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Weight Status Measures Collected in the Healthy Communities Study:

Protocols and Analyses

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Abstract

The Healthy Communities Study is one of the largest studies to assess the relationship between characteristics of community programs and policies to prevent childhood obesity and obesity-related outcomes. The purpose of this paper is to describe the protocol that was developed for collecting the anthropometric data for the study and the procedures for analyzing the data. Data were collected from 2013 to 2015 and analyses will be completed by mid-2016. During in-home visits, Healthy Communities Study staff collected height, weight, and waist circumference measurements from child participants and height and weight measurements from adult participants. The protocol for obtaining these measurements was adapted from the protocol used by the National Health and Nutrition Examination Survey, with modifications to accommodate assessments conducted in homes rather than in a Mobile Examination Center. In addition to anthropometric data from in-home visits, the Healthy Communities Study collected retrospective height and weight measurements from the medical records of child participants. These data were used to calculate trajectories of BMI and BMI *z*-scores. The study implemented procedures for ensuring the accuracy of the in-home measurements and abstracted medical data. These procedures included automatically checking the ranges on entered data, reviewing data for end-digit patterns, and abstracting selected medical records using two independent abstractors to assess agreement. The collection of longitudinal height and weight measures will allow researchers to address several pressing questions related to how characteristics of community programs and policies are associated with obesity-related outcomes among children.

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Introduction

Obesity is a major public health issue in the U.S. The prevalence of obesity among children is of particular concern, because high BMI during childhood is associated with obesity and chronic disease in adulthood.[13] In 2011 2012, 17.7% of U.S. children aged 6 11 years and 20.5% aged 12 19 years were considered obese (defined as having a BMI at or above the 95th percentile of CDC growth charts for child's age and gender).[4] In response to this public health issue, community programs and policies targeting childhood obesity are being implemented across the U.S. These programs and policies vary in approach, intensity level, duration, funding, target population, and implementation techniques.

Although studies exist that examine the impact of individual programs or policies, the Healthy Communities Study (HCS) is the first study to systematically examine how different aspects of community programs and policies targeting childhood obesity are related to childhood obesity outcomes.[5] The three main aims of the HCS are to :

1. determine the associations between characteristics of community programs and policies and obesity outcomes in children;
2. identify factors that modify or mediate the associations; and
3. examine the associations between characteristics of programs and policies and obesity outcomes in children in communities that have a high proportion of African American or Hispanic residents.

A unique component of the HCS is the collection of anthropometric data from two sources: in-home visits and medical record abstraction. The in-home data provided reliable and standardized anthropometric measurements at a point in time that can be linked to characteristics of programs and policies observed in the community concurrently. Medical record abstraction for child participants provided retrospective data on height, weight, counseling for weight loss, medications, and chronic conditions. These data will allow for longitudinal analyses (including BMI trajectories) that are not possible with the in-home visit data collected at a point in time.

The purpose of this paper is to describe the protocol that was developed for collecting the anthropometric data for the HCS and the procedures planned for analyzing these data.

Methods

Sampling Procedure

Data were collected from 2013 to 2015 and analyses will be completed by mid-2016. The study was approved by the Battelle Memorial Institute IRB, and parents provided written informed consent for their child's participation. A description of the human subject protections is included in another article in this issue.[6]

Approximately 5,000 children were recruited from 130 communities to participate in the study. Communities were defined using high school attendance boundaries, and they were selected using a complex sampling design to ensure representativeness across regions of the

country, urbanicity, race/ethnicity makeup of the community, income, and known programs and policies to address childhood obesity.[7] After selecting communities, schools were identified within those communities from which to recruit households, and child participants were selected from participating households who met the study's recruitment goals related to gender, age, and race/ethnicity.[6] The child participants were evenly distributed across ages 4 15 years and across gender; 21.5% were African American and 43.5% were Hispanic. The over-representation of minority children in the HCS will provide sufficient data to study subpopulations known to have a higher prevalence of obesity.[4]

Two adults per household were selected for anthropometric measurement. The first priority was to obtain measurements for both biological parents of the study child. If a biological parent was present but refused to be measured, the parent was asked to provide self-reported measurements. If one of the biological parents was not available during the visit for measurement or self-reporting, the parent present was asked to provide proxy-reported height and weight measurements for the absent parent. If proxy-reported measurements for the absent biological parent could not be obtained, another adult who cares for the child was selected for measurement. If multiple alternative caregivers were available, the adult who spent the most time caring for the child was selected for measurement. Adult measurements were collected to provide information on potential shared hereditary and environmental influences on obesity-related outcomes. The adult data (along with the child's stature, chronological age, gender, and weight) can be used to estimate the child's mature stature using regression coefficients.[8] Future researchers can use the caregiver data to explore hypotheses about the relationship between caregiver obesity-related outcomes and child obesity-related outcomes through mechanisms such as meal planning and choice of activities.

Training of Field Data Collectors

During the in-home visits, trained field data collectors (FDCs) collected anthropometric data from the child participant and up to two adults living in the household. FDCs were accompanied by quality control (QC) staff on selected home visits. Both the FDCs and QC staff were hired by Battelle specifically for this study, and trained and certified by Battelle researchers at its corporate headquarters. Between one and three FDCs were assigned to each of the study communities.

Training of FDC and QC staff consisted of watching videos that demonstrated the proper method to take anthropometric measurements, followed by in-person demonstrations. All FDC and QC staff trainees were required to be certified in anthropometric measurement. A trainer measured height, weight, and waist circumference on a set of volunteer children and height and weight on a set of volunteer adults not participating in the study (for a total of five kinds of measurements: child height, child weight, child waist circumference, adult height, and adult weight). Trainees were required to take the same kinds of measurements on the same set of children and adults. In order to be certified, a trainee was required to match the trainer's measurements to within 0.5 cm for height, 0.1 kg for weight, and 2.0 cm for waist circumference on two different adults and two different children (for a total of ten correct measurements).

Data Collection Procedures for In-Home Measurements

During in-home visits, height, weight, and waist circumference were measured on each child participant, and height and weight were measured on two adults living in the household. Waist circumference was measured because it can provide insight into the distribution of adiposity better than BMI alone.[9]

The protocol for taking in-home anthropometric measurements was adapted from the procedures used in the National Health and Nutrition Examination Survey (NHANES).[10] HCS participants were asked to wear a t-shirt and shorts, but could refuse to change clothing. Weight measurements were taken with participants standing in the center of the scale with their arms at their sides facing straight ahead. Height measurements were taken without hair ornaments, buns, braids, and jewelry. The headpiece was lowered onto the top of the participant's head and the measurement was taken after a deep inhalation. Waist circumference measurements were taken on the right side with the participant holding his or her shirt up. The examiner palpated the hip and made a horizontal line with a cosmetic pencil at the top of the ilium and a vertical line at the mid-axillary line. A steel measuring tape was extended around the participant with the zero end of the tape placed underneath the measurement value. The tape was pulled snug without compressing the skin, and it was checked to ensure that it was horizontal and parallel to the ground. The measurement was taken at the end of the participant's normal expiration.

A key difference between the HCS and NHANES protocols is that HCS measurements were taken inside the participants' homes using different FDCs in different parts of the country, whereas NHANES participants are measured in a Mobile Examination Center using the same data collectors across the country. Some NHANES procedures needed to be revised for the HCS to adjust to the in-home setting and the constraints of the study, as indicated in Table 1. In addition, a second round of anthropometric measurements was collected 1 week later on approximately 10% of the child participants as part of the study's enhanced protocol.[6]

Medical Record Abstraction Procedures

The HCS collected data from the medical records of child participants in order to construct a history of weight, height, and obesity-related medical conditions. Information collected from the medical records included date of visit; height and weight at visit; whether the record mentioned counseling or referral for counseling for nutritional, physical activity, or sedentary activity; and any diagnoses of 45 specific medical conditions (including diabetes and hypertension) and whether medications were prescribed for these conditions. Based on recent studies, HCS is expected to collect an average of 3.2 height/weight measurements per child from medical records, with an average time between first and last measurement of 2.97 years.[11] Approximately 87% of HCS participants had at least one BMI measurement available from the medical records.

During the in-home visit, the FDC asked the family to complete a medical record release form listing the child's physicians and consenting to the release of medical records from those physicians. Families were asked to list provider contact information, medical record

number, ages when the child saw the provider, an estimate of the number of times the child had his or her height and weight measured by the provider, and whether the child would continue to see that medical provider.

Time and budget constraints of the study did not permit the collection of medical record data for all child participants and from all physicians reported for each child. A protocol was developed to identify, for each child, a single physician who was contacted from among those listed on the release form. The goal was to limit the number of physicians to contact while maximizing the number of height/weight measurements obtained while the child lived in the study community. The study utilized only records for the child while living inside of the community because these height/weight measurements can be linked to community program and policy characteristics. The expected number of records available from each provider was calculated based on the age when the child moved into the community (available from the main household questionnaire), the ages when the child saw the physician, and the estimated number of height/weight measurements collected by the physician. In order to ensure diverse representation from at-risk groups, participants who were minority, low-income, or participating in the HCS enhanced protocol were selected at a higher rate for the medical record review than participants without these characteristics, even if a potentially higher number of records could have been obtained from the latter group.

Each selected provider was contacted by phone to confirm the fax number. A fax was then sent to the provider requesting records from all of the child's visits to that provider. Records could not be obtained without a signed release form, and participants were allowed to skip any part of the form that they felt uncomfortable completing. Some providers released records if the release form was incomplete, such as missing the relationship of the child to the signatory of the form. No providers were willing to release records if the form was missing the child's date of birth.

A trained abstractor reviewed each record and entered the requisite data into a template designed in Microsoft Excel. Abstractors were registered nurses who were trained via webinar to use the Excel template. If the record contained a growth curve plot but no specific height/weight numbers, no height/weight information was collected from the record. Illegible records were dealt with on an ad hoc basis by the study management team. Abstractors were instructed to record whether nutritional, physical activity, or sedentary counseling, or referral for counseling, was indicated in the record. If no counseling or referral was mentioned, it was assumed that no counseling or referral was done.

Quality Control Procedures

During in-home visits, all child and adult measures were taken twice and entered into the study information management system. The system calculated the difference between the two measurements in real time. For differences exceeding 0.5 cm for height, 0.1 kg for weight, or 2.0 cm for waist circumference, the system alerted the FDC that a third measurement was required. The system also alerted the FDC if the entered child measurement was out of range (defined as below the first or above the 99th percentile for that child's age/gender group). FDCs used this prompt to check for any keying errors and

correct them. After verifying that the data entered were correct, the measurements were stored in the information management system to be used in the analysis.

The QC staff accompanied FDCs on selected home visits to observe measurement. FDCs who were observed to deviate substantially from the protocol were re-trained before conducting additional in-home visits.

Data from completed in-home visits were monitored on a weekly basis. The data collected by each FDC were reviewed to assess the number of third measurements and out-of-range measures. Out-of-range measures for children were described above; for adults, the out-of-range limits were the first and 99th percentiles of all adults based on NHANES.[12] Any out-of-range measurements were retained and flagged in the study data set, and they remain available for future researchers planning to analyze the data. Data were reviewed to determine if the FDCs' recordings exhibited end-digit preferences (e.g., always rounding to the nearest zero or 0.5 in the measurements). Supervisors reviewed the protocol with FDCs whose recordings exhibited abnormal patterns or end-digit preferences.

An independent, dual-entry review process was used to evaluate the performance of the medical record abstractors. Approximately 10% of the abstracted records in the study underwent a blinded, second abstraction by an independent abstractor. After resolving any discrepancies, corrected information was added to the information management system. If discrepancies were identified on more than 5% of the records reviewed for an abstractor, the abstractor was retrained and 100% of the next ten records entered by that abstractor were reviewed. This initial review corrected all of the problems, and no additional reviews were needed. Summary reports on medical record abstraction were reviewed on a weekly basis, and any issues identified during review were corrected.

Planned Analyses of Anthropometric Data

The weight status data play a central role in three planned analyses that will address the major aims of the HCS. The outcome of interest for these analyses will be BMI *z*-scores (based on CDC age- and gender-specific growth charts[13]) and BMI (which may be a better measure of change in adiposity for longitudinal analyses).[14] The exposure of interest is the community program and policy score, a weighted sum of the duration, reach, and behavior change strategy of all of the programs and policies in place in that community in a given year.[15]

One analysis will use only the in-home measurements to identify cross-sectional associations between BMI/BMI *z*-score and community program and policy score, using metrics of diet quality (e.g., fruit and vegetable intake) and the volume of moderate to vigorous physical activity as potential mediators of the relationship.[16,17] A second analysis will combine the in-home measurements with the medical record measurements to investigate longitudinal changes in BMI/BMI *z*-score with changes in community program and policy scores over time. A third analysis planned for the anthropometric data is to examine sociodemographic modifiers of the relationship between characteristics of community programs and policies and obesity-related outcomes in children. In all of the analyses, the large number of participants in the HCS will allow for the creation of age- and

gender-specific cohorts across the sample of communities, with sufficient sample size in each cohort to ascertain the association between characteristics of community programs and policies and obesity-related outcomes.

The in-home measurements are expected to be highly accurate because they were collected by trained FDCs following a standard protocol, whereas data from medical records are subject to variability because each measurement may be taken by a different person following a different protocol.[18] The longitudinal analysis will make use of error-in-measurement correction methods to account for the different levels of accuracy between in-home and medical record data.[7,19,20] Medical records within 2 weeks of the in-home visit will provide a direct measure of the potential error associated with abstracted medical records. After characterizing the relationship between anthropometric data obtained from in-home visits and data from medical records, appropriate adjustments will be made to the statistical methods to draw inferences using the entire collection of BMI data.

Discussion

Many methods are used to assess body composition. Techniques such as dual energy X-ray absorptiometry and air displacement plethysmography are more accurate than BMI, but they are more costly and require a high level of technical training.[9] The HCS used BMI, supplemented with waist circumference data, as a reasonable surrogate for adiposity in children, because other techniques are not practical for field studies.[9,21]

Limitations

The anthropometric data collected in the HCS have some limitations. In-home measurements were collected by a large number of FDCs, potentially resulting in variation in measurements. Steps taken to mediate the potential variation include centralized training, certification, and QC of the data. Another limitation is that the medical record measurements were recorded by a diverse set of medical professionals with varying degrees of training in anthropometrics. Measurements recorded in these settings do not follow the same protocol and are not always performed by the same person on every visit, but the resulting variability is small enough that the data are suitable for research.[18]

Conclusions

Despite these limitations, the HCS adopted an innovative approach of combining in-home anthropometric measurements with medical records to obtain longitudinal data on a large sample of U.S. children. Statistical adjustments can be made to the analyses to account for inaccuracies in the data sources by utilizing medical visits that occurred within 2 weeks of the in-home visit. The study data, combined from multiple sources, will allow researchers to address several pressing questions related to how characteristics of community programs and policies are associated with obesity-related outcomes among children.

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Table 1

Differences Between NHANES and HCS Protocols for Collecting Anthropometric Measurements

Topic	NHANES Protocol	HCS Protocol
Number of staff taking waist measurements	Two	One
Ensuring tape measure is level	Mirrors are available to provide a better view of participant	FDC looks from another angle to ensure tape is level
Type of clothing worn by participant	Disposable slippers, shirt, and pants	Participants were asked to wear a t-shirt and shorts but could refuse to change clothing; FDC records what type of clothing was worn for the measurements
Equipment for height and weight measurement	Standardized electronic equipment installed in Mobile Examination Center	Portable equipment necessary Height: ShorrBoard Infant/Child/Adult Height Measuring Board w/ Auto-Lock Head/Footpiece Weight: Seca 874 electronic personal scale
Participant refuses to have skin marked for waist circumference measurement	No procedure specified	If the child or caregiver refused mark, child was asked to place his/her finger on the measurement site
Participant refuses measurement or refuses to remove shoes	Recorded as Could Not Obtain	Obtain self-reported weight (adult) or proxy weight (child)

NHANES, National Health and Nutrition Examination Survey; HCS, Healthy Communities Study