDC or WHO growth curve z-score <−4 or >5) (Centers for Disease Control and Prevention, 2015). We used each child's most recent valid WFL or BMI measure within the 2012–2014 study period; hereafter, the "index encounter."

Sociodemographic characteristics—Patient-level sociodemographics were ascertained from the patient table: sex (male, female), date of birth, race/ethnicity (non-Hispanic white, African American, Asian, Native Hawaiian/Pacific Islander, other/unknown; or Hispanic of any race), and primary language spoken at home (English, Spanish, other) are reported by the patient and recorded by clinical staff. Date of birth was used to calculate age at each encounter.

Standard workflows stipulate that payer (uninsured, Medicaid, commercial, other public non-portable coverage), income as a percent of the Federal Poverty Level (FPL; calculated from household income and household size) and residential address are confirmed with the patient and updated routinely (approximately semi-annually) by clinic staff. We report the most recently reported payer and FPL among encounters in 2012–2014 and U.S. Census-defined regions (Northeast, Midwest, South, West) based on the most recently reported state of residence.

Statistical analysis

To evaluate key factors required for early life obesity research, we conducted descriptive analysis on availability of BMI measures, sociodemographic characteristics, weight status, and longitudinal follow-up of the cohort. Given the large sample size, we focused on the magnitude of group differences rather than statistical significance. We calculated prevalence of each weight status category, stratified by age group (<2 and 2–5 years) to account for the differences in reference curves and weight status definitions. To evaluate potential bias resulting from the transient nature of the safety net population, we assessed the degree to which those with longer follow-up differed with respect to sociodemographic characteristics and BMI.

RESULTS

The ADVANCE Early Life Cohort had 216,473 children who had at least one valid BMI recorded at encounters between 1/1/2012 and 12/31/2014 when they were 0–5 years of age (Figure 2). Among the 149,129 OCHIN patients who met the age criterion, 19,555 (13.1%) were excluded because they did not have a BMI measure during this period. Among those remaining, 1,187 (0.9%) had invalid BMI measures, and an additional 16,654 had valid BMI

measures only when they were >5 years of age. Similar exclusions were observed in HCN patients.

Among patients who met the age criterion (n=285,654), those excluded from the cohort due to missing (n=32,050) or invalid (n=2,160) BMI measures in 2012–2014 (n=34,971; versus included, n=216,473) have a higher prevalence of uninsurance and missing data on other variables (race/ethnicity, income) (Appendix, Table S1). Those excluded due to age restrictions are similar to the final cohort, except for characteristics linked to age, including Medicaid eligibility and BMI z-score and classification.

Sociodemographic and geographic diversity

The cohort is 49.1% female and 33.3% are <2 years of age (Table 1). Hispanics are the largest racial/ethnic group (45.4%), followed by non-Hispanic white (29.2%) and Black (17.9%). Only 7.6% of cohort families have incomes >200% of FPL, with 56.9% <100% of FPL (compared to 24% nationally (CDC, 2014)) and 32.0% <50% of FPL. Another 23% have missing or invalid income data. Most children (67.8%) had primary Medicaid coverage at their most recent encounter. About one-fourth (26.5%) have EHR documentation that Spanish is the primary language spoken at home. Children reside predominantly in the West and South regions, corresponding to the central locations of OCHIN and HCN, respectively.

Weight status

Among children <2 years, 7.6% had high WFL (Table 2a). Among children 2–5 years, 15.0%, 12.7%, and 2.4% were overweight, obese, and severely obese, respectively (Table 2b). Prevalence of high WFL and overweight/obesity was slightly higher in boys than in girls; and higher in Blacks and Native Hawaiian/Pacific Islanders, older children, and those with lower income (Tables 2a–b). Overweight/obesity prevalence was higher in the Northeast region, and higher in OCHIN (32.0%) than HCN (28.1%) (Table 2b). Severe obesity was highest in 4–5 year old children (3.1%), Hispanics (3.2%), and Native Hawaiian/Pacific Islanders (3.0%). Subgroup differences in obesity prevalence were generally reflected in higher mean WFL and BMI z-scores (Tables 2a–b).

Prevalence of low WFL (<2 years) and underweight (2–5 years) were both 5.3%. Low WFL and underweight prevalence varied by sociodemographic characteristics; in particular, prevalences were highest in the Southern region and within HCN.

Longitudinality of BMI data

Children in the cohort had an average of 9.7 encounters, providing an average of 4.7 valid BMI measures per child in the 2012–2014 period (Table 3). The number of valid BMI measures varied from 1 to 10 (90th percentile) or more measures per child. 79.2% of children had 2 valid BMI measures between 2006 and 2014, and 47.2% had 5 BMI measures. A higher percentage of OCHIN children had historical BMI measures prior to 2011 than HCN children (24.0% vs. 10.9; data not shown); longitudinality was otherwise similar for OCHIN and HCN.

Availability of BMI measures collected through the child's life span are reported in Table 4. 74.7% of infants had 2 valid BMI measures. Among children with a BMI measure when they were 4–5 years of age, 21.9% had 1 BMI measure when they were younger than 2 years; 9.8% had a BMI measure in the first six months of life.

Among 4–5 year old children, those with available BMI measures as early as infancy, 12 to <24 months, or >2 years, were similar with respect to sex and mean BMI z-score (Table 5). Those with (vs. without) BMI measures in infancy were less likely to be Black or African American; and more likely to be Hispanic, have Medicaid, have incomes below 200% of FPL, and to be overweight at ages 4–5.

DISCUSSION

The ADVANCE Early Life Cohort provides an exceptionally large, racially and ethnically diverse population of low-income children who are typically under-represented in research on early life determinants of health. We present evidence that the cohort addresses critical research challenges of studying early life processes through which obesity develops in socially vulnerable children.

First, our cohort represents an understudied, vulnerable population, with 32% in extreme poverty (<50% FPL). Our cohort will enable investigation of gradations of poverty and interactions between racial/ethnic groups and modifiable factors such as socioeconomic status or access to care, which is often infeasible due to insufficient sample size. The national scope of the population will support research on environmental exposures such as food policy, chemical exposures, or health care access that vary geographically. It will also provide a foundation for research on transforming clinical care to incorporate family-based behavioral interventions (Willis et al., 2014) and strategies for linking patients to community-based resources (Garg, Toy, Tripodis, Silverstein, & Freeman, 2015).

Second, our cohort spans the full spectrum of weight status, based on objectively measured weight and stature. Obesity prevalence in our cohort (7.1% high WFL in children <2 years; 12.7% obese, 2.4% severely obese in children 2–5years) was similar to a nationally representative samples: 7.1% in children <2 years (Ogden, Carroll, Kit, & Flegal, 2014), 11.1% obese and 2.6% severely obese in children 2–5 years (Skinner & Skelton, 2014)) and 14.7 % obese in a national sample of low-income children ages 2–4 years. comprised predominantly of Special Supplemental Nutrition Program for Women, Infants, and Children participants (Pan, McGuire, Blanck, May-Murriel, & Grummer-Strawn, 2015). Yet disparities in obesity prevalence become more pronounced later in childhood (Skinner & Skelton, 2014); that is, children with lower socioeconomic status tend to be born smaller, then experience faster growth in infancy and early childhood, which can continue throughout childhood (Boone-Heinonen, Messer, Andrade, & Takemoto, 2016). Therefore, research is needed on clinical and community supports that can prevent the socioeconomic divergence in obesity as children grow into adolescents. Furthermore, underweight was common in our cohort (5.3%, compared to 3.4% nationally)(Fryar & Ogden, 2012), potentially reflecting the challenges of hunger or lack of access to basic needs facing low-income populations, or greater prevalence of underlying health conditions that restrict growth.

Third, our cohort provides longitudinal measures needed to study early life determinants of obesity in low-income populations. While segments of the safety net population are transient, we observed substantial follow-up for a large proportion of our population. For example, >10,000 children 4–5 years of age had historical BMI measures spanning into infancy, which can support investigation of early life growth patterns and obesity later in life. Children with and without BMI measures spanning from infancy through 4–5 years were similar with respect to sex, income, and BMI. Because differences in race/ethnicity and region in part reflects later onboarding of HCN to the EHR (typically 2011 or after), which is located in the Southeastern U.S., we expect these differences to decrease as children age. Longitudinal research will require more detailed examination of systematic differences in children with varying durations of follow-up and application and development of appropriate adjustment strategies.

Collectively, our findings suggest that our cohort and similar EHR-based cohorts are promising for longitudinal research on obesity development in early life. Important next steps are to apply the data for hypothesis-based research about early origins of obesity and disparities, and to extend this work to other health outcomes, including obesity sequela (e.g., diabetes) and other conditions such as asthma or infectious disease.

Limitations

A critical limitation of our cohort is that, like other EHR-based data sources, data on key factors such as breastfeeding are not typically available. We are positioned to integrate these variables, consistent with Institute of Medicine's recommendations to integrate social determinants of health into EHRs (IOM, 2014). Ongoing advancements in natural language processing methods used to extract information from clinician notes (Pivovarov & Elhadad, 2015) can further enhance EHR databases. Yet specialized data, such as detailed infant feeding or diet, is outside the scope of routine clinical interaction and will require ancillary data collection.

The cohort represents children who obtained clinical care for well child visits or other visits at OCHIN or HCN clinics; systematic differences in those included versus excluded from safety net clinics can result in overestimation of disease prevalence and bias in exposure-disease associations and requires appropriate adjustment strategies and interpretation. Other limitations include mobility in and out of the safety net population and error in and lack of validation of anthropometric and sociodemographic measures. For example, we assumed that stature measures reflect length in children under two years of age. We included BMI measures recorded at encounters other than well-child visits; in our safety net population, preliminary analysis suggested that differential exclusion of uninsured children was of greater concern than underestimation of BMI due to illness. Validation of measures in the EHR needs to be assessed overall, and across provider, clinic, or health network.

Conclusions

Early childhood obesity and severe obesity are critical problems in the safety net population, with clear racial/ethnic disparities. The ADVANCE Early Life cohort offers unique

opportunities to identify and mitigate early life determinants of obesity in this large, diverse population of low-income children.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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SIGNIFICANCE

What is known

Early life determinants of health are understudied in low-income populations. Electronic health records provide longitudinal clinical data on large U.S. populations, but typically omit uninsured and socially vulnerable children.

What this article adds

The ADVANCE Early Life Cohort is the first national low-income study population that leverages electronic health record data from two networks of Federally-Qualified Health Centers. This cohort of >200,000 low-income children provides the sociodemographic diversity, full spectrum of weight status, and substantial longitudinality required to conduct future research on early life determinants of obesity in low-income children.
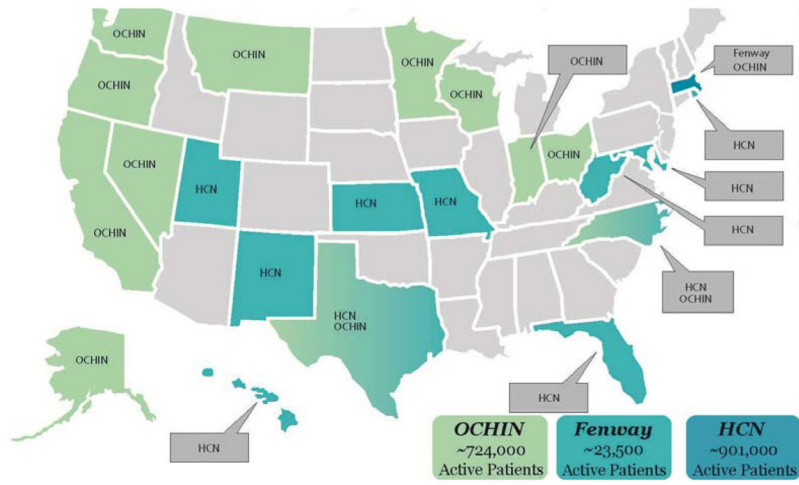
Figure 1.
Geographic distribution of ADVANCE clinics
As of September 2013
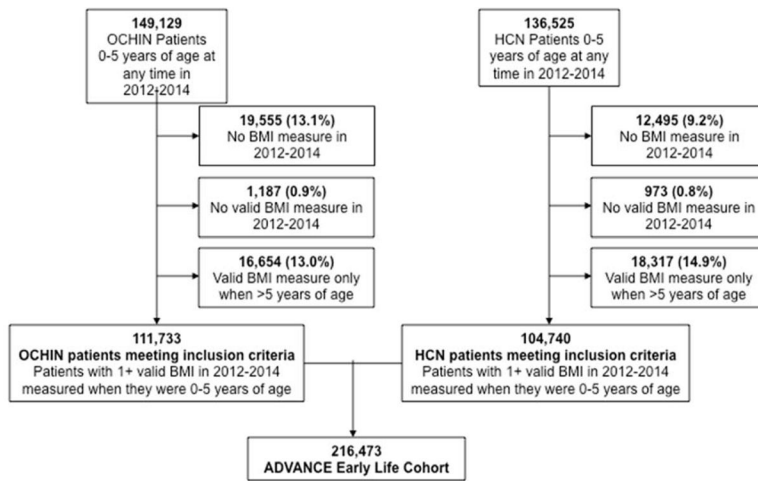
Figure 2.
Identification of the ADVANCE Early Life Cohort

Table 1

Sociodemographic characteristics of the ADVANCE Early Life Cohort (n=216,473)[a]

	Count	Percent
Sex		
Male	110,154	50.9
Female	106,319	49.1
Age		
0–<6 months	24,282	11.2
6 to <12 months	16,061	7.4
12 to <24 months	31,873	14.7
2 to <4 years	53,269	24.6
4 to <6 years	90,988	42.0
Race-Ethnicity		
Asian	5,451	2.5
Native Hawaiian/Pacific Islander	1,347	0.6
Black or African American	38,838	17.9
White	63,287	29.2
Other/Unknown	9,347	4.3
Hispanic	98,203	45.4
Income as percent of FPL[b]		
0–50%	69,345	32.0
>50–100%	53,969	24.9
>100–138%	17,398	8.0
>138–200%	9,628	4.4
>200%	16,368	7.6
Missing or invalid	49,765	23.0
Insurance status[c]		
Uninsured	25,040	11.6
Medicaid	146,810	67.8
Commercial	27,710	12.8
Other public non-portable coverage	16,913	7.8
Missing	401	0.2
Language		
English	150,747	69.6
Spanish	57,280	26.5
Other	7,171	3.3
Missing	1,275	0.6
Region		
Northeast	10,642	4.9
Midwest	21,457	9.9
South	82,792	38.2
West	101,424	46.9

	Count	Percent
Missing	158	0.1

[a]OCHIN and HCN patients who, between 1/1/2012 and 12/31/2014, had at least one valid BMI measure when they were 0–5 years of age, regardless of weight status

[b]Last known FPL.

[c]At most recent visit

HCN, Health Choice Network; FPL, Federal Poverty Level

Table 2a

Weight for length (WFL) classification and z-score, by sociodemographic subgroups of interest: 0 to <24 months of age [count (%)]:ADVANCE Early Life Cohort[a]

| | WFL classification [count (%)] | | | |
	Low weight for length	Normal weight for length	High weight for length	WFL z-score [mean (SD)]
Total	3,807 (5.3)	62,916 (87.1)	5,493 (7.6)	0.19 (1.31)
Sex				
Girls	1,804 (5.1)	30,990 (88.0)	2,428 (6.9)	0.21 (1.34)
Boys	2,003 (5.4)	31,926 (86.3)	3,065 (8.3)	0.17 (1.28)
Age				
0–<6 months	2,860 (11.8)	20,544 (84.6)	878 (3.6)	−0.37 (1.36)
6 to <12 months	496 (3.1)	14,483 (90.2)	1,082 (6.7)	0.25 (1.19)
12 to <24 months	451 (1.4)	27,889 (87.5)	3,533 (11.1)	0.59 (1.18)
Race/ethnicity				
Asian	104 (5.4)	1,703 (89.0)	107 (5.6)	0.03 (1.25)
Native Haw/Pacific Isl	33 (6.5)	431 (84.5)	46 (9.0)	0.27 (1.37)
Black or African Am	788 (6.1)	11,082 (86.1)	995 (7.7)	0.15 (1.35)
White	1,311 (6.0)	19,163 (87.4)	1,459 (6.7)	0.08 (1.32)
Other/Unknown	270 (6.9)	3,362 (85.9)	280 (7.2)	0.06 (1.36)
Hispanic	1,301 (4.2)	27,175 (87.4)	2,606 (8.4)	0.31 (1.28)
Income as percent of FPL[b]				
0–50%	1,401 (5.8)	20,994 (86.5)	1,888 (7.8)	0.18 (1.34)
>50–100%	924 (5.4)	14,953 (87.2)	1,273 (7.4)	0.18 (1.31)
>100–138%	234 (4.3)	4,846 (88.5)	393 (7.2)	0.20 (1.28)
>138–200%	157 (5.2)	2,653 (87.4)	227 (7.5)	0.16 (1.29)
>200%	274 (6.3)	3,819 (87.6)	265 (6.1)	0.05 (1.30)
Missing or invalid	817 (4.6)	15,651 (87.4)	1,447 (8.1)	0.25 (1.30)
Region				
Northeast	196 (5.8)	2,906 (86.7)	251 (7.5)	0.17 (1.32)
Midwest	326 (4.6)	6,026 (85.7)	676 (9.6)	0.34 (1.33)
South	1,861 (6.9)	23,338 (86.9)	1,655 (6.2)	0.02 (1.33)
West	1,420 (4.1)	30,593 (87.6)	2,904 (8.3)	0.29 (1.28)
Health system				
OCHIN	1,335 (3.4)	34,141 (87.8)	3,406 (8.8)	0.00 (1.35)
HCN	2,472 (7.4)	28,775 (86.3)	2,087 (6.3)	0.35 (1.25)

[a] Weight for length classified according to World Health Organization sex-specific growth curves. Low and high weight-for-length were defined as <2.3rd and > 97.7th percentiles, respectively

[b] Last known FPL.

HCN, Health Choice Network; FPL, Federal Poverty Level

Table 2b

Body Mass Index (BMI) classification and z-score (2–5 years), by sociodemographic subgroups of interest [count (%)]: ADVANCE Early Life Cohort[a]

	BMI classification [count (%)]					
	Under-weight	Normal BMI	Overweight	Obese	Severe obese	BMI z-score [mean (SD)]
Total	7,607 (5.3)	93,309 (64.7)	21,674 (15.0)	18,270 (12.7)	3,397 (2.4)	0.41 (1.23)
Sex						
Girls	3,697 (5.2)	46,315 (65.1)	10,923 (15.4)	8,460 (11.9)	1,702 (2.4)	0.39 (1.20)
Boys	3,910 (5.3)	46,994 (64.2)	10,751 (14.7)	9,810 (13.4)	1,695 (2.3)	0.42 (1.26)
Age						
2 to <4 years	3,655 (6.9)	35,849 (67.3)	7,148 (13.4)	6,038 (11.3)	579 (1.1)	0.25 (1.26)
4 to <6 years	3,952 (4.3)	57,460 (63.2)	14,526 (16.0)	12,232 (13.4)	2,818 (3.1)	0.50 (1.20)
Race/ethnicity						
Asian	340 (9.6)	2,434 (68.8)	374 (10.6)	331 (9.4)	58 (1.6)	0.08 (1.32)
Native Haw/Pacific Isl	41 (4.9)	537 (64.2)	127 (15.2)	107 (12.8)	25 (3.0)	0.45 (1.26)
Black or African Am	1,837 (7.1)	17,509 (67.4)	3,555 (13.7)	2,629 (10.1)	443 (1.7)	0.23 (1.25)
White	2,468 (6.0)	28,347 (68.5)	5,882 (14.2)	4,045 (9.8)	612 (1.5)	0.27 (1.20)
Other/Unknown	325 (6.0)	3,634 (66.9)	746 (13.7)	635 (11.7)	95 (1.7)	0.31 (1.23)
Hispanic	2,596 (3.9)	40,848 (60.9)	10,990 (16.4)	10,523 (15.7)	2,164 (3.2)	0.58 (1.22)
Income as percent of FPL[b]						
0–50%	2,511 (5.6)	29,106 (64.6)	6,682 (14.8)	5,695 (12.6)	1,068 (2.4)	0.39 (1.25)
>50–100%	1,847 (5.0)	23,389 (63.5)	5,748 (15.6)	4,880 (13.3)	955 (2.6)	0.44 (1.24)
>100–138%	619 (5.2)	7,697 (64.5)	1,794 (15.0)	1,528 (12.8)	287 (2.4)	0.42 (1.24)
>138–200%	370 (5.6)	4,293 (65.1)	987 (15.0)	793 (12.0)	148 (2.2)	0.37 (1.22)
>200%	687 (5.7)	7,962 (66.3)	1,751 (14.6)	1,362 (11.3)	248 (2.1)	0.34 (1.22)
Missing or invalid	1,573 (4.9)	20,862 (65.5)	4,712 (14.8)	4,012 (12.6)	691 (2.2)	0.41 (1.21)
Region						
Northeast	298 (4.1)	4,382 (60.1)	1,230 (16.9)	1,142 (15.7)	237 (3.3)	0.59 (1.25)
Midwest	886 (6.1)	9,358 (64.9)	2,173 (15.1)	1,698 (11.8)	314 (2.2)	0.36 (1.24)
South	3,545 (6.3)	36,826 (65.8)	7,745 (13.8)	6,583 (11.8)	1,239 (2.2)	0.31 (1.26)
West	2,874 (4.3)	42,681 (64.2)	10,508 (15.8)	8,837 (13.3)	1,607 (2.4)	0.47 (1.20)
Health system						

| | BMI classification [count (%)] | | | | | |
	Under-weight	Normal BMI	Overweight	Obese	Severe obese	BMI z-score [mean (SD)]
OCHIN	3,038 (4.2)	46,472 (63.8)	11,776 (16.2)	9,791 (13.4)	1,774 (2.4)	0.32 (1.27)
HCN	4,569 (6.4)	46,837 (65.6)	9,898 (13.9)	8,479 (11.9)	1,623 (2.3)	0.49 (1.19)

[a]BMI percentiles were classified according to Centers for Disease Control 2000 growth curves: underweight (<5th percentile), normal weight (5th to <85th), overweight (85th to <95th), obese (95th to <20% higher than the 95th percentile), and severe obese (20% higher than the 95th percentile).

[b]Last known FPL.

HCN, Health Choice Network; FPL, Federal Poverty Level

Table 3

Longitudinal data availability of the ADVANCE Early Life Cohort[a]

Number of encounters in 2012–2014 mean number (SD) per child	9.7 (10.1)
Number of valid BMI measures in 2012–2014	
Mean number (SD) per child	4.7 (4.5)
Median number (10%, 90%) per child	3 (1, 10)
Children with 1, 2, 3–4, or ≥5 valid BMI measures per child from 2006–2014 (#/%)	
1	45,226 (20.9%)
2	28,519 (13.2%)
3–4	40,601 (18.8%)
≥5	102,127 (47.2%)
Children with a valid BMI measures observed in calendar year (#/%):	
2011	54,820 (25.3%)
2010	24,843 (11.5%)
2009	10,215 (4.7%)
2006–2008	3,030 (1.4%)

[a]OCHIN and HCN patients who, between 1/1/2012 and 12/31/2014, had at least one valid BMI measure when they were 0–5 years of age, regardless of weight status.

HCN, Health Choice Network

Table 4

BMI availability over the life spans of children in the ADVANCE Early Life Cohort[a]

	Age at index visit[b]			
	0 to <12 months	12 to <24 months	2 to <4 years	4 to <6 years
Number of children	40,171	31,901	53,413	90,988
Number of valid BMI measures per child				
1	10,148 (25.3%)	5,336 (16.7%)	11,844 (22.2%)	17,898 (19.7%)
2	7,284 (18.1%)	2,869 (9.0%)	5,822 (10.9%)	12,544 (13.8%)
3	6,136 (15.3%)	2,067 (6.5%)	3,774 (7.1%)	10,319 (11.3%)
4	5,186 (12.9%)	1,869 (5.8%)	3,019 (5.7%)	8,231 (9.1%)
5+	11,417 (28.4%)	19,760 (62.0%)	28,954 (54.2%)	41,996 (46.2%)
Age at first BMI				
0 to <6 months	36,378 (90.6%)	19,939 (62.5%)	21,916 (41.0%)	8,885 (9.8%)
6 to <12 months	3,793 (9.4%)	3,354 (10.5%)	3,855 (7.2%)	2,959 (3.3%)
12 to <24 months	-NA-	8,608 (27.0%)	7,784 (14.6%)	8,045 (8.8%)
2 to <4 years	-NA-	-NA-	19,858 (37.2%)	25,176 (27.7%)
4 to <6 years	NA-	-NA-	-NA-	45,923 (50.5%)
Children who had at least 1 valid BMI measure when child was:				
0 to <6 months	36,378 (90.6%)	19,939 (62.5%)	21,916 (41.0%)	8,885 (9.8%)
6 to <12 months	15,872 (39.5%)	21,849 (68.5%)	24,058 (45.0%)	11,056 (12.2%)
12 to <24 months	-NA-	31,901 (100.0%)	32,063 (60.0%)	18,989 (20.9%)

[a]OCHIN and HCN patients who, between 1/1/2012 and 12/31/2014, had at least one valid BMI measure when they were 0–5 years of age, regardless of weight status.

[b]Index visit is the last visit in 2012–2014 with a valid BMI.

HCN, Health Choice Network

Table 5

Comparison of children with weight status measures across key life stages, among children in the ADVANCE Early Life Cohort with BMI measured when they were 4 to <6 years of age (n=90,988)

	Earliest period with weight status measures		
	Infancy (0 to <12 months)	Early childhood (12 to <24 months)	24+ months
Sex			
Male	5,976 (50.5)	4,122 (51.2)	36,006 (50.6)
Female	5,868 (49.5)	3,923 (28.8)	35,093 (49.4)
Race-Ethnicity			
Asian	277 (2.3)	179 (2.2)	1,695 (2.4)
Native Hawaiian/Pacific Islander	106 (0.9)	43 (0.5)	341 (0.5)
Black or African American	1,500 (12.7)	1,409 (17.5)	13,460 (18.9)
White	2,967 (25.1)	2,035 (25.3)	20,484 (28.8)
Other/Unknown	308 (2.6)	201 (2.5)	2,700 (3.8)
Hispanic	6,686 (56.5)	4,178 (51.9)	32,419 (45.6)
Income as percent of FPL[b]			
0–50%	3,583 (30.3)	2,352 (29.2)	21,814 (30.7)
>50–100%	3,789 (32.0)	2,475 (30.8)	17,202 (24.2)
>100–138%	1,567 (13.2)	844 (10.5)	6,446 (9.1)
>138%–200%	492 (4.2)	279 (3.5)	2,303 (3.2)
>200%	875 (7.4)	637 (7.9)	7,106 (10.0)
Missing or invalid	1,538 (13.0)	1,458 (18.1)	16,228 (22.8)
Insurance status[c]			
Uninsured	690 (5.8)	622 (7.7)	8,565 (12.1)
Medicaid	9,335 (78.8)	5,786 (71.9)	45,321 (63.7)
Commercial	1,025 (8.7)	961 (12.0)	10,053 (14.1)
Other public non-portable coverage	794 (6.7)	676 (8.4)	7,160 (10.1)
BMI z-score (mean)[d]	0.6 (1.2)	0.5 (1.2)	0.5 (1.2)
BMI classification[d]			
Underweight	441 (3.7)	338 (4.2)	3,173 (4.5)
Normal weight	7,261 (61.3)	5,047 (62.7)	45,152 (63.5)
Overweight	2,026 (17.1)	1,254 (15.6)	11,246 (15.8)
Obese[b]	1,742 (14.7)	1,148 (14.3)	9,342 (13.1)
Severe obese	374 (3.2)	258 (3.2)	2,186 (3.1)

[a] OCHIN and HCN patients who, between 1/1/2012 and 12/31/2014, had at least one valid BMI measure when they were 4–5 years of age, regardless of weight status.

[b] Last known FPL.

[c] At most recent visit

[d] At index visit (latest observed well child visit with a valid BMI within 2012–2014)

HCN, Health Choice Network; FPL, Federal Poverty Level