

# Data needs for B-24 and beyond: NHANES data relevant for nutrition surveillance of infants and young children<sup>1–3</sup>

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## ABSTRACT

The period from birth to 24 mo (B-24) is a critical phase in which nutrient requirements for growth and development are high and several transitions in food consumption practices occur. A few large-scale national studies (eg, the Feeding Infants and Toddlers Study and Infant Feeding Practices Study) offer important insights into infant feeding practices and food consumption patterns in young children in the United States. The NHANES collects comprehensive cross-sectional data on the nutrition and health of Americans including infants and toddlers. This article describes the NHANES program and data from NHANES 1999–2010 on young children that are relevant for the B-24 Project. NHANES is a nationally representative survey of the noninstitutionalized US population that combines personal interviews with standardized physical examination and measurements via mobile examination centers. Data on infant feeding practices (breastfeeding and timing of introduction and nature of complementary foods), dietary intake (two 24-h recalls), and nutrient supplements are collected. Data on demographic characteristics, anthropometric measurements, biomarkers of nutrient status, food security, and participation in federal nutrition programs are also available. Data can be accessed online, downloaded, and pooled over several survey cycles, allowing examination of infant feeding practices, food and nutrient intakes, and nutritional status of Americans <2 y old. Subgroup analyses by race-ethnicity and income status are also possible. NHANES responds to evolving data needs, as feasible, in the context of the survey design, research priorities, and funding. It offers a vehicle for potentially gathering additional data on children <2 y to address the objectives of the B-24 Project in the future. *Am J Clin Nutr* 2014;99(suppl):747S–54S.

## INTRODUCTION

Evaluating the evidence base to support the inclusion of infants and children from birth to 24 mo of age in the *Dietary Guidelines for Americans* (the B-24 Project) is an important federal initiative of the US Department of Health and Human Services and the USDA together with academic and industry partners. The goal of the B-24 Project is to examine and evaluate the existing literature to identify current knowledge and research gaps that need to be addressed for the development of dietary guidelines for infants and toddlers. The first 2 y of life are critical in human development; nutrition practices during early childhood can influence short- and long-term health and disease (1, 2). Infancy is a period of high nutrient needs and a time of rapid transition from a primarily milk-based diet (either breast milk or infant formula) to a varied diet with several food groups being consumed

on a daily basis (3). In addition, the second year of life continues to be a critical time of steady growth and development during which nutrient needs remain high (4). This period is characterized by continued transition to family foods and the development of food preferences (5, 6) that can be an important determinant of food choices and intake in later life (7–9).

A few large-scale studies, notably the Feeding Infants and Toddlers Study (FITS)<sup>4</sup> conducted in 2002 (10) and 2008 (FITS 2008) (11) and the Infant Feeding Practices Study II (IFPS II) (12), provide insight on developing dietary guidelines for children <2 y of age. The FITS involved a large, national, cross-sectional sample of US infants and toddlers aged 4–24 mo in FITS 2002 ( $n = 3022$ ) and aged 0–47 mo in FITS 2008 ( $n = 3273$ ;  $n = 1812$  for children <2 y) and assessed their usual nutrient intakes and food consumption patterns. Feeding practices, dietary intake data, and reported weight were obtained by telephone. In FITS 2002, a 24-h dietary recall was obtained for 3022 infants and a second-day dietary recall was collected from a subsample of respondents (23% of the day 1 sample) for the estimation of usual nutrient intakes. A similar sample design was used for FITS 2008 in which a second-day dietary recall was collected from 28% of the day 1 sample. In FITS 2002 and 2008, food consumption analyses were based on 1-d mean intakes of the population; the personal computer version of the Software of Intake Distribution Estimation (PC-SIDE; version 1.0.0.1, 2003; Iowa State University) was used with the replicate data to adjust for intraindividual variation (10, 13, 14). The samples were selected at a national level by using a commercial list of infants and toddlers (rather than a national population-based sample frame) and may represent children from a higher socioeconomic status and underrepresent certain race and ethnic subgroups (10, 11).

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<sup>4</sup> Abbreviations used: DBQ, Diet Behavior and Nutrition Questionnaire; FITS, Feeding Infants and Toddlers Study; IFPS II, Infant Feeding Practices Study II; MEC, mobile examination center.

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IFPS II is a large longitudinal study of infant feeding conducted in the United States that followed women from the third trimester of pregnancy through their infants' first year of life (15). Pregnant women were identified through a nationally distributed consumer opinion panel. Those who met specific eligibility criteria were mailed monthly questionnaires. Dietary information was collected by using a 7-d food-recall chart. Substantial sample size decline was noted over follow-up, from  $n = 3033$  at the neonatal survey to  $n = 1807$  at the 12-mo survey, with more women with a higher socioeconomic status at follow-up (3). The IFPS II provides important insights into several infant feeding practices (breastfeeding and timing of introduction and nature of complementary foods). Together, the series of FITS (2002 and 2008) and IFPS II provide key information for the B-24 Project.

In addition to the studies described above, the NHANES may provide some useful insights into the food and nutrient intake and feeding practices of young children. The purpose of this article was 1) to provide an overview of NHANES, its methodology, and operations and 2) to highlight the data collected since 1999 that may be used to fulfill the objectives of the B-24 Project.

## OVERVIEW OF NHANES

NHANES is a program of studies that is designed to collect data on the health, nutritional status, and health behaviors of the noninstitutionalized civilian household population of the United States. It is conducted by the National Center for Health Statistics of the CDC. This comprehensive survey is unique in that it combines personal interviews with standardized physical examinations and laboratory tests. The interviews are conducted in the home and at the mobile examination center (MEC). The physical examinations and biological samples are collected at the MEC for laboratory analysis on-site and at 25–30 collaborating laboratories across the United States. The post-MEC components involve collection of additional dietary data as well as other components that vary by survey cycle.

### NHANES sample design

NHANES has had a long history that began in the early 1960s (16). Since then, several cycles of NHANES have been conducted as a series of surveys focusing on different population groups (varying in ages of persons sampled or ethnic-racial groups examined) or health topics. In 1999, NHANES became a continuous survey, sampling US residents of all ages, with a changing focus on a variety of health and nutrition measurements to meet emerging needs. The goals of the continuous NHANES are to provide prevalence data on selected diseases and risk factors for the US population; to monitor trends in selected diseases, behaviors, and environmental exposures; to explore emerging public health needs; and to maintain a national probability sample of baseline information on the health and nutritional status of the US household population (16).

NHANES has a complex, multistage, probability-sampling design and examines a nationally representative sample of ~5000 persons each year. These persons are selected from 15 different county locations that are selected from a sampling frame of 3000 counties. The 4 stages of the sampling include selection of the following: 1) primary sampling units, which are

counties or small groups of contiguous counties; 2) segments within primary sampling units that are a block or a group of blocks of households; 3) specific households within segments; and 4) eligible individuals within a household. Since the continuous NHANES, certain subgroups have been oversampled. Specifically, non-Hispanic blacks, Mexican Americans, low-income whites, adolescents 12–19 y of age, and older persons ( $\geq 70$  y) were oversampled in 1999–2006. In addition, a supplemental sample of pregnant women was also included. From 2007 to 2010, Hispanics, non-Hispanic blacks, low-income whites, and older persons ( $\geq 80$  y) were oversampled. In more recent surveys (2011–2014), Asian Americans are being oversampled (16). Sample weights are assigned to each sample person so that weighted estimates are representative of the US noninstitutionalized population. Informed consent is obtained at various levels (household interview, examination, child assent for minors aged 7–17 y; and consent for specimen storage). For minors, a parent or guardian is asked to provide documented consent.

### NHANES operations

NHANES data collection begins with a household interview identifying eligible members in the household by using a computer-assisted personal interview tool that is linked to US Census data. For consenting persons, a household interview is conducted that includes demographic, socioeconomic, dietary (including supplement use), and health-related questions. Participants are then scheduled for a physical examination at the MEC ~2–3 wk later. The MEC provides a standardized and automated data collection mechanism. The MEC examination consists of medical, dental, and physiologic measurements, as well as laboratory tests that are administered by trained medical personnel, including a physician, health technicians, laboratory staff, and interviewers. Dietary intake data are collected at the MEC (first 24-h recall) and by telephone (second 24-h recall 7–10 d later) by using the Automated Multiple Pass Method of the USDA (17, 18) through the “What We Eat in America” component of NHANES. The examination response rates in NHANES are generally between 70% and 80% with some variation across survey cycles.

In addition, after the MEC examination, various cycles of NHANES have included data collection on different components. These include a physical activity monitor, home-collected urine sample, tuberculosis skin-test reading, and vacuum-collected home dust sample.

Data analyses are coordinated with several federal and non-federal partners. In particular, dietary data are analyzed by using the USDA Food and Nutrient Database for Dietary Studies (19). The dietary supplement nutrient data from NHANES are analyzed by using the NHANES Dietary Supplement Ingredient Database (a label-based database created by the NHANES program).

### NHANES data relevant to the B-24 Project

NHANES collects data on feeding practices, food intake, as well as growth and health outcomes in conjunction with a laboratory component for individuals  $>1$  y old that allows the assessment of the status of certain nutrients. Available data from the continuous NHANES (1999 onward) are described in the following section. These data are publicly released every 2 y and are freely available to download from the NHANES homepage

**TABLE 1**  
NHANES data: sections and key information

Section	Information
Demographic <sup>1</sup>	Age, sex, income, race-ethnicity, family, health insurance, housing characteristics
Dietary <sup>2,3</sup>	Individual food files—day 1 and day 2 (since 2002) Total nutrient intakes—day 1 and day 2 (since 2002) Nutrient supplements intake—30 d and 24 h (since 2007)
Examination <sup>2</sup>	Body measures <ul style="list-style-type: none"> <li>• Weight, recumbent length/height (<math>\geq 0</math> mo)</li> <li>• Head circumference (0–6 mo)</li> <li>• Mid-upper arm circumference (<math>\geq 2</math> mo)</li> <li>• Skinfold thickness (<math>\geq 2</math> mo): triceps, subscapular</li> </ul>
Laboratory <sup>2</sup>	Analytes vary by survey year
Questionnaires	Diet, behavior, and nutrition <sup>4</sup> Early childhood <sup>1</sup> Food security <sup>5</sup> Consumer behavior <sup>1</sup> Medical conditions <sup>1</sup> Respiratory health <sup>1</sup>

<sup>1</sup> Collected through interviews administered in the home.<sup>2</sup> Day 1 dietary recall, examination, and laboratory components carried out at the mobile examination center.<sup>3</sup> Day 2 dietary recall is administered by telephone.<sup>4</sup> Questions relevant to infants and toddlers 0–24 mo old were collected through interviews administered in the home.<sup>5</sup> Household food security questions were administered in the home and answered by the household reference person.

(<http://www.cdc.gov/nchs/nhanes.htm>) under questionnaires, data sets, and related documentation ([http://www.cdc.gov/nchs/nhanes/nhanes\\_questionnaires.htm](http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm)). The data are organized by 2-y time frames corresponding to each survey cycle under various sections on the online access pages (**Table 1**).

The demographic file provides information for key variables such as age, sex, income, race-ethnicity, family composition, educational level, health insurance, and housing characteristics collected during the initial household interview (Table 1). Dietary data collected at the MEC for the day 1 recall and by telephone for the second-day recall are available in separate files listing

individual foods consumed and total nutrient intakes by day of recall. In addition, nutrient supplement intake can be accessed for the month preceding the household interview and for each of the 2 d of the 24-h recalls in separate files. In the examination section on the webpage, under the rubric “Body Measures,” data are available on traditional anthropometric measurements (eg, height and weight for all children and skinfold thicknesses for children aged  $\geq 2$  mo). In addition, data are collected on several questionnaires administered either at home during the household interview or during the MEC examination. In a few cases, data are collected during the post-MEC telephone interview (eg, post hoc module of the Consumer Behavior Questionnaire) (Table 1). NHANES data can be combined over several survey years to produce estimates with greater precision and smaller sampling error and to perform trends analysis.

NHANES is unique in that biological specimens such as blood, urine, hair, and saliva are collected to address specific research needs in the age and sex group concerned. The specimens collected and analyses conducted vary by survey cycle depending on research priorities, feasibility, and available funding. With regard to the B-24 Project, NHANES collects blood samples for children aged  $>1$  y. These samples are immediately processed by trained laboratory staff on-site at the MEC and sent to collaborating laboratories for analysis. Laboratory analyses are conducted by using state-of-the art techniques and standardized procedures. Tests for heavy metals include cadmium, lead, and mercury. Tests for iron status are based on a comprehensive panel including serum transferrin receptors (with C-reactive protein measured in some NHANES cycles to control for inflammation), and biomarkers for vitamin status of certain water- and lipid-soluble vitamins (eg, folic acid, vitamin B-6, vitamin B-12, and vitamin D) are also determined. A summary of nutritional biomarkers for children aged  $\geq 1$  y by survey cycle is provided in **Table 2**. Data can be pooled over survey cycles to increase the sample size depending on the research question being addressed.

The Diet Behavior and Nutrition Questionnaire (DBQ) can serve as an important resource, with data relevant to the B-24 Project (**Table 3**). Data include whether the participant ever

**TABLE 2**  
Blood-based laboratory tests in children 1–2 y of age<sup>1</sup>

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010
Heavy metals						
Cadmium, lead	x	x	x	x	x	x
Mercury	x	x	x	x		
Iron <sup>2</sup>						
Serum iron	x	x				
Ferritin	x	x	x	x	x	x
Free erythrocyte protoporphyrin	x	x				
TIBC	x	x				
Transferrin receptors			x	x	x	x
Transferrin saturation	x	x				
Vitamins						
RBC folate			x	x	x	x
Serum folate			x	x	x	x
Vitamin B-12			x	x		
Vitamin B-6			x	x	x	x
Vitamin D			x	x	x	x

<sup>1</sup> RBC, red blood cell; TIBC, total iron binding capacity; x, data were collected.<sup>2</sup> C-reactive protein was determined for respondents  $>1$  y of age in 2003–2006 and may be used to control for inflammation.

**TABLE 3**  
Diet Behavior and Nutrition Questionnaire<sup>1</sup>

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010
Ever breastfed or fed breast milk	x	x	x	x	x	x
Age stopped breastfeeding	x	x	x	x	x	x
Age first fed formula daily	x	x	x	x	x	x
Age stopped receiving formula	x	x	x	x	x	x
Age first fed milk on a daily basis	x	x	x	x	x	x
Type of milk first fed	x	x	x	x	x	x
Age started eating other foods	x	x	x	x	x	x
Age started eating solid food	x	x	x	x	x	x
Past 30-d milk product consumption <sup>2</sup>	x	x	x	x	x	x

<sup>1</sup> x indicates data were collected.<sup>2</sup> Collected for respondents >1 y of age.

received breast milk, the timing of introduction of formula or other milk, the timing of introduction of solid foods, and the age at which feeding formula was stopped. In addition, data on food allergies were also collected during 2007–2010. Questions were asked about whether the child has food allergies in general, and if so, to which certain specific foods (wheat, corn, cow milk, eggs, fish, shellfish, corn, peanut, other nuts, soy products, etc).

The Early Childhood Questionnaire is another source of information relevant to the B-24 initiative on events related to birth and early childhood (**Table 4**). These include reported birth weight and weight status <5.5 pounds or 2.5 kg (low birth weight) or >9 pounds or 4.1 kg (macrosomia), and whether the sample child received newborn care (in an intensive care unit), attended day care, and participated in the Head Start program.

Another rich facet of NHANES data pertains to food insecurity. Data were collected on this component during 2003–2008, although different questions on this topic were asked from 1999 to 2002. Questions assessed food security at the household, adult, and child level. Household food security questions were administered in the home and answered by the household reference person. Questions with regard to individual-level food security were administered at the MEC only when a household had affirmed food insecurity. The receipt of Food Stamp Program benefits were collected during the household interview. Information pertaining to participation in the Special Supplemental Nutrition Program for Women, Infants, and Children were collected in the DBQ, administered at home. In addition, a Consumer Behavior Questionnaire was administered during

2007–2010 at home as part of the NHANES family questionnaire, with additional questions asked during a post-MEC telephone interview. The household reference person answered questions on key topics, including family food expenditures, time spent on cooking dinner, and number of meals prepared by the family. The Consumer Behavior Phone module assessed family-level knowledge and behavior regarding topics such as eating out, awareness of MyPyramid, factors influencing food choices at a grocery store, and use of food labels and organic foods. However, this amount of detail was not collected in 1999–2006 (**Table 5**; details described below).

NHANES collects information on health conditions through several questionnaires. Notably, the medical conditions questionnaire administered at home provides data on anemia, bronchitis, asthma, liver disease, cancer, vision problems, as well as family history of certain conditions. For the youngest age group (1–2 y old), only questions on anemia and asthma are asked. Another questionnaire that offers interesting data relevant to the B-24 Project is the Respiratory Health Questionnaire. It collects information on respiratory symptoms (cough, phlegm, wheezing or whistling in the chest, and hay fever and medical visits and medications relevant to these conditions). Respondents younger than 1 y of age were not administered this questionnaire; and relevant to B-24, only respondents aged 1–2 y (through their proxy) were administered questions on wheezing. Given the increase in allergies and respiratory symptoms (20), this data set may be of interest to researchers in relation to infant feeding and food consumption practices during the first 2 y of life.

**TABLE 4**  
Early Childhood Questionnaire<sup>1</sup>

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010
Maternal smoking during pregnancy	x	x	x	x	x	x
Mother's age at birth	x	x	x	x	x	x
Birth weight, weight status <sup>2</sup>	x	x	x	x	x	x
Received newborn care at health facility	x	x	x	x	x	
Child care						
Ever attended day care <sup>3</sup>	x	x	x			
Now attends day care <sup>3</sup>	x	x	x			
Now attends Head Start <sup>4</sup>	x	x	x	x	x	

<sup>1</sup> x indicates data were collected.<sup>2</sup> Weight > or <5.5 pounds and weight > or <9.0 pounds.<sup>3</sup> Respondents aged 2 mo to 15 y.<sup>4</sup> Respondents aged 0–5 y.

**TABLE 5**Number of participants with data available on key variables for the B-24 Project by survey cycle and age<sup>1</sup>

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010	Total
Total who presented at the MEC examination (0–23.9 mo) <sup>2</sup>	682	850	777	833	727	707	4576
Age							
0–5.9 mo	209	226	194	221	197	182	1229
6–11.9 mo	211	292	245	259	231	206	1444
12–23.9 mo	262	332	338	353	299	319	1903
Poverty-income ratio							
Age 0–5.9 mo	185	211	187	206	179	167	1135
Age 6–11.9 mo	189	276	229	248	214	191	1347
Age 12–23.9 mo	262	320	321	335	278	297	1813
Race-ethnicity <sup>3</sup>							
Age 0–5.9 mo	188	197	167	197	172	145	1066
Age 6–11.9 mo	179	255	220	231	191	171	1247
Age 12–23.9 mo	217	298	320	320	235	264	1654
Body measures <sup>4</sup>							
Age 0–5.9 mo	209	182	194	221	197	182	1185
Age 6–11.9 mo	211	232	244	258	229	204	1378
Age 12–23.9 mo	259	257	336	352	297	318	1819
Day 1 diet interview							
0–5.9 mo	205	225	192	214	193	179	1208
Did not consume breast milk	138	129	113	118	120	119	737
Consumed breast milk	67	96	79	96	73	60	471
6–11.9 mo	207	283	238	248	225	203	1404
Did not consume breast milk	168	225	195	187	181	160	1116
Consumed breast milk	39	58	43	61	44	43	288
12–23.9 mo	230	314	311	317	288	303	1763
Did not consume breast milk	211	290	295	297	269	282	1644
Consumed breast milk	19	24	16	20	19	21	119
Day 2 diet interview <sup>5</sup>							
0–5.9 mo	N/A	N/A	181	193	172	165	711
Did not consume breast milk	N/A	N/A	106	108	105	107	426
Consumed breast milk	N/A	N/A	75	85	67	58	285
6–11.9 mo	N/A	N/A	218	228	191	174	811
Did not consume breast milk	N/A	N/A	176	169	152	136	633
Consumed breast milk	N/A	N/A	42	59	39	38	178
12–23.9 mo	N/A	N/A	287	272	229	246	1034
Did not consume breast milk	N/A	N/A	272	254	213	230	969
Consumed breast milk	N/A	N/A	15	18	16	16	65
Laboratory data (12–23.9 mo) <sup>6</sup>	155	187	226	219	171	184	1142
Early Childhood Questionnaire <sup>7,8</sup>							
Age 0–5.9 mo	209	226	194	221	197	182	1229
Age 6–11.9 mo	211	292	245	259	231	206	1444
Age 12–23.9 mo	262	332	338	353	299	319	1903
Diet Behavior and Nutrition Questionnaire <sup>7,9</sup>							
Age 0–5.9 mo	209	226	194	221	197	182	1229
Age 6–11.9 mo	211	292	245	259	231	206	1444
Age 12–23.9 mo	262	332	338	353	299	319	1903
Food Security Questionnaire <sup>7,10</sup>							
Age 0–5.9 mo	207	224	192	217	196	182	1218
Age 6–11.9 mo	209	290	242	257	228	206	1432
Age 12–23.9 mo	259	328	334	348	295	317	1881

(Continued)

TABLE 5 (Continued)

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010	Total
Consumer Behavior Questionnaire <sup>7,11</sup>							
Age 0–5.9 mo	N/A	N/A	N/A	N/A	195	180	375
Age 6–11.9 mo	N/A	N/A	N/A	N/A	231	206	437
Age 12–23.9 mo	N/A	N/A	N/A	N/A	293	317	610
Respiratory Health Questionnaire (12–23.9 mo) <sup>7,12</sup>	233	302	313	324	272	289	1733

<sup>1</sup> MEC, mobile examination center; N/A, not administered; WIC, Women, Infants, and Children.

<sup>2</sup> Age in months at the MEC examination was used to categorize age (variable: RIDAGEEX).

<sup>3</sup> Oversampling of population subgroups was changed in the sample design for the 2007–2010 survey period. All Hispanic persons were targeted for oversampling rather than just Mexican American persons. This has implications for merging of survey years for analysis by race-ethnic subgroups; refer to the NHANES Analytic Guidelines on the NHANES website for details ([http://www.cdc.gov/nchs/data/nhanes/analyticnote\\_2007-2010.pdf](http://www.cdc.gov/nchs/data/nhanes/analyticnote_2007-2010.pdf)). The “Other” race category was not shown; *n* based on non-Hispanic whites, non-Hispanic blacks, and Mexican Americans.

<sup>4</sup> *n* based on body weight (variable: BMXWT).

<sup>5</sup> Day 2 dietary interviews were conducted by telephone.

<sup>6</sup> *n* based on hemoglobin results from the complete blood count determination (variable: LXBHGB).

<sup>7</sup> Target age groups for the questionnaires vary by survey year and question, consult questionnaire, and code book.

<sup>8</sup> Number of responders to the question “weight at birth, lbs” (variable: ECD070A).

<sup>9</sup> Number of responders to the question “ever breastfed or fed breast milk” (variable: DBQ010). The 2007–2010 survey years contained questions on food allergy.

<sup>10</sup> Number of responders to the question “anyone in household receiving WIC benefits in past 12 mo” (variable: FSD160 1999/2002 and FSQ162 2003/2010).

<sup>11</sup> Number of responders to the question “fruits available at home” (variable: CBQ020).

<sup>12</sup> Number of responders to the question “wheezing or whistling in chest in past year” (variable: RDQ070).

Unweighted numbers of participants with data available on key variables relevant to the B-24 Project for children <2 y by survey year and age are presented in Table 5. These numbers are based on age at MEC examination (variable name: RIDAGEEX) calculated from the date of birth given by the mother at the household interview. This variable is more accurate to use because it represents the exact age at which most data on child feeding practices, nutrition, and growth are collected at the MEC examination visit. The age of the child at the time of the household interview is also available in the demographic file (variable name: RIDAGEMN).

Over the 12-y period since NHANES became continuous, 4576 infants and toddlers were examined at the MEC visit. The number of participants varies depending on the variable of interest, survey cycle, and response rates. The response rates on most components administered at home or at the MEC for these 6 survey cycles are >80%, and for the dietary recall MEC examination component the response rate is >85% in this age group. For instance, for participants with complete and reliable day 1 and day 2 dietary data, preliminary analyses indicate that pooling over 2–3 consecutive survey cycles would provide stable estimates for energy intake (dietary data) by age group (0–5.9, 6–11.9, and 12–23 mo). Pooling data over 3 survey cycles would be needed for further race-ethnic group stratification (Table 6). This pooling would provide sample sizes comparable to other surveys such as the FITS. On the other hand, for description of findings based on variables such as exclusively breastfed (from the DBQ) or reporting findings stratified by breastfeeding status (consumed breast milk or not on the day of dietary recall), the sample sizes may not be sufficient from NHANES, particularly when data are further stratified. Thus, particular attention needs to be paid to the sample sizes as well as to the relative SEs and variance estimates when 2- or 3-level stratified subanalyses are of interest.

Some limitations in the use of NHANES data must be outlined. Although most nutrition components are the mainstay of the survey, several specific components cycle in and out of the survey

and may not be in all survey cycles. In addition, breast-milk consumption is not quantified in the survey but can be estimated following assumptions used in the FITS (11, 13). Biochemical tests are limited to a few analytes because of limited blood volume sampled in this age group. In addition, breast milk from mothers and urine samples for young children are not collected. NHANES collects limited data on nutrition in the family context and on child care issues. Although comprehensive data on growth and health outcomes are collected, information on cognitive and neuromotor development is not determined in the survey. In addition, subanalysis by narrow categories involving stratification by  $\geq 2$  variables may lack statistical power. Linkage between mother and child data are not possible with the use of the publicly available data but may be feasible via the National Center for Health Statistics Research Data Center. However, such analyses would have limited generalizability because mother-child pairs are not part of the original NHANES sample design and the sample size is likely too small to yield reliable estimates.

NHANES data have been used primarily to describe the prevalence of major diseases and to assess nutritional status and its association with health promotion and disease prevention. NHANES offers rich data that can be useful to study the role of nutrition/diet in the growth and development and health of young infants and toddlers in the United States (Table 7). Data from NHANES can be used to examine several important aspects of infant and toddler nutrition, such as describing the food and nutrient intakes and food patterns of a nationally representative sample of children under 2 y of age and dietary supplement use in this critical period of life. In addition, complementary feeding practices (timing of introduction and nature of solid foods) as well as the transition from breast milk to formula or cow milk and to table foods could be described in relation to sociodemographic variables, such as age, income, and race-ethnicity. Food behavior (eating out, use of labels/MyPyramid information) can also be examined in this nationally representative sample.

Another rich dimension of NHANES is the laboratory assessment of nutritional status and environmental exposures (eg,

**TABLE 6**Unweighted sample sizes for dietary intake data<sup>1</sup>

	1999–2000	2001–2002	2003–2004	2005–2006	2007–2008	2009–2010	Total
Participants with day 1 dietary recall data <sup>2</sup>							
Sex	642	822	741	779	706	685	4375
Male	344	416	385	424	366	333	2268
Female	298	406	356	355	340	352	2107
Race	594	725	664	699	580	563	3825
Non-Hispanic white	155	283	232	236	238	228	1372
Non-Hispanic black	100	186	178	144	117	106	831
Mexican American	294	256	254	319	225	229	1577
Poverty-income ratio	642	822	741	779	706	685	4375
<130%	397	477	433	419	392	390	2508
≥130%	245	822	308	360	314	295	2344
Participants with day 1 and 2 dietary recall data <sup>2</sup>							
Sex	N/A	RDC <sup>3</sup>	686	693	592	585	2556
Male	N/A	RDC	351	379	303	285	1318
Female	N/A	RDC	335	314	289	300	1238
Race	N/A	RDC	617	625	495	479	2216
Non-Hispanic white	N/A	RDC	218	215	202	195	830
Non-Hispanic black	N/A	RDC	161	122	100	86	469
Mexican American	N/A	RDC	238	288	193	198	917
Poverty-income ratio	N/A	RDC	686	693	592	585	2556
<130%	N/A	RDC	403	369	319	334	1425
≥130%	N/A	RDC	283	324	273	251	1131

<sup>1</sup> N/A, not administered; RDC, Research Data Center.

<sup>2</sup> The variable “Dietary Recall Status” was used to identify respondents eligible for analysis on the basis of a reliable recall (value = 1). Respondents reporting breast-milk consumption (value = 4) were also included because breast-milk consumption can be imputed by methodology used by Briefel et al (11). The variable name for “Dietary Recall Status” has changed over the NHANES survey cycles, as follows: DRDDRSTS (1999–2000), DRDDRSTZ (2001–2002), and for 2003–2010 DR1DRSTZ and DR2DRSTZ.

<sup>3</sup> Second-day recalls were available only for 2002 through the National Center for Health Statistics Research Data Center.

heavy metals). Determinants of status of selected nutrients in this age group could be explored further, and associations between dietary intake and nutrient status can also be addressed. Diet and biochemical status indicators of nutrition exposure can be linked to growth on the basis of the direct measurements by trained and skilled staff. In addition, subgroup analyses by race-ethnicity, income status, food security, and participation in federal assistance programs can be conducted by pooling over several survey cycles.

Finally, because of the history of the continuous survey and data collection using standardized protocols across the nation and over time, trends analysis can be conducted to examine changes in food and nutrition practices and nutrient intake. The data are publicly available online from the NHANES homepage along with detailed online tutorials on NHANES and on the use of dietary data. Together, these can offer a rich resource to health scientists to help better understand the role of nutrition in growth,

development, and health toward formulating sound public health policy, directing and designing health programs and services, and expanding the health knowledge in the United States. Furthermore, NHANES is a dynamic program that responds to emerging research needs and can offer a vehicle for gathering additional data to address the objectives of the B-24 Project in the future.

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## REFERENCES

1. Barker DJ, Osmond C, Kajantie E, Eriksson JG. Growth and chronic disease: findings in the Helsinki Birth Cohort. *Ann Hum Biol* 2009;36:445–58.
2. Dyer JS, Rosenfeld CR. Metabolic imprinting by prenatal, perinatal, and postnatal overnutrition: a review. *Semin Reprod Med* 2011;29:266–76.
3. Grummer-Strawn LM, Scanlon KS, Fein SB. Infant feeding and feeding transitions during the first year of life. *Pediatrics* 2008;122(suppl 2):S36–42.
4. Fomon S. Nutrition in normal infants. St Louis, MO: Mosby Year Book, 1993.
5. Picciano MF, Smiciklas-Wright H, Birch LL, Mitchell DC, Murray-Kolb L, McConahy KL. Nutritional guidance is needed during dietary transition in early childhood. *Pediatrics* 2000;106:109–14.
6. Schwartz C, Scholtens PA, Lalanne A, Weenen H, Nicklaus S. Development of healthy eating habits early in life: review of recent evidence and selected guidelines. *Appetite* 2011;57:796–807.

**TABLE 7**

Research topics that NHANES data can address

- Nutrient and food intakes; dietary supplement use
- Food, beverage, and snack consumption patterns
- Salt use and sodium intake
- Transitions
  - Breast milk → formula → cow milk; table foods
- Food behavior (purchasing, eating out), food allergies
- Blood-based nutrient and environmental exposures
- Exposures can be linked to growth based on direct measurements by trained staff

7. Birch L, Savage JS, Ventura A. Influences on the development of children's eating behaviours: from infancy to adolescence. *Can J Diet Pract Res* 2007;68:s1-5.
8. Lytle LA, Seifert S, Greenstein J, McGovern P. How do children's eating patterns and food choices change over time? Results from a cohort study. *Am J Health Promot* 2000;14:222-8.
9. Mannino ML, Lee Y, Mitchell DC, Smiciklas-Wright H, Birch LL. The quality of girls' diets declines and tracks across middle childhood. *Int J Behav Nutr Phys Act* 2004;1:5.
10. Devaney B, Kalb L, Briefel R, Zavitsky-Novak T, Clusen N, Ziegler P. Feeding Infants and Toddlers Study: overview of the study design. *J Am Diet Assoc* 2004;104(suppl 1):s8-13.
11. Briefel RR, Kalb LM, Condon E, Deming DM, Clusen NA, Fox MK, Harnack L, Gemmill E, Stevens M, Reidy KC. The Feeding Infants and Toddlers Study 2008: study design and methods. *J Am Diet Assoc* 2010;110(suppl):S16-26.
12. Fein SB, Grummer-Strawn LM, Raju TN. Infant feeding and care practices in the United States: results from the Infant Feeding Practices Study II. *Pediatrics* 2008;122(suppl 2):S25-7.
13. Butte NF, Fox MK, Briefel RR, Siega-Riz AM, Dwyer JT, Deming DM, Reidy KC. Nutrient intakes of US infants, toddlers, and pre-schoolers meet or exceed dietary reference intakes. *J Am Diet Assoc* 2010;110(suppl):S27-37.
14. Siega-Riz AM, Deming DM, Reidy KC, Fox MK, Condon E, Briefel RR. Food consumption patterns of infants and toddlers: where are we now? *J Am Diet Assoc* 2010;110(suppl):S38-51.
15. Fein SB, Labiner-Wolfe J, Shealy KR, Li R, Chen J, Grummer-Strawn LM. Infant Feeding Practices Study II: study methods. *Pediatrics* 2008;122(suppl 2):S28-35.
16. National Center for Health Statistics, US Department of Health and Human Services, CDC. National Health and Nutrition Examination Survey: plan and operations, 1999-2010. Washington, DC: US Government Printing Office, 2013. [Vital and Health Statistics, Series 1, Number 56.]
17. Blanton CA, Moshfegh AJ, Baer DJ, Kretsch MJ. The USDA Automated Multiple-Pass Method accurately estimates group total energy and nutrient intake. *J Nutr* 2006;136:2594-9.
18. Thompson FE, Subar AF. Dietary assessment methodology. In: Coulstam AM, Boushey CJ, Ferruzzi MG, eds. Nutrition in the prevention and treatment of disease. San Diego, CA: Academic Press, 2013:5-30.
19. Moshfegh AJ, Rhodes DG, Baer DJ, Murayi T, Clemens JC, Rumpler WV, Paul DR, Sebastian RS, Kuczynski KJ, Ingwersen LA, et al. The US Department of Agriculture Automated Multiple-Pass Method reduces bias in the collection of energy intakes. *Am J Clin Nutr* 2008;88:324-32.
20. Akinbami LJ, Moorman JE, Bailey C, Zahran HS, King M, Johnson CA, Liu X. Trends in asthma prevalence, health care use, and mortality in the United States, 2001-2010. *NCHS Data Brief* 2012(94):1-8.