Add Health-Wave V: Full Sample Cross-Sectional Weighting Specifications

Paul Biemer and Dan Liao

1. Introduction

The National Longitudinal Study of Adolescent to Adult Health (Add Health) is a longitudinal survey of a nationally representative sample of U.S. adolescents in grades 7-12 selected during the 1994-95 school year. This cohort of students has been followed into young adulthood with four prior waves, all conducted by face-to-face interviewing. Wave II was conducted in 1996, Wave III in 2002 and Wave IV in 2008. Add Health combines longitudinal survey data on respondents' social, economic, psychological and physical well-being with contextual data on the family, neighborhood, community, school, friendships, peer groups, and romantic relationships, providing unique opportunities to study how social environments and behaviors in adolescence are linked to health and achievement outcomes in young adulthood. Add Health traced, located, and interviewed many of these cohort members in the Wave V follow-up during the period 2016-2018 to collect social, environmental, behavioral, and biological data with which to track the emergence of chronic disease as the cohort moves through their fourth decade of life.

Wave V data collection is quite unique in several ways. First, for the first time, the data collection employed a mixed mode, two-phase survey design. In the first phase, sample members were contacted primarily by mail and email and asked to complete either a web or paper questionnaire. In the second phase, a subsample of nonrespondents were followed up in the field to obtain an in-person interview. Most of the remaining nonrespondents were contacted by phone and asked to complete a short, phone questionnaire.

The Wave V sample was split into four random subsamples referred to as Samples 1, 2a, 2b and 3 (see **Exhibit 1**). These samples were sent to the field more or less during sequential time periods spanning about three years. Sample 1 included some experiments that were embedded in the data collection to inform the design of the subsequent mixed mode samples. Samples 2a and 2b were run in parallel following Sample 1. Sample 2a was conducted by mixed modes like Sample 1; however, the design of Sample 2a was improved, having benefitted from the Sample 1 experiments and the experience of having fielded Sample 1. Sample 2b is a control sample that was conducted simultaneously with Sample 2a. It used the traditional face to face protocol as in the prior waves, but on a much smaller scale. Sample 2b was used to estimate the effect of transitioning the Add Health from face to face to a two-phased, mixed mode design. Sample 3's design was essentially identical to Sample 2a and was fielded only a few months after Sample 2a was fielded. Comparisons between combined Samples 1, 2a and 3 with Sample 2b will provide estimates of the effects of the change in the mode of data collection. That mode analysis is now underway.

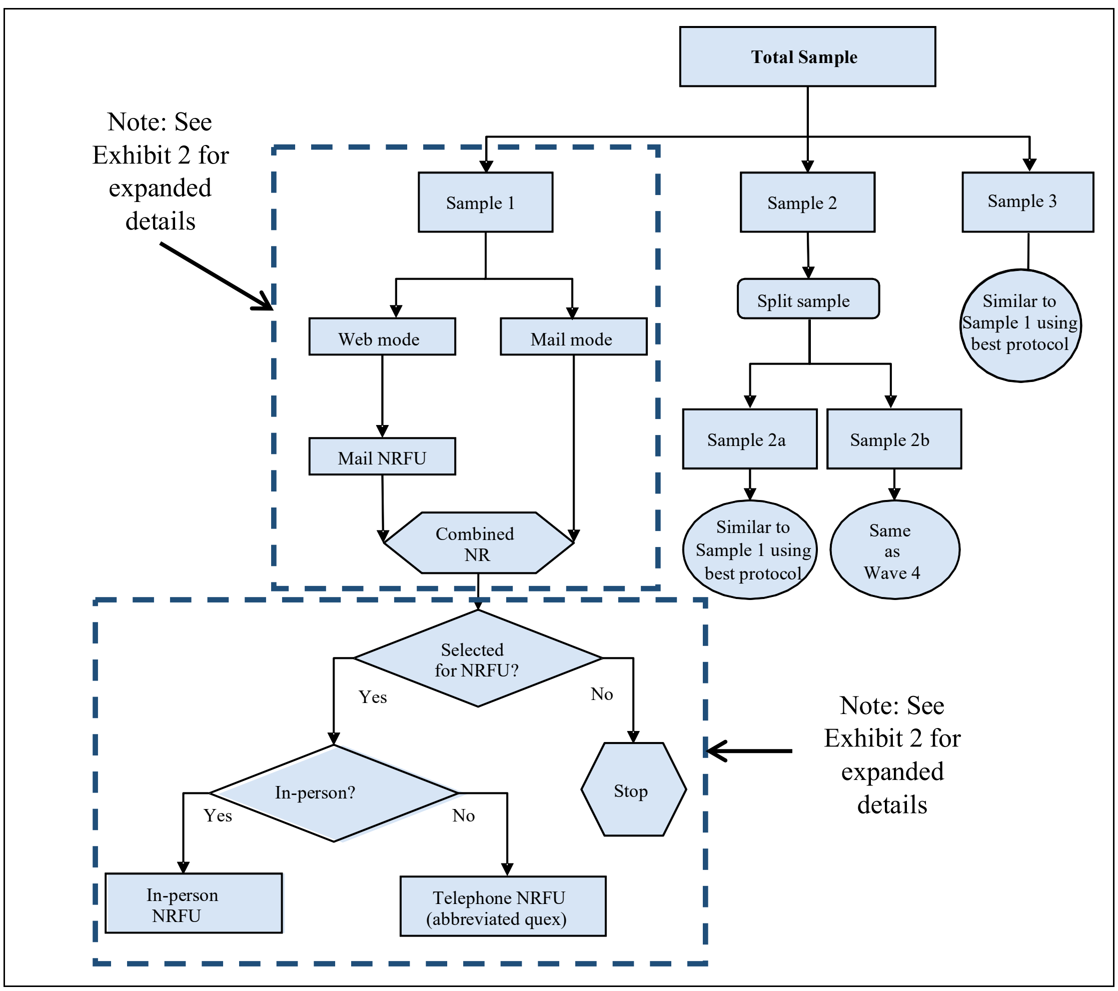
Prior to releasing the final combined sample, the data collected for Sample 1 was released as a preliminary data set so that users could gain experience in analyzing Add Health data under the new design and to prepare themselves for analysis of the final dataset. This preliminary release also served as a QC check on the weight development process so that any issues with the weighting can be, hopefully, detected and corrected before the final release. The details regarding the weighting of Sample 1 can be found in Biemer and Liao (2017).

Three weight sets have been prepared for Wave V serving distinct purposes. The present document provides an overview of the Wave V sampling design and the weighting specifications for the following samples: (a) the combination of Samples 1, 2a and 3, (b) Sample 2b alone, and (c) the combination of all four samples: 1, 2a, 2b and 3. Weights (a) and (b) will be required for the mode comparison study while weights (c) will be the Wave V Grand Sample weight that will be used by most analysts for their cross-sectional analyses. Weight sets (a) and (b) were used in the mode analysis while weight set (c) constitutes the Grand Sample weight for the entire Wave V sample.

2. Overview of the Sample Design

The eligible sample for Add Health-Wave V consisted of all Add Health-Wave I respondents who were neither deceased nor living in long-term incarcerations during the Wave V survey period. This included approximately 19,828 persons who participated in Wave I. As previously described and shown in **Exhibit 1**, this sample was randomly divided into four subsamples – referred to as Samples 1, 2a, 2b and 3 – with approximately 40%, 14%, 8% and 38% of the units in each sample, respectively. Section 3 provides some details on the systematic sampling scheme used to select the four subsamples. Data collection for Sample 1 began in 2016 while data collection for Samples 2a, 2b and 3 began in 2017 and concluded in late-2018.

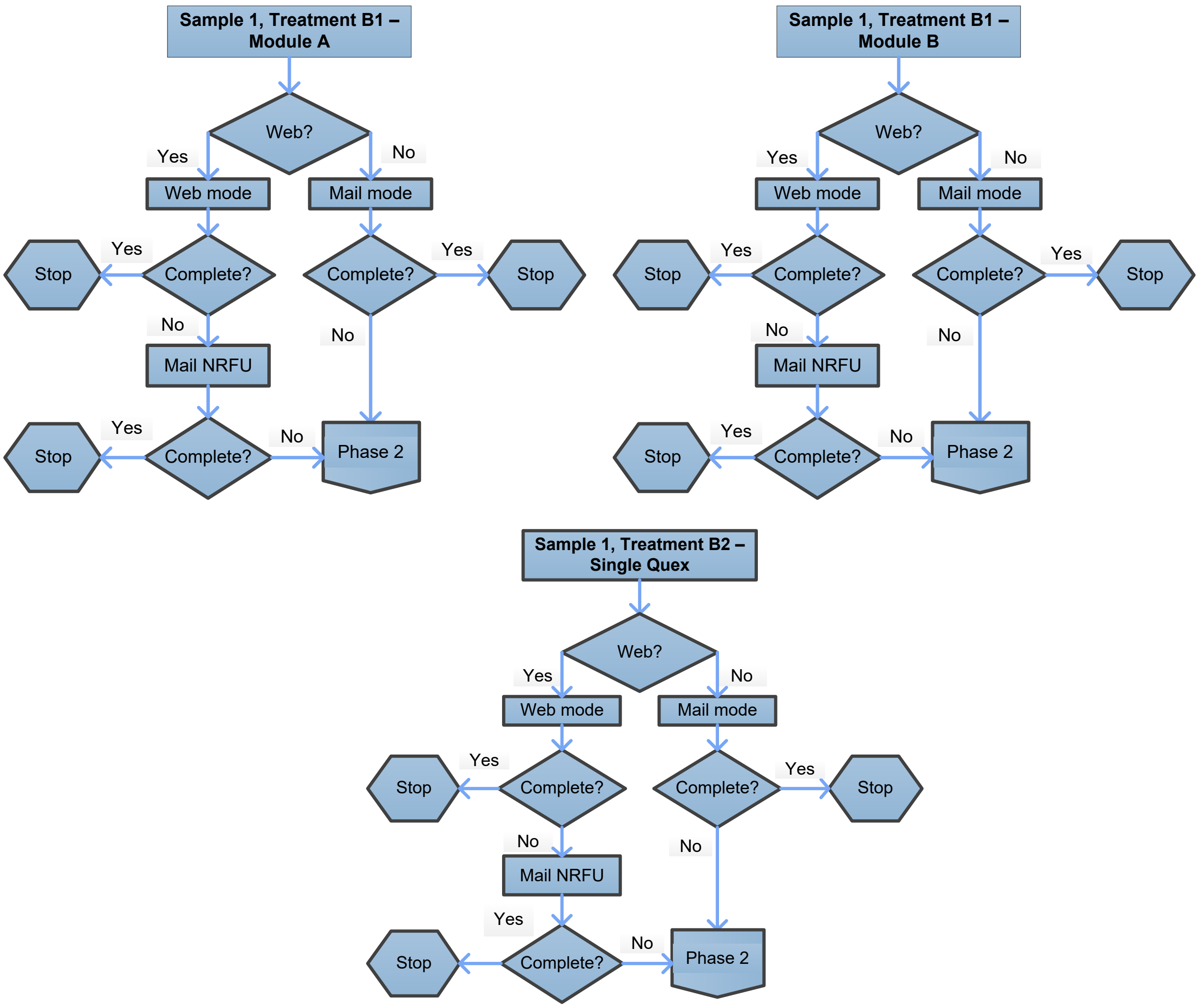
Exhibit 1. Overview of Wave V Sample Design



Samples 1, 2a and 3 used a web/paper data collection protocol while Sample 2b was collected using in-person interviewing, replicating the Wave IV protocol to the extent possible. Data collection for Samples 1, 2a and 3 involved two phases. Phase 1 was the web/paper data collection that was applied to all sample members in these samples. Following Phase 1, a subsample of nonrespondents were followed up primarily by in-person interviewing. The nonresponse follow-up (NRFU) phase of the survey is referred to as Phase 2. For budgetary reasons, one constraint on the design was that the cost of data collection was to be approximately the same for Samples 1, 2 and 3. For that reason, Samples 2a and 2b were smaller than the other two Samples (i.e. Samples 1 and 3) because the per unit cost for field interviewing is considerably higher than the mixed-mode approach. All four subsamples are random samples of the entire Wave V sample and, thus, each is representative of the Wave V target population. Sample 1 was weighted separately from the other three samples and was released as an early, preliminary version of the Wave V data structure. The details of the Sample 1 weighting process can be found in Biemer and Liao (2017). As described in this document, all four samples will be combined and weighted as a single sample for the final data release.

Exhibit 2 provides an overview of the experiments that were embedded in Sample 1. Sampled cases were split between two experimental treatments: a sequential modular questionnaire design featuring two, separate questionnaire modules vs. a content-equivalent, single-module questionnaire design. In addition to this questionnaire treatment, two incentive protocols were also compared experimentally. For each treatment, the option of responding by either web or paper was offered to sample members; however, response by the web was encouraged and incentivized. The modular questionnaire design was intended to minimize the impact of the interview length and potential respondent burden on the response rate. As expected, some respondents only complete one of the two modules which reduced the full completion rate for this experimental condition. As previously noted, a long questionnaire alternative was also tested that combined the two modules into one, integrated questionnaire. This treatment resulted in more complete data and thus a slightly higher and significant increase in the completion rate. Based upon these results, the modular questionnaire was dropped for Samples 2a and 3 in favor of the single, long questionnaire. The experimental design is described in more detail in Biemer and Liao (2017).

Exhibit 2. Sample 1, Phase 1 Data Collection Process



In Samples 1, 2a and 3, a subset of nonrespondents was followed up interviewers in the field which formed a second phase of data collection. Sample 1 followup was treated somewhat differently than Samples 2a and 3. In Sample 1 only, a small number of Phase 1 nonresponding cases were also contacted by telephone using a very short questionnaire. Also, in Sample 1, a random sample of approximately 50% of the nonrespondents were selected for field follow-up after the full web/paper protocol was attempted (in Phase 1) on these cases with no interview. In Samples 2a and 3, the proportion of cases selected for Phase 2 was only about 20%. The decision to reduce the Phase 2 sample size was based upon analysis that suggested the smaller sampling rate would save substantial costs while still considerably reducing the mean squared error of the estimates.

3. Sample Selection

As previously noted, the sampling frame for Wave V interview consists of an estimated sample of 19,828 persons from Wave I who were eligible for Wave IV whether or not they responded to Wave IV. To ensure that Samples 1, 2a, 2b and 3 are random samples of the entire

Wave V sample and each is representative of the Wave V target population, a systematic sampling scheme was implemented to randomly select the four samples.

3.1. Sorting Sampling Frame

Prior to sampling, the sampling frame (i.e., the eligible Wave I sample) was sorted by key stratification variables so that the four samples are approximately balanced with respect to the sorting variables and the proportions of the sample in each implicit stratum are approximately the same for each sample. The sorting variables were used in the following order: LGBTQ indicator variable in Wave IV (to facilitate the Add Health Sexual Minority Ancillary Study), and then region, state, gender, race and age.

To compensate for item missingness in the geographic and demographic characteristics in Wave IV, the information reported in the most recent wave from each frame member was used. As an example, if state of residence is known for a frame member based upon information collected for Wave IV, then that information was used in sorting. Otherwise, the most current information available on state of residence was used.

3.2. Selecting Samples

After sorting the sampling frame, sampling proceeded by selecting an element from the list at random and then labelling each unit in the list according to the following pattern: **1-2-3-1-3**. This sequence was initiated at a randomly selected point in the sorted frame, was repeated until the end of the file was reached, and then continued from the beginning of the file until the starting point was again reached. Then all units with a "1" were assigned to Sample 1, "2" were assigned to Sample 2, and "3" to Sample 3. This sampling scheme resulted in assigning about 40% cases to Sample 1, 20% cases to Sample 2, and 40% cases to Sample 3.

Next, we systematically selected 31.5% of the 3,966 cases in Sample 2 and assigned them to Sample 2b with the remainder being assigned to Sample 2a. Maintaining the same sort for Sample 2 as in the original frame, we assigned the number $m = k \times 0.315$ to the kth case in the file for $k = 1, \ldots, 3966$ (i.e., the size of Sample 2). We then assigned to Sample 2b, all cases labeled $[m,1]$, $[m,2]$, …$[m,1250]$ where $[m,b]$ denotes unit whose value of m is nearest to the integer b for $b = 1, \ldots, 1250$. Sample 2a then consisted of the remaining cases in Sample 2.

4. Response Rates by Subsample and Overall

Tables 1a-1d provides the final statuses of the cases in all four samples. Table 1e provides the final statuses for the combined four-sample data set. The combined unweighted response rate for the Wave V sample is 62.79 percent and the weighted response rate is 69.27 percent. The formula for the weighted response has the form

$$\mathrm{RR_W} = \frac{\sum_{i=1}^{n_E} \omega_i (r_{1i} + r_{2i} / \pi_{2i})}{\sum_{i=1}^{n_E} \omega_i}$$

where n_E is the number of eligible sample members, r_{1i} =1 if the *i*th case responds in Phase 1 and is 0 otherwise, r_{2i} =1 if the *i*th case responds in Phase 2 and is 0 otherwise, and π_{2i} is the Phase 2 inclusion probability defined in equation (5) below. The unweighted response rate has the same form except ω_i and π_{2i} are replaced by 1.

Table 1a. Final Statuses of Cases for Wave V - Sample 1

Type	Unweighted Count	Unweighted Percent	Weighted[a] Count	Weighted Percent
Eligible Cases				
Completed	4,775	60.21%	5,985,741	68.46%
Nonresponse	3,092	38.99%	2,687,951	30.74%
Total	7,867	99.19%	8,673,692	99.20%
Ineligible Cases				
Deceased	55	0.69%	52,726	0.60%
Other	8	0.10%	15,725	0.18%
Total	63	0.79%	68,451	0.78%
Cases with Unknown				
Deceased without Date of Death	1	0.01%	1,326	0.02%
All Cases	7,931	100.00%	8,743,469	100.00%
Overall Response		60.70%		69.01%

a: The weighted counts for the "Completed" and "Nonresponse" categories are based on the formula to calculate the weighted response rate; the weighted counts for other categories are based on Wave I grand weight.

Table 1b. Final Statuses of Cases for Wave V - Sample 2A

Type	Unweighted Count	Unweighted Percent	Weighted[a] Count	Weighted Percent
Eligible Cases				
Completed	1,717	63.22%	2,088,308	67.96%
Nonresponse	966	35.57%	938,316	30.54%
Total	2,683	98.79%	3,026,624	98.50%
Ineligible Cases				
Deceased	25	0.92%	29,299	0.95%
Other	5	0.18%	9,558	0.31%
Total	30	1.11%	38,857	1.27%
Cases with Unknown				
Deceased without Date of Death	3	0.11%	7,285	0.24%
All Cases	2,716	100.00%	3,072,766	100.00%
Overall Response		64.00%		69.00%

a: The weighted counts for the "Completed" and "Nonresponse" categories are based on the formula to calculate the weighted response rate; the weighted counts for other categories are based on Wave I grand weight.

Table 1c. Final Statuses of Cases for Wave V - Sample 3

Type	Unweighted Count	Unweighted Percent	Weighted[a] Count	Weighted Percent
Eligible Cases				
Completed	4,706	61.67%	5,744,444	67.99%
Nonresponse	2,807	36.78%	2,561,125	30.31%
Total	7,513	98.45%	8,305,569	98.31%
Ineligible Cases				
Deceased	74	0.97%	92,903	1.10%
Other	42	0.55%	45,630	0.54%
Total	116	1.52%	138,532	1.64%
Cases with Unknown				
Deceased without Date of Death	2	0.03%	4,602	0.05%
All Cases	7,631	100.00%	8,448,703	100.00%
Overall Response		62.64%		69.16%

a: The weighted counts for the "Completed" and "Nonresponse" categories are based on the formula to calculate the weighted response rate; the weighted counts for other categories are based on Wave I grand weight.

Table 1d. Final Statuses of Cases for Wave V - Sample 2B

Type	Unweighted Count	Unweighted Percent	Weighted[a] Count	Weighted Percent
Eligible Cases				
Completed	1,102	71.10%	1,199,536	70.39%
Nonresponse	424	27.36%	473,722	27.80%
Total	1,526	98.45%	1,673,258	98.19%
Ineligible Cases				
Deceased	9	0.58%	11,690	0.69%
Other	14	0.90%	18,608	1.09%
Total	23	1.48%	30,297	1.78%
Cases with Unknown				
Deceased without Date of Death	1	0.07%	592	0.04%
All Cases	1,550	100.00%	1,704,147	100.00%
Overall Response		72.22%		71.69%

a: The weighted counts for the "Completed" and "Nonresponse" categories are based on the formula to calculate the weighted response rate; the weighted counts for other categories are based on Wave I grand weight.

Table 1e. Final Statuses of Cases for Wave V – Full Sample

Type	Unweighted Count	Unweighted Percent	Weighted[a] Count	Weighted Percent
Eligible Cases				
Completed	12,300	62.03%	15,018,029	68.36%
Nonresponse	7,289	36.76%	6,661,114	30.32%
Total	19,589	98.80%	21,679,143	98.68%
Ineligible Cases				
Deceased	163	0.82%	186,618	0.85%
Other	69	0.35%	89,520	0.41%
Total	232	1.17%	276,138	1.26%
Cases with Unknown				
Deceased without Date of Death	7	0.04%	13,804	0.06%
All Cases	19,828	100.00%	21,969,085	100.00%
Overall Response		62.79%		69.27%

a: The weighted counts for the "Completed" and "Nonresponse" categories are based on the formula to calculate the weighted response rate; the weighted counts for other categories are based on Wave I grand weight.

5. Overview of the Cross-sectional Weighting Process

As noted previously, the Add Health full sample consists of four subsamples referred to as Samples 1, 2a, 2b and 3. Samples 1, 2a and 3 were conducted by a mixture of three modes – web, paper and face to face interviewing – using a two-phase field collection design. Sample 2b was conducted solely by face to face interviewing using protocols long established in Waves I through IV. The mode analysis that is currently in progress will compare the combined Samples 1,2a and 3 with Sample 2b to estimate possible mode/system effects associated with the new data collection methodology. Add Health users will want to be advised of the possible methodological affects associated with the new mixed mode design and how those affects might influence estimates of longitudinal change. To facilitate the mode analysis, the combination of Samples 1, 2a and 3 and Sample 2b are weighted separately as described in this document. Samples 1, 2a and 3 (referred to as the mixed-mode samples) are weighted using procedures similar to those used for the Sample 1 preliminary release data file. Two sets of weights were developed for Sample 2b (referred to as the face to face sample). One set of weights (referred to as the "traditional" weights) uses weighting procedures that are similar to those used in Waves 1, 2, 3 and 4. A second set of weights (referred to as the optimized weights) were optimized to take advantage of the information available from Samples 1a, 2a and 3 that can be used for weighting. In addition to these three sets of weights, we also produced a set of cross-sectional weights that combines all four samples into one "grand" sample. These weights are referred to as the Wave V Grand Sample weights.

In each case, the samples were weighted for either one or two-phase unequal probability sampling and adjusted for nonresponse. To produce the weights for Samples 1, 2a and 3, the Wave I weights were constructed in accordance with its two-phase design and then adjusted for nonresponse and further calibrated to the Wave I eligible sample. Some components of the weights were also be calibrated to key questionnaire variables. For Sample 2b standard weights, the Wave

I weight associated with each case in the responding sample were adjusted for nonresponse using Wave IV-like procedures. For the optimize weights, the standard weight was further re-calibrated to the full Wave I eligible sample as well as Samples 1, 2a and 3 using both demographic variables and questionnaire variables. To produce the weights for the four samples combined, the mixed mode and face to face mode weights were combined using an optimal mixing strategy. For each set of weights, adjustments were made appropriately to account for deaths, incarcerations and other losses of Wave I sample eligibility as described below.

In order to understand all of various stages of weighting, it is important to review the Phase 2 sample selection process. Thus, the next section describes how the Phase 2 Nonresponse Follow-up (NRFU) sample was selected for the mixed mode samples. Based upon these probabilities of selection, selection weights for the mixed mode samples as well as adjustment factors to optimally compensate for nonresponse will be specified. Section 7 will describe the weighting procedures for the face to face sample and Section 8 will describe the approach we will use to combine all four samples into a single Wave V sample and to produce the Wave V Grand Sample weight.

6 Weighting the Mixed Mode Samples

The computation of nonresponse weights for the Wave V mixed mode samples is quite different from the weighting that was done in previous waves of the Add Health because the NRFU phase (referred to as Phase 2) was implemented for these samples following the web/mail phase (Phase 1). Phase 2 used a dual-mode (in-person and, for Sample 1only, telephone) interview protocol. For this design, a random sample of the nonrespondents was followed up in person using CAPI interviewing after most of Phase 1 was completed. For Sample 1, the remaining sample of the nonresponding cases (i.e., those not selected for in-person NRFU) were contacted by telephone to conduct an abbreviated (approximately 5-15 minute) telephone NRFU interview on non-sensitive topics that could inform estimates of the nonresponse bias and update contact information. However, this telephone NRFU was not conducted for Samples 2a and 3. It is possible to incorporate the Sample 1 telephone NRFU cases in the weighting; however, given the small number of telephone NRFU cases (a total of 80), the use of an interview-assisted (rather than self-administered) mode for these cases, and the fact that only a few items were asked of these respondents, it is doubtful that such weighting would lead to improvements in estimation accuracy. For those reasons, we did not use the telephone NRFU cases in the weight calibration process; rather, these cases were treated as Phase 2 nonrespondents.

Although Phase 2 (NRFU) was conducted as two separate data collections – one for Sample 1 and another for Samples 2a and 3 –some aspects of the weighting process (primarily, the estimation of response propensity and calibration factors) treats these three subsamples as a single sample to achieve greater efficiencies in the weight adjustment process. Combining the Phase 2 samples across subsamples provides greater stability in the post-survey adjustment factors and should also lead to a more effective bias reduction.

6.2 Selecting the NRFU Subsample

For purposes of weighting, we define Phase 1 as all data collection operations that preceded the selection of the Phase 2 sample and Phase 2 as all data collection operations that followed Phase 2 sample selection. After the mixed mode samples completed Phase 1, cases that were not interviewed and were eligible for Phase 2 CAPI follow-up (using the eligibility criteria to be described below) were subjected to a sampling process for the CAPI Phase 2 NRFU data collection. After the Phase 2 sample was drawn, some Phase 1 nonrespondents subsequently completed the interview by the Phase 1 mixed mode protocol. In fact, we can distinguish among three types cases who were nonrespondents at the time the Phase 2 sample was selected but who eventually responded:

1. Cases selected for Phase 2 who were completed by in-person interview as per the design.
2. Cases selected for Phase 2 who were subsequently completed by the mixed mode process rather than in-person.
3. Cases that were not selected for Phase 2 but who subsequently completed an interview using the mixed mode process.

Cases under points 1 and 2 are treated as Phase 2 respondents in the weighting process. However, cases under point 3 will be treated as Phase 1 respondents because they were not selected for Phase 2. This will affect the Phase 2 weights because these respondents should not be represented by the weights assigned to Phase 2 respondents. Therefore, below we included an adjustment to account for these cases in the weighting process.

Let $S^{(V)}$ denote the eligible Wave V sample which, as described above, was split into four mutually exclusive and exhaustive random samples denoted by $S^{(1)}$, $S^{(2a)}$, $S^{(2b)}$ and $S^{(3)}$. This section provides the weighting specifications for $S^{(MM)} = S^{(1)} \cup S^{(2a)} \cup S^{(3)}$ which is the combination of the mixed mode samples. Further denote the union of Samples 2a and 3 as $S^{(2a+3)}$. Let $R_1^{(MM)}$ denote Phase 1 respondents in $S^{(MM)}$. As noted above, $R_1^{(MM)}$ includes sample members in $S^{(MM)}$ under category 3; i.e., the were nonrespondents who eventually became respondents but were not selected for Phase 2. Thus, let $N_1^{(MM)} = S^{(MM)} \setminus R_1^{(MM)}$ denote the sample members in $S^{(MM)}$ in the mixed mode samples who did not respond interview in Phase 1 excluding Phase 1 nonrespondents who responded in Phase 2 and were not part of the Phase 2 sample. Let $R_2^{(MM)}$ denote the Phase 2 respondents excluding those who responded without being selected for Phase 2 and let $R^{(MM)} = R_1^{(MM)} \cup R_2^{(MM)}$ denote all respondents in $S^{(MM)}$.

As will be discussed below, not all cases in $N_1^{(MM)}$ were available for NRFU even though they were eligible for Wave V and some cases were selected for NRFU with certainty. A fraction of the remaining cases were also selected for face to face NRFU. For Sample 1, most of the cases that were not selected for face to face NRFU were eligible for CATI NRFU which used an abbreviated questionnaire approach. These cases are treated as nonrespondents in the weighting process. For Samples 2a and 3, no CATI NRFU was conducted. Thus, substantial number of cases received no Phase 2 followup by either mode.

Since Sample 1 was field about one year prior to the other samples, that sample's Phase 2 cases were selected separately from the other two mixed mode samples (Samples 2a and 3). For Sample 1, about 2,450 nonrespondents were selected and for Samples 2a and 3, about 2,778 were selected. Thus, the combined Phase 2 (NRFU) sample consists of $n_2^{(MM)}$=2,450 + 2,778 = 5,228 units selected from $N_1^{(MM)}$.

These 5,228 cases as well as the cases sent to CATI NRFU cases were selected according to the following steps:

1. All low propensity cases that were released in the Phase 1 Pilot Sample were selected with certainty for CAPI NRFU.

2. Sample 1 cases that completed Module A and not Module B were selected with certainty for CAPI NRFU.

3. Cases that were excluded from NRFU include: 1) cases with no names, 2) deceased[1], 3) incarcerated/institutionalized, 4) with hostile refusals, 5) out of country, and 6) mentally/physically incapable.

4. The remaining Phase 1 nonrespondent cases were selected as follows:

    a. In Sample 1 only, two strata were formed based upon telephone number status; (1) cases having valid telephone numbers and (2) cases without one. For the CAPI NRFU sample, cases without address were also excluded. In Samples 2a and 3, no strata were formed because there was no CATI NRFU.

    b. The Phase 2 sample was then selected systematically with probability proportionate to a specific size measure (viz., the Wave I so-called grand sample weight[2]) as described below after sorting the cases. For Sample 1, cases were sorted by the two strata in (a) as well as the experimental treatment assignments (i.e. different questionnaire and incentive assignments) within stratum. For Samples 2a and 3, cases were only sorted by response propensity groups.

    c. For Sample 1, we selected two replicate samples with the second replicate (approximately 200 cases) held in reserve and to be released if needed to achieve the required number of CAPI NRFU cases. As it turned out, none of the reserve cases were released to Phase 2 data collection. In Samples 2a and 3, no reserve sample was selected.

    d. In Sample 1, all eligible cases with valid telephone numbers that were not selected for CAPI NRFU were sent to CATI NRFU. In Sample 2a and 3, these cases were retired from data collection.

---

[1] An unusual case was excluded from the NRFU. This sample member recently completed module A. A few weeks later, the sample member's mother called to tell us the sample member died. This case would normally be coded as "deceased" in the interview process. However, the fact that the sample member responded to module A suggests the person should be retained coded as a nonrespondent for Module B.

[2] There are a few cases with Wave I grand sample weight (variable GSWGT1) missing, because they were nonprobability sample and selected with certainty at Wave I. Their Wave I grand sample weights were assigned the value 1 in the selection process.

Let $\pi_{2i}^{(s)}$ denote the Phase 2 NRFU selection probability for sample s =1, 2a and 3. Let $n_{N1}^{(MM)}$ denote the number of cases in $N_1^{(MM)}$, let n_B denote the number of cases in $N_1^{(MM)}$ that were selected with certainty in steps 1 and 2 above. For these cases, $\pi_{2i}^{(s)}=1$, regardless of the value of s. Let n_C denote the number of cases in $N_1^{(MM)}$ that were excluded in step 3. For these cases, $\pi_{2i}^{(s)}=0$ regardless of the value of s. Let $N_1'^{(MM)}$ denote the set of remaining $n_{N1}'^{(MM)}=n_{N1}^{(MM)}-n_B-n_C$ cases in $N_1^{(MM)}$ that are eligible to be sampled for CAPI NRFU in step 4. In step 4, we selected a sample of $n_2^{(MM)}$ cases from $N_1'^{(MM)}$ as described below.

Let $N_1'^{(s)}=N_1'^{(MM)}\cap S^{(s)}$ for s = 1 or 2a+3; i.e., $N_1'^{(s)}$ are the cases in $N_1'^{(MM)}$ than belong to sample s. For Sample 1, we defined the Phase 2 CAPI NRFU selection probability as

$$\pi_{2i}^{(1)}=\frac{n_2'^{(1)}\omega_i}{\omega_+^{(1)}},\ \text{for all } i\in N_1'^{(1)} \tag{1}$$

where[3] $\omega_+^{(1)}=\sum_{i\in N_1'^{(MM)}}\omega_i$, i.e., the total of the grand weights for the cases in $N_1'^{(1)}$ and $n_2'^{(1)}$ is the sample size selected in Phase 2 for Sample 1, not including cases that were preselected with certainty. Using systematic pps sampling, we selected a sample of size $n_2'^{(1)}$ units from $N_1'^{(1)}$ with probabilities given by (1). Prior to sampling, a case for which $\pi_{2i}^{(1)}\geq 1$ was selected for Phase 2 with a probability of 1. This case was then removed $N_1'^{(1)}$ and $n_2'^{(1)}$ was reduced by 1. Equation (1) was then recomputed for all remaining cases in $N_1'^{(1)}$ and selection process began again with the new value of $n_2'^{(1)}$. The process was repeated until all remaining units in $N_1'^{(s)}$ satisfied the condition that $\pi_{2i}^{(1)}<1$ and the required number of sample cases were drawn. This resulted in the sample $S_2'^{(1)}$ with $n_2'^{(1)}$ units, at least some of which were selected with certainty. Let $S_2^{(1)}$ denote the entire Phase 2 sample consisting of $n_2^{(1)}=n_2'^{(1)}+n_B$ units, including units that were preselected with certainty.

This same approach was used to select the NRFU samples from $N_1^{(2a+3)}$; i.e., the set of nonrespondents in the sample $S^{(2a+3)}$. Again, certainty cases were removed as well as cases with 0 probabilities before probabilistic sampling was implemented. Denote this reduce set of nonrespondents by $N'^{(2a+3)}$. Thus, for sample $N'^{(2a+3)}$,

$$\pi_{2i}^{(2a+3)}=\frac{n_2'^{(2a+3)}\omega_i}{\omega_+^{(2a+3)}},\ \text{for all } i\in N_1^{(2a+3)} \tag{2}$$

[3] Note that this sum excludes Phase 2 completes that were not selected in Phase 2 because they are not part of the set $N_1'^{(1)}$.

where[4] $\omega_+^{(2a+3)} = \sum_{i \in N_1'^{(2a+3)}} \omega_i$ where $n_2'^{(2a+3)}$ excludes the preselected certainty units. The resulting sample size including preselected certainty units is denoted by $n_2^{(2a+3)}$. Thus, two NRFU samples were produced: $S_2^{(1)}$ and $S_2^{(2a+3)}$ with selection probabilities $\pi_{2i}^{(1)}$, $i = 1,\ldots, n_2^{(1)}$ and $\pi_{2i}^{(2a+3)}$, $i = 1, \ldots, n_2^{(2a+3)}$.

6.3 Weighting the Combined Respondent Sample in Both Phases 1 and 2

6.3.1 Estimators for Wave V Population Total

Given the complexity of the Wave V design for the mixed mode samples, there are several ways in which a combined mixed mode estimator can be constructed. However, based upon lessons learned from developing the Sample 1 preliminary weights, only one estimator will be considered in this work which is a composite estimator that seeks to minimize the MSE of the estimates

Denote the eligible AHSMs in Sample 2b as $S^{(2b)}$ and note that

$$\hat{Y}_1 = \sum_{i \in S^{(MM)}} \omega_i y_i + \sum_{i \in S^{(2b)}} \omega_i y_i \tag{3}$$

is the estimator of the eligible population total at Wave V assuming full response in both $S^{(MM)}$ and $S^{(2b)}$. The estimation of the second term on the right of (3) will be discussed in Section 7. For now, the focus is on estimating the first term on the right.

Let $R_2^{(s)}$ denote the members of $S_2^{(s)}$ that respond to the NRFU and let $n_{R2}^{(s)}$ denote its size, for s = 1, 2a+3 and let $R_2 = R_2^{(1)} \cup R_2^{(2a+3)}$; i.e., the set of all sample members who responded in Phase 2 . Similarly, let $R_1 = R_1^{(1)} \cup R_1^{(2a+3)}$ denote the Phase 1 respondents.

Let $\rho_{1i} = \Pr(i \in R_1)$ denote the Phase 1 response propensity, $\rho_{2i} = \Pr(i \in R_2 \mid i \notin R_1)$ denote the Phase 2 response propensity and $\pi_{2i} = \Pr(i \in S_2^{(MM)} \mid i \in N_1^{(MM)})$ denote the Phase 2 selection probability defined above where $S_2^{(MM)} \subseteq N_1^{(MM)}$ is the combined sample selected for Phase 2 NRFU.

The composite estimator will use the Phase 1 only estimator defined as $\tilde{Y}_1 = \sum_{i \in R_1} \tilde{w}_{1i} y_i$ where $\tilde{w}_{1i} = \hat{\rho}_{1i}^{-1} \omega_i$, where $\hat{\rho}_{1i}$ is an estimate of the response propensity for the *i*th case in R_1 which will be discussed subsequently. The other component is

[4] Note that this sum excludes Phase 2 completes that were not selected in Phase 2 because they are not part of the set $N_1'^{(2a+3)}$

$$\tilde{Y}_2 = \sum_{i \in R_1 \cup R_2} \tilde{w}_{2i} y_i \tag{4}$$

where $\tilde{w}_{2i}$ is defined as follows. Let

$$\begin{aligned} \pi_{2i} &= \pi_{2i}^{(1)} \text{ if } i \in R_2^{(1)} \\ &= \pi_{2i}^{(2a+3)} \text{ if } i \in R_2^{(2a+3)} \end{aligned} \tag{5}$$

Then define

$$\tilde{w}_{2i} = \begin{cases} \omega_i & \text{if } i \in R_1^{(MM)} \\ (\pi_{2i}\hat{\rho}_{2i})^{-1}\omega_i & \text{if } i \in R_2^{(MM)} \end{cases} \tag{6}$$

where $\hat{\rho}_{1i}$ is defined as before, $\hat{\rho}_{2i}$ is an estimator of the Phase 2 response propensity whose estimation will be described subsequently, $R_1^{(MM)} = R_1^{(1)} \cup R_1^{(2a+3)}$ and $R_2^{(MM)} = R_2^{(1)} \cup R_2^{(2a+3)}$.

It can be shown that any convex combination of these two estimators will provide a consistent estimator of the first term on the right in (3). Note that $\tilde{Y}_1$ only uses the data from Phase 1 while $\tilde{Y}_2$ uses data from both phases. In what follows, we will use both estimators to form a composite estimators of the form $\alpha_1\tilde{Y}_1 + (1-\alpha_1)\tilde{Y}_2$ for non-negative constants α_1 and α_2 whose sum does not exceed 1 and that, in some sense, minimize the variances of the estimates.

6.3.2 Estimating the Response Propensities

The primary goal of the NRFU weighting is to achieve the maximum reduction of nonresponse bias while minimizing, to the extent possible, the variation in the nonresponse adjustment weights. One key way of achieving this goal is the estimation of the two-phase response propensities. We used the WTADJUST procedure in SUDAAN® (2012) (a generalized exponential model [GEM] module, see Research Triangle Institute 2012) in this estimation process which is equivalent to logistic regression but allows for the estimated propensities to be constrained to limit weight variation.

The response propensities defined in the previous section will be estimated using the combined mixed mode sample. Let n_τ denote the cardinality of $R_\tau^{(MM)}$ where $\tau = 1,2$ denotes the data collection phase. We used (unweighted) models for estimating $\rho_{\tau i}$, the response propensity to Phase τ , of the form:

$$\hat{\rho}_{\tau i} = \frac{\exp\left(\mathbf{x}_{\tau i}\hat{\boldsymbol{\beta}}_\tau\right)/U_\tau}{1+\exp\left(\mathbf{x}_{\tau i}\hat{\boldsymbol{\beta}}_\tau\right)} \tag{7}$$

where $\tau = 1,2$ denotes the phase, $\mathbf{x}_{\tau i}$ is the *i*th row of the $n_\tau \times p_{\tau+}$ matrix $\mathbf{X}_\tau = [\mathbf{X}_{\tau 1} \mid \mathbf{X}_{\tau 2}]$, $\mathbf{X}_{\tau 1}$ is an $n_\tau \times p_{\tau 1}$ matrix of covariates that are mostly related to the response mechanism, $\mathbf{X}_{\tau 2}$ is an

$n_\tau \times p_{\tau 2}$ matrix of covariates that are mostly related to the key Add Health outcomes, $\boldsymbol{\beta}_\tau$ is a $p_{\tau+}$ dimensional column vector of coefficients to be estimated by GEM separately for each phase using explanatory variables, $\mathbf{X}_\tau$, and $p_{\tau+} = p_{\tau 1} + p_{\tau 2}$. The dependent variable for the propensity model for Phase 1 is r_{1i} which is 1 if the i^{th} unit in $S^{(MM)}$ responded at Phase 1. The dependent variable for the propensity model for Phase 2 is r_{2i} which defined only over the set $S^{(MM)}$ □ R_1 is 1 if the i^{th} unit in $S^{(MM)}$ □ R_1 responded in Phase 2 and is 0 otherwise. Further, let U_τ is the maximum size of the nonresponse adjustment factor (i.e. the maximum value of $1/\hat{\rho}_{\tau i}$).

Variables that were tested for inclusion in $\mathbf{X}_{\tau 1}$ and $\mathbf{X}_{\tau 2}$ include: age, gender, race and ethnicity, region, urbanicity, state, level of effort (LOE) to contact at Wave III and IV, incentive assignment and response propensity group at Wave V, and subsample indicator at Wave V (i.e. Sample 1, 2a, 2b or 3). Selection of the final response propensity models for the weights used a regression tree method similar to that used for propensity modeling in the designed experiments in Sample 1.

An equivalent approach to (7) for estimating form the response propensity can be written in the form of calibration estimators following RTI International (2016). For estimating ρ_{1i} , we solved the following equations for $\hat{\rho}_{1i}$:

$$\sum_{i \in R_1^{(MM)}} \hat{\rho}_{1i}^{-1} \dot{\mathbf{x}}_{1i} = \sum_{i \in S^{(MM)}} \dot{\mathbf{x}}_{1i} \qquad (8)$$

where $\dot{\mathbf{x}}_{\tau i}$ is the ith column of $\mathbf{X}'_\tau$ and the $\hat{\rho}_{1i}$ are selected to minimize $\sum_{i \in R_1^{(MM)}} |1 - \hat{\rho}_{1i}^{-1}|$. Similarly, for estimating ρ_{2i} , we solved the following equations for $\hat{\rho}_{2i}$:

$$\sum_{i \in R_2^{(MM)}} \hat{\rho}_{2i}^{-1} \dot{\mathbf{x}}_{2i} = \sum_{i \in S_2^{(MM)}} \dot{\mathbf{x}}_{2i} \qquad (9)$$

subject to the appropriate minimization constraints. These estimates of ρ_{1i} and ρ_{2i} will then be used to compute $\tilde{w}_{\tau i}$.

6.3.3 Population Calibration of the Estimators

The estimators $\tilde{Y}_v$ can be further improved by replacing the $\tilde{w}_{vi}$ weights with calibrated weights, w_{vi} , $v = 1,2$. Let $\mathbf{z}_i = (z_{i1}, z_{i2}, \ldots, z_{ip})$ denote a p dimensional row vector of auxiliary variables with known (or precisely and unbiasedly estimated) totals, $Z_k, k = 1,\ldots, p$, respectively. For example, z_{ik} maybe a binary indicator for the kth cell in the race×sex×age cross-classification table based upon Wave I classifications of race, sex and date of birth. Define

$$Z_k = \sum_{i \in \mathrm{W1{\sim}D1}} \omega_i z_{ik} \qquad (10)$$

where ω_i is the previously defined Wave I grand sample weight for the ith sample person and the sum is over all persons in Wave I (denoted by W1) after excluding all persons in Wave I who are deceased or otherwise ineligible at Wave V (denoted by D1)[5]. Thus, Z_k is the Wave I estimate of the current Wave I population total of z_{ik} for the entire eligible Wave V sample, $S^{(V)}$.

Using WTADJUST, we seek constants a_{2i} such that the following calibration equations hold

$$\sum_{i \in R_1^{(MM)} \cup R_2^{(MM)}} a_{2i} \tilde{w}_{2i} z_{ik} = Z_k \tag{11}$$

for $k = 1,\ldots, p$. Thus, the final weight from the stage of the adjustment process is $w_{2i} = a_{2i} \tilde{w}_{2i}$ and the estimator of the total, Y, can be written as $\hat{Y}_2 = \sum_{i \in R_1^{(MM)} \cup R_2^{(MM)}} w_{2i} y_i$

Note that with regard to bias, $\hat{Y}_2$ is preferred to $\tilde{Y}_1$, even if $\tilde{Y}_1$ were calibrated to the z-variables, because the former estimator incorporates data from Phase 2 to adjust for nonresponse bias. However, the weighting associated with the second phase sample suggests that this estimator may have less desirable variance properties than $\tilde{Y}_1$. We can form a composite estimator using $\tilde{Y}_1$ and $\hat{Y}_2$ that has both desirable bias and variance properties in that it will have bias on par with $\hat{Y}_2$ and variance on par with $\hat{Y}_1$. Before this composite estimator can be formed, post-stratification calibration was performed on $\tilde{Y}_1$ so that it is equal to $\hat{Y}_2$ for specific variables from the Add Health-Wave V questionnaire.

Let $\boldsymbol{\xi}_i = (\xi_{1i}, \xi_{2i}, \ldots, \xi_{qi})'$ denote a vector of all the variables in $\mathbf{z}_i$ (i.e. race×sex×age) plus some Wave V questionnaire variables whose totals are to be controlled in the subsequent post-stratification calibration process. CPC provided the list of these Wave V questionnaire variables as shown in Appendix A. For the jth variable, let $\hat{\Xi}_{vj}$, $j = 1,...,q$, denote the weighted totals for $\boldsymbol{\xi}_i$ over all respondents ($i \in R_1^{(MM)} \cup R_2^{(MM)}$) using weights $w_{2i} = a_{2i} \tilde{w}_{2i}$ in (11).

Using WTADJUST, we determined constants the $a_{1|2i}$ that simultaneously satisfy the following constraints for $k = 1,\ldots,p$ and $j = 1, \ldots, q$:

$$\hat{Y}_{1|2} = \sum_{i \in R_1^{(MM)}} a_{1|2i} \tilde{w}_{1i} \xi_{ji} = \hat{\Xi}_{2j} \tag{12}$$

Note that each category of a discrete variable in Appendix A represents a constraint in the calibration equation in (12). If there are too many constraints, there is a risk that the calibration routine will not converge and solutions for $a_{1|2i}$ cannot be computed. To reduce this risk, variables having many categories were recoded by collapsing the smallest categories into larger adjacent

---

[5] The set D1 does not include some proportion of persons whose are deceased but whose date of death are unknown. This adjustment will be made to the final weights in Section 8.

categories. However, to retain the maximum amount of information for calibration, this recoding process was used quite sparingly. In the end, all calibrations converged and the constraints were satisfied.

Denoting these new weights by $w_{1|2i} = a_{1|2i}\tilde{w}_{1i}$ we form a composite estimator of Y as follows:

$$\begin{aligned}\hat{Y}_{\text{opt}}^{(MM)} &= \alpha_{1|2}\hat{Y}_{1|2} + (1-\alpha_{1|2})\hat{Y}_2 \\ &= \sum_{i\in R_1^{(MM)}} w_{1i}^{(MM)} y_i + \sum_{i\in R_2^{(MM)}} w_{2i}^{(MM)} y_i\end{aligned} \tag{13}$$

where

$$\begin{aligned}w_{1i}^{(MM)} &= \alpha_{1|2} w_{2|1i} + (1-\alpha_{1|2}) w_{2i} \\ w_{2i}^{(MM)} &= w_{2i}\end{aligned}$$

$$\alpha_{1|2} = \frac{UWE(w_2)}{UWE(w_{2|1}) + UWE(w_2)} \tag{14}$$

where $UWE(w_2)$ the unequal weighting effect defined as $UWE(w_2) = (1 + cv_{w2}^2)$ where cv_{w2} is the coefficient of variation of the weights, w_2 over the sample $R_1^{(MM)}$ and $UWE(w_{2|1})$ is defined analogously with where $cv_{w2|1}$ the coefficient of variation of the weights, $w_{2|1}$ for the sample $R_1^{(MM)}$ (see Singh, et al, 2003, eq. 3.2a for the formula upon with this equation is based).

7. Optimized Control Sample Weights

Weighting the control sample, Sample 2b, which was conducted by the in-person mode, is more straightforward than the mixed mode sample because it only consists of one phase of data collection. Still, it is more complex than the weighting used in prior Add Health waves because it will be used not only as an integrated component of the overall sample, but also as a standalone sample to facilitate the mode analysis. For the former purpose, the weights will be optimized to maximally reduce weight variation and nonresponse bias. For the latter purpose, the weighting approaches used for prior waves will be used. We first will discuss the optimal weighting approach.

The Sample 2b estimator is designed to estimate the second term on the right in (3) (i.e., $\sum_{i\in S^{(2b)}} \omega_i y_i$) can be written as

$$\hat{Y}_{2b} = \sum_{i\in R^{(2b)}} w_i^{(2b)} y_i \tag{15}$$

where $R^{(2b)}$ is set of respondents in $S^{(2b)}$ and $w_i^{(2b)} = b_{1i}\hat{\rho}_i^{-1}\omega_i$ is the final weight for the sample. This weight is the product of the Wave I grand weight, the inverse of the estimated response propensity for Sample 2b, $\hat{\rho}_i$, and a calibration factor, b_{1i}, that will be used to further reduce the risk of nonresponse and differential mode bias.

The response propensity will be estimated in much the same way as $\hat{\rho}_{1i}$ was estimated in for the mixed mode samples. Likewise, the calibration factor b_{1i} will be estimated in much the same way the factor $a_{1|2i}$ in equation (12) which incorporated demographic variables and questionnaire variables in the calibration equations. For example, to compute b_{1i}, weighted totals for a subset of questionnaire variables will be formed from the composite weight derived the mixed mode samples. Then sample 2b will be calibrated to these totals as in equation (12), except replacing R_1 by $R^{(2b)}$ in the equation. Because of the small sample size of Sample 2b, some survey questionnaire variables are further eliminated in equation (12) to make the calibration model more parsimonious and enable the calibration procedure to converge.

8. Computing the Final Weight for the Combined Mixed Mode and Face to Face Samples

Note that, up to this stage of the weighting process, both the mixed mode estimator, $\hat{Y}_{\text{opt}}^{(MM)}$, and Sample 2b estimator, $\hat{Y}_{2b}$, are calibrated to the Wave V total, $T_V = \sum_{i \in \text{W1\sim D1}} \omega_i$. However, one further adjustment is needed in order to properly account for deceased persons who date of death is unknown. Note that Add Health sample members who died on or prior to March 3, 2016 (the date Wave V was fielded) are not eligible for Wave V while persons who died after this date are still eligible. The total weight associated with eligible deceased persons should be included in T_V while ineligible deceased persons should not be included in T_V.

Let d denote the weighted proportion of deceased persons having a known date of death whose date of death is after the cut-off date for eligibility; i.e., March 3, 2016, and whose weight should be included in T_V. Let D_U denote the set of all deceased persons having unknown date of death. Then $A_D = d \sum_{i \in D_U} \omega_i$ is the total weight attributed to deceased persons with unknown date of death who whose weight should be included in T_V. Let $F_D = \dfrac{T_V + A_D}{T_V}$ be the adjustment factor that should be applied to the final weight to account for unknown date of death persons not included in T_V.

The final sample weight for the combined sample (i.e., Samples 1, 2a, 2b and 3) will be formed as a convex combination of the two sets of weights as follows. Let $R^{(MM)} = R_1^{(MM)} \cup R_2^{(MM)}$ denote the set of respondents in the mixed mode samples (i.e. Samples 1, 2a and 3) and recall that $R^{(2b)}$ is the set of respondents in Sample 2b. Write $\hat{Y}_{\text{opt}}^{(MM)}$ as

$$\hat{Y}_{\text{opt}}^{(MM)} = \sum_{i \in R^{(MM)}} w_i^{(MM)} y_i \tag{16}$$

where $w_i^{(MM)} = w_{1i}^{(MM)}$ for $i \in R_1^{(MM)}$ and $w_i^{(MM)} = w_{2i}^{(MM)}$ for $i \in R_2^{(MM)}$. Define w_{FINALi} as

$$w_{FINALi} = \begin{cases} \lambda F_D w_i^{(MM)} & \text{if } i \in R^{(MM)} \\ (1-\lambda) F_D w_i^{(2b)} & \text{if } i \in R^{(2b)} \end{cases}$$

where $\lambda = \frac{n_{eff}^{(MM)}}{n_{eff}^{(MM)} + n_{eff}^{(2b)}}$, $n_{eff}^{(MM)}$ is the effective sample size for the mixed mode samples given by $n_{eff}^{(MM)} = n^{(MM)} / UWE(w_i^{(MM)})$, where $n^{(MM)}$ is cardinality of $R^{(MM)}$; $n_{eff}^{(2b)} = n^{(2b)} / UWE(w^{(2b)})$ is the effective sample size for the Sample 2b , $n^{(2b)}$ is the cardinality of $R^{(2b)}$. As described in the previous section, the calibration procedure for Sample 2b eliminates some calibration variables in equation (12) to make the model converge. To make the weight totals based on w_{FINALi} meet with all the control totals defined in equation (12), w_{FINALi} is further calibrated to all the calibration variables included in equation (12).

9. Traditional Control Sample Weights

One analysis that will be conducted to evaluate possible mode effects between mixed and face to face modes, is to compare the mixed mode sample estimates with the face to face mode. For this analysis, the goal is to evaluate the effect of mode on comparisons of Wave V with Wave IV and early waves. For this purpose, the mode analysis will use a weight for Sample 2b that similar in design to the weights used in Wave IV and earlier waves. The earlier waves only used a nonresponse propensity adjustment without calibration adjustments. Nonresponse adjustments were calculated separately for each school using the Wave I grand sample weights.

The nonresponse-adjusted cross-sectional weights were poststratified to estimates of the grade-sex-race subpopulations derived from the Wave I grand sample weights, after adjusting for the deceased at Wave IV. The estimates were calculated by summing the Wave I grand sample weights for all the sample members of each grade-sex-race domain that were alive at Wave IV.

The nonresponse adjustment for the traditional weight will be calculated similarly to Wave IV. This simply involved adjusting the Wave I grand sample weights for additional Wave V, Sample 2b nonresponse. Thus, define the weight

$$w_i^{(TRAD)} = b_i \hat{\rho}_i^{-1} \omega_i \tag{17}$$

where $\hat{\rho}_i$ is now estimated similar to the Wave IV adjustment and b_i is a post-stratification adjustment factor based upon grade-sex-race cross-classifications. According to Chen and Suchindran (2010), grade variable ranges from Grade 7 to Grade 12 and race is a binary variable, indicating Black and Non-Black. Weight $w_i^{(TRAD)}$ will be referred to as the traditional weight while $w_i^{(2b)}$ will be referred to as the optimal weight for Sample 2b respondents.

Prior to Wave V, nonresponse adjustments were calculated separately for each school using the Wave I grand sample weights. Only respondents having a positive Wave I grand sample weight (*i.e.*, were Wave I respondents) are assigned cross-sectional weights. Weights are set to zero (for nonrespondents) or missing (for ineligible cases), otherwise. The nonresponse-adjusted cross-sectional weights were then poststratified to estimates of the grade-sex-race subpopulations derived from the Wave I grand sample weights, after adjusting for the deceased at the most recent. Thus, these estimates reflect the portion of the 1995 population (represented by the Wave I sample) that would have been eligible at the current. The estimates are calculated by summing the Wave I grand sample weights for all the sample members of each grade-sex-race domain that were alive at Wave V.

Applying this approach to Sample 2b is problematic because the size of Sample 2b is only about 10% of the full Wave V sample and nonresponse adjustments at the school level would be based upon very small sizes. To stabilize the nonresponse adjustment, we will first collapse schools with less than 4 cases into one school class and treat each individual school with 4 or more cases as one school class. We will then calculate the unweighted response rate within each school class as the preliminary response propensity estimate, $\hat{\rho}_i^{\mathrm{P}}$ for all $i \in S^{(2b)}$. The derived response propensity estimates will then be sorted by magnitude and partitioned into ten, approximately equal, response propensity classes, $C = 1,\ldots, 10$. Let $\overline{r}_C$ denote the unweighted response rate for the units in class C and set $\hat{\rho}_i = \overline{r}_C$ in (17) for all $i \in C$.

The post-stratification adjustment factors will be computed in a similar manner. Form the cross-classification table for grade, sex and race for the eligible Wave V population (including Samples 1, 2a, 2b and 3) and let d denote the dth cell in this table. Likewise, classify the respondents in Sample 2b (i.e., $R^{(2b)}$) according to this same cross-classification. Let $S_d^{(V)}$ denote the set of eligible, Wave V ADSMs in the d^{th} cell and let $R_d^{(2b)}$ denote the corresponding Sample 2b respondents in this cell. Let $G_d = \sum_{i \in S_d^{(V)}} \omega_i$, $g_d = \sum_{i \in R_d^{(2b)}} \hat{\rho}_i \omega_i$, and $H_d = G_d / g_d$. This step produces $w_i^{(TRAD)}$ in (17).

References

Biemer, P. and Liao, D. (2017). "Add Health-Wave V: Sample 1 Design and Weighting," internal memorandum dated 8-14-2017.

Ping Chen and Chirayath M. Suchindran. 2010. "*National Longitudinal Study of Adolescent Health: Wave I, III, & IV Longitudinal Weight*." Carolina Population Center, UNC-Chapel Hill.

Research Triangle Institute (2012). *SUDAAN Language Manual*, Volumes 1 and 2, Release 11. Research Triangle Park, NC: Research Triangle Institute.

Singh, A. C., Iannacchione, V.G. and Dever, J.A. (2003). *Efficient Estimation for Surveys with Nonresponse Follow-Up Using Dual-Frame Calibration*. Proceedings of the American Statistical Association, Survey Research Methods Section, 3919-3930.

Appendix A. List of Wave V Questionnaire Variables Whose Totals are Controlled in the Poststratification Calibration Process

Module	Teleform Section Name	Web Variable Name	Web Question
A	Background	BACK4	A person's appearance, style, or dress may affect the way people think of them. On average, how do you think people would describe your appearance, style, or dress?
A	Household	HH11	Are you currently: married, widowed, divorced, separated, never married
A	Employment	CEMP19	Are you currently working for pay?
A	Employment	CEMP20	On how many jobs are you currently working for pay?
A	Employment	CEMP16_pre	Have you ever served in the military?
A	Income	INC54	Suppose you and others in your household were to sell all of your major possessions (including your home), turn all of your investments and other assets into cash, and pay off all of your debts. Would you have something left over, break even, or be in debt?
A	Income	INC60	Think of this ladder as representing where people stand in the United States. At the top of the ladder (step 10) are the people who have the most money and education, and the most respected jobs. At the bottom of the ladder (step 1) are the people who have the least money and education, and the least respected jobs or no job. Where would you place yourself on this ladder? *Pick the number for the step that shows where you think you stand at this time in your life, relative to other people in the United States.*
A	Healthcare	HEA63	What is your current weight in pounds?
A	Healthcare	HEA66g	Has a doctor, nurse, or other health care provider ever told you that you have or had … Depression?
A	Sexual Experiences and Pregnancy	SEX96	How old were you the first time you ever had vaginal intercourse?
A	Sexual Experiences and Pregnancy	SEX110	Please choose the description that best fits how you think about yourself. (heterosexual, homosexual, bisexual)
A	Sexual Experiences and Pregnancy	PREG117	How many of those children are still living?

Module	Teleform Section Name	Web Variable Name	Web Question
A	Tobacco, Alcohol, and Substances	SUBS130_pre	Have you ever smoked or used tobacco?
A	Tobacco, Alcohol, and Substances	SUBS137	During the past 30 days, on how many days did you drink alcohol (beer, wine, or liquor)?
A	Tobacco, Alcohol, and Substances	SUBS146	During the past 30 days, on how many days did you use marijuana?
A	Tobacco, Alcohol, and Substances	SUBS151d	Pain killers or opioids, such as Vicodin, OxyContin, Percocet, Demerol, Percodan, or Tylenol with codeine
B	Personality	PERS6	I like to take risks.
B	Personality	PERS6a	I finish whatever I begin.
B	Criminal Justice	JUST75	Have you ever served time in a jail, prison, juvenile detention center or other correctional facility?
B	Illness and Physical Limitations	SOC92	In the past 12 months, about how many hours did you spend on volunteer or community service work?
B	Illness and Physical Limitations	SOC93	How often do you usually vote in local or statewide elections?