california
health
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CHIS 2019-2020 Methodology Report Series

Report 5

Weighting and Variance Estimation

September 2021

UCLA CENTER FOR
HEALTH POLICY RESEARCH

CALIFORNIA HEALTH INTERVIEW SURVEY

CHIS 2019-2020 METHODOLOGY SERIES

REPORT 5

**WEIGHTING AND VARIANCE
ESTIMATION**

SEPTEMBER 2021

www.chis.ucla.edu

This report describes the weighting and variance estimation methods used in CHIS 2019-2020. This report presents the steps used to create the analytical weights for analyzing the data from the adult, child, and adolescent interviews.

Suggested citation:

California Health Interview Survey. *CHIS 2019-2020 Methodology Series: Report 5 - Weighting and Variance Estimation*. Los Angeles, CA: UCLA Center for Health Policy Research, 2021.

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PREFACE

Weighting and Variance Estimation is the fifth and final in a series of methodological reports describing the 2019-2020 California Health Interview Survey (CHIS 2019-2020). The other reports are listed below.

CHIS is a collaborative project of the University of California, Los Angeles (UCLA) Center for Health Policy Research with multiple funding sources from public, private, and non-profit organizations. SSRS was responsible for data collection and the preparation of five methodological reports from the 2019-2020 survey. The survey examines public health and health care access issues in California. The survey is the largest state health survey ever undertaken in the United States.

Methodological Report Series for CHIS 2019-2020

The methodological reports for CHIS 2019-2020 are as follows:

- Report 1: Sample Design;
- Report 2: Data Collection Methods;
- Report 3: Data Processing Procedures;
- Report 4: Response Rates; and
- Report 5: Weighting and Variance Estimation.

The reports are interrelated and contain many references to each other. For ease of presentation, the references are simply labeled by the report numbers given above. After the Preface, each report includes an "Overview" (Chapter 1) that is nearly identical across reports, followed by detailed technical documentation on the specific topic of the report.

Report 5: Weighting and Variance Estimation (this report) describes the weighting and variance estimation methods from CHIS 2019-2020. The purpose of weighting the survey data is to permit analysts to produce estimates of the health characteristics for the entire California population and subgroups including counties, and in some cases, cities. This report presents the steps used to create the analytical weights for analyzing the data from the adult, child, and adolescent interviews.

For further methodological details not covered in this report, refer to the other methodological reports in the series at http://healthpolicy.ucla.edu/chis/design/Pages/methodology.aspx. General information on CHIS data can be found on the California Health Interview Survey Web site at http://www.chis.ucla.edu or by contacting CHIS at CHIS@ucla.edu.

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1. CHIS 2019-2020 SAMPLE DESIGN AND METHODOLOGY SUMMARY

1.1 Overview

A series of five methodology reports are available with more detail about the methods used in CHIS 2019-2020.

- Report 1 – Sample Design;
- Report 2 – Data Collection Methods;
- Report 3 – Data Processing Procedures;
- Report 4 – Response Rates; and
- Report 5 – Weighting and Variance Estimation.

For further information on CHIS data and the methods used in the survey, visit the California Health Interview Survey Web site at http://www.chis.ucla.edu or contact CHIS at CHIS@ucla.edu. For methodology reports from previous CHIS cycles, go to http://www.chis.ucla.edu/chis/design/Pages/methodology.aspx

The CHIS is a population-based multimode (web and telephone) survey of California's residential, noninstitutionalized population conducted every other year since 2001 and continually beginning in 2011. CHIS is the nation's largest state-level health survey and one of the largest health surveys in the nation. The UCLA Center for Health Policy Research (UCLA-CHPR) conducts CHIS in collaboration with multiple funding sources from public, private, and non-profit organizations. CHIS collects extensive information for all age groups on health status, health conditions, health-related behaviors, health insurance coverage, access to health care services, and other health and health-related issues.

The sample is designed and optimized to meet two objectives:

1) Provide estimates for large- and medium-sized counties in the state, and for groups of the smallest counties (based on population size), and

2) Provide statewide estimates for California's overall population, its major racial and ethnic groups, as well as several racial and ethnic subgroups.

The CHIS sample is representative of California's non-institutionalized population living in households. CHIS data and results are used extensively by federal and State agencies, local public health agencies and organizations, advocacy and community organizations, other local agencies, hospitals, community clinics, health plans, foundations, and researchers. These data are used for analyses and

publications to assess public health and health care needs, to develop and advocate policies to meet those needs, and to plan and budget health care coverage and services. Many researchers throughout California and the nation use CHIS data files to further their understanding of a wide range of health related issues (visit UCLA-CHPR's publication page at http://healthpolicy.ucla.edu/publications/Pages/default.aspx for examples of CHIS studies).

1.2 Switch in Sampling and Data Collection Methodology

Starting in 2019-2020, the CHIS transitioned from a dual-frame landline/cellphone random digit dial (RDD) methodology to an address-based sample (ABS) methodology with multimode data collection that takes place on the web or by telephone. The CHIS research team deemed this change necessary due to decreasing response to telephone surveys, the improved geographical precision available for stratification when using the US Postal Service Delivery Sequence file of addresses as a sampling frame, and the lower cost of a study where the majority of interviews are completed online.

Prior to launching data collection in 2019, CHIS conducted two experiments in 2018 to test the effectiveness of an ABS mail push-to-web design with a telephone nonresponse follow-up. The first experiment was limited to three counties (Los Angeles, Santa Clara, and Tulare) to achieve a preliminary assessment of the efficacy of the proposed design (see Wells et al., 2018). Following the initial positive results from that test, a statewide pilot test was conducted in the late 2018 implementing a number of additional experiments and improvements based on the previous lessons learned (see Wells et al., 2019). Given that these additional improvements resulted in higher response and reductions in cost compared to maintaining the 2017-2018 design, CHIS committed to transitioning to the new design for the 2019-2020 cycle.

For CHIS 2019-2020, respondents are invited to either complete the survey online or call in to be interviewed by a member of the SSRS interviewing staff. Respondents receive an initial invitation letter with a $2.00 pre-incentive. This is followed by a reminder postcard and, in 2019, a final certified mail letter for all nonresponders[1]. In 2020, the certified mail letter was replaced with a standard letter and final postcard. Where addresses can be matched to a listed telephone number, the nonresponding households are also called six times to attempt to complete an interview before the sampled household is considered to be a resolved nonresponse.

See more about what's new in the 2019-2020 CHIS sampling and data collection here:

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[1] For the last 2019 mailing, the certified letter was replaced with a standard letter.

In order to provide CHIS data users with more complete and up-to-date information to facilitate analyses of CHIS data, additional information on how to use the CHIS sampling weights, including sample statistical code, is available at http://www.chis.ucla.edu/chis/analyze/Pages/sample-code.aspx.

Additional documentation on constructing the CHIS sampling weights is available in the *CHIS 2019-2020 Methodology Series: Report 5—Weighting and Variance Estimation* posted at http://www.chis.ucla.edu/chis/design/Pages/methodology.aspx. Other helpful information for understanding the CHIS sample design and data collection processing can be found in the four other methodology reports for each CHIS cycle and year.

1.3 Sample Design Objectives

The CHIS 2019-2020 sample was designed to meet the two sampling objectives discussed above: (1) provide estimates for adults in most counties and in groups of counties with small populations; and (2) provide estimates for California's overall population, major racial and ethnic groups, and for several smaller racial and ethnic subgroups.

To achieve these objectives, CHIS employed an address-based sample design. For the ABS sample, the 58 counties in the state were grouped into 44 geographic sampling strata, and 14 sub-strata were created within the two most populous counties in the state (Los Angeles and San Diego). The same geographic stratification of the state has been used since CHIS 2005. The Los Angeles County stratum included eight sub-strata for Service Planning Areas, and the San Diego County stratum included six sub-strata for Health Service Districts. Most of the strata (39 of 44) consisted of a single county with no sub-strata (see counties 3-41 in Table 1-1). Three multi-county strata comprised the 17 remaining counties (see counties 42-44 in Table 1-1). A sufficient number of adult interviews were allocated to each stratum and sub-stratum to support the first sample design objective for the two-year cycle—to provide health estimates for adults at the local level.

In addition, for CHIS 2019-2020, statistical modeling was used to determine the likelihood that specific targeted groups of interest for oversampling resided at addresses in the sample, and a hierarchy was established to determine the degree of over or undersampling among these strata. CHIS 2017-2018 data were used to build the models. All available auxiliary data from voter registration databases, consumer databases, Marketing Systems Group database information (specifically, all ranges of surnames), and Census Planning Database data were appended to the CHIS 2017-2018 data. All these

appended data served as the independent variables (features) in random forest models, while self-reported attributes (demographics, etc.) served as the dependent variables.

Models for CHIS 2019-2020 were specifically designed to predict the following household attributes:

1. Korean
2. Vietnamese
3. Other Asian
4. Hispanic or Spanish-Speaker
5. Low Educational Attainment or not a US Citizen
6. Have children (under 19)

Since these six models are run independently, households can be predicted to include more than one of the six target groups. For this reason, models were applied to the sample hierarchically with preference to the higher listed model (for example, a household predicted to be Korean was scored as Korean no matter what else they might have been predicted to be).

Utilizing these models results in two additional sample groups, or strata: 1) sample records for which none of the models predicted any attribute ("Residual" sample) and 2) sample for which no auxiliary data were found ("No Match" sample). The final step in utilizing the models was to develop relative sampling fractions by which households were selected within the modeled strata.

Within each geographic and modeled stratum combination, residential addresses were selected, and within each household, one adult (age 18 and over) respondent was randomly selected. In those households with adolescents (ages 12-17) and/or children (under age 12), one adolescent and one child of the randomly selected parent/guardian were randomly selected. The adolescent was interviewed directly via CATI or Web. Most frequently the child interview was completed by the randomly selected respondent who was the parent or guardian. Less frequently and only within the CATI program, an adult sufficiently knowledgeable about the child's health could complete the child interview.

Table 1-1. California county and county group strata used in the CHIS 2019-2020 sample design

1. Los Angeles	7. Alameda	27. Shasta
1.1 Antelope Valley	8. Sacramento	28. Yolo
1.2 San Fernando Valley	9. Contra Costa	29. El Dorado
1.3 San Gabriel Valley	10. Fresno	30. Imperial
1.4 Metro	11. San Francisco	31. Napa
1.5 West	12. Ventura	32. Kings
1.6 South	13. San Mateo	33. Madera
1.7 East	14. Kern	34. Monterey
1.8 South Bay	15. San Joaquin	35. Humboldt
2. San Diego	16. Sonoma	36. Nevada
2.1 N. Coastal	17. Stanislaus	37. Mendocino
2.2 N. Central	18. Santa Barbara	38. Sutter
2.3 Central	19. Solano	39. Yuba
2.4 South	20. Tulare	40. Lake
2.5 East	21. Santa Cruz	41. San Benito
2.6 N. Inland	22. Marin	42. Colusa, Glenn, Tehama
3. Orange	23. San Luis Obispo	43. Del Norte, Lassen, Modoc,
4. Santa Clara	24. Placer	Plumas, Sierra, Siskiyou, Trinity
5. San Bernardino	25. Merced	44. Amador, Alpine, Calaveras, Inyo,
6. Riverside	26. Butte	Mariposa, Mono, Tuolumne

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

The CHIS two-year ABS sample is of sufficient size to accomplish the second objective as well, to produce statistically stable estimates for small population groups such as racial/ethnic subgroups, children, adolescents, etc.

1.4 Data Collection

To capture the rich diversity of the California population, interviews were conducted in six languages: English, Spanish, Chinese (Mandarin and Cantonese dialect), Vietnamese, Korean, and Tagalog. Tagalog was administered by phone only. These languages were chosen based on analysis of 2010 Census data to identify the languages that would cover the largest number of Californians in the CHIS sample that either did not speak English or did not speak English well enough to otherwise participate.

SSRS collaborated with UCLA on the methodology and collected data for CHIS 2019-2020, under contract with the UCLA Center for Health Policy Research. SSRS is an independent research firm that specializes in innovative methodologies, optimized sample designs, and reaching low-incidence populations. For all sampled households, one randomly selected adult in each sampled household either completed an on-line survey or was interviewed by telephone by an SSRS interviewer. In addition, the study sampled one adolescent and one child if they were present in the household and the sampled adult was their parent or legal guardian. Thus, up to three interviews could have been completed in each household. The child interview was moved in 2019-2020 to take place immediately after Section A of the adult survey and the rostering of the household. The adolescent survey took place either immediately after the adult with phone interviews or in a separate session online.

If the screener respondent was someone other than the sampled adult, children and adolescents could be sampled as part of the screening interview, and the extended child (and adolescent) interviews could be completed before the adult interview if the interview was completed by phone. This "child-first" procedure was first used in CHIS 2005 and has been continued in subsequent CHIS cycles because it substantially increases the yield of child interviews. Table 1-2 shows the number of completed adult, child, and adolescent interviews in CHIS 2019-2020 by mode of interview. Note that these figures were accurate as of data collection completion for 2019-2020 and may differ slightly from numbers in the data files due to data cleaning and edits. Sample sizes to compare against data files you are using are found online at http://www.chis.ucla.edu/chis/design/Pages/sample.aspx.

Table 1-2. Number of completed CHIS 2019-2020 interviews by mode of interview and instrument

Type of sample[1]	Adult	Child	Adolescent
Total ABS	44,109[1]	6,557	2,212
Completes by Web	40,072	6,295	2,000
Completes by phone	4,037	262	212

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Includes interviews meeting the criteria as partially complete.

Interviews in all languages were administered using SSRS's computer-assisted web interviewing and computer-assisted telephone interviewing (CAWI/CATI) system. As expected, the CATI interviews were longer in duration. The duration of the CATI interviews averaged almost 48 minutes, 26 minutes, and 23minutes for the adult, child, and adolescent interviews, respectively; the duration of the CAWI interviews averaged around 35 minutes, 13 minutes, and 17 minutes for the adult, child, and adolescent interviews, respectively. Interviews in non-English languages typically took longer to complete across

both modes: the non-English CATI interviews had an average length of about 64 minutes, 31 minutes, and 29 minutes for the adult, child, and adolescent interviews respectively; the non-English CAWI interviews had an average length of about 47 minutes, 18 minutes, and 20 minutes for the adult, child, and adolescent interviews, respectively. Just over four and half percent of the adult interviews were completed in a language other than English, as were about nine percent of all child (parent proxy) interviews and one percent of all adolescent interviews.

Table 1-3 shows the major topic areas for each of the three survey instruments (adult, child, and adolescent). If questions were asked in only one year of survey implementation, the specific year is indicated in the table.

Table 1-3. CHIS 2019-2020 survey topic areas by instrument

Health status	Adult	Adolescent	Child
General health status	✓	✓	✓
Days missed from work or school due to health problems	✓	✓	✓

Health conditions	Adult	Adolescent	Child
Asthma	✓	✓	✓
Diabetes, pre-diabetes/borderline diabetes	✓		
Heart disease, high blood pressure	✓		
Physical disability	✓		
Physical, behavioral, and/or mental conditions			✓
Developmental assessment, referral to a specialist by a doctor			✓

Covid-19	Adult	Adolescent	Child
Covid testing history and effects of pandemic	✓		

Mental health	Adult	Adolescent	Child
Mental health status	✓	✓	
Perceived need, access and utilization of mental health services	✓	✓	
Functional impairment, stigma, three-item loneliness scale	✓		
Suicide ideation and attempts	✓	✓	
Mental health and technology	✓	✓	

Health behaviors	Adult	Adolescent	Child
Dietary and nutritional intake, breastfeeding (younger than 3 years)	✓	✓	✓
Physical activity and exercise, sedentary time		✓	✓
Commute from school to home		✓	✓
Alcohol use/abuse		✓	
Cigarette and E-cigarette use	✓	✓	
Marijuana use	✓	✓	
Opioid use	✓		
Chewing tobacco, tobacco flavors	✓		
Exposure to second-hand smoke	✓		
Sexual behaviors	✓	✓	
HIV testing, HIV prevention medication (PrEP/Truvada)	✓	✓	
Contraceptive use, birth control	✓	✓	

Sexual violence	Adult	Adolescent	Child
Past unwanted sexual encounter	✓		

(continued)

Table 1-3. CHIS 2019-2020 survey topic areas by instrument (continued)

Women's health	Adult	Adolescent	Child
Pregnancy status/plans and birth control	✓	✓	

Dental health	Adult	Adolescent	Child
Last dental visit, main reason haven't visited dentist	✓	✓	✓
Delays in getting care			✓
Current dental insurance coverage	✓		✓
Condition of teeth	✓	✓	

Neighborhood and housing	Adult	Adolescent	Child
Safety, social cohesion	✓	✓	✓
Homeownership	✓		
Park use, park and neighborhood safety		✓	✓
Civic engagement, community involvement	✓	✓	

Access to and use of health care	Adult	Adolescent	Child
Usual source of care, visits to medical doctor	✓	✓	✓
Emergency room visits	✓	✓	✓
Delays in getting care (prescriptions and medical care)	✓	✓	✓
Communication problems with doctor	✓		✓
Timely appointment	✓	✓	✓
Access to specialist and general doctors	✓		
Tele-medical care	✓		
Care coordination	✓	✓	✓

Voter engagement	Adult	Adolescent	Child
Voter engagement	✓		

Food environment	Adult	Adolescent	Child
Access to-affordable foods	✓		
Availability of food in household over past 12 months	✓		
Hunger	✓		

Health insurance	Adult	Adolescent	Child
Current insurance coverage, spouse's coverage, who pays for coverage	✓	✓	✓
Health plan enrollment, characteristics and assessment of plan	✓	✓	✓
Whether employer offers coverage, respondent/spouse eligibility	✓		
Coverage over past 12 months, reasons for lack of insurance	✓	✓	✓
High deductible health plans	✓	✓	✓
Medical debt, hospitalizations	✓		

(continued)

Table 1-3. CHIS 2019-2020 survey topic areas by instrument (continued)

Public program eligibility	Adult	Adolescent	Child
Program participation (CalWORKs, Food Stamps, SSI, SSDI, WIC, TANF)	✓	✓	✓
Assets, child support, Social security/pension, worker's compensation	✓		
Medi-Cal renewal	✓		
Reason for Medi-Cal non-participation	✓	✓	✓
Parental involvement/adult supervision	**Adult**	**Adolescent**	**Child**
Parental involvement			✓
Child care and school	**Adult**	**Adolescent**	**Child**
Current child care arrangements			✓
Paid child care	✓		
First 5 California: Talk, Read, Sing Program / Kit for New Parents			✓
Preschool/school attendance, school name		✓	✓
Caregiving	**Adult**	**Adolescent**	**Child**
Caregiving	✓		
Employment	**Adult**	**Adolescent**	**Child**
Employment status, spouse's employment status	✓		
Hours worked at all jobs	✓		
Industry and occupation, firm size	✓		
Income	**Adult**	**Adolescent**	**Child**
Respondent's and spouse's earnings last month before taxes	✓		
Household income, number of persons supported by household income	✓		
Respondent characteristics	**Adult**	**Adolescent**	**Child**
Race and ethnicity, age, gender, height, weight	✓	✓	✓
Veteran status	✓		
Marital status, registered domestic partner status (same-sex couples)	✓		
Sexual orientation	✓		
Gender identity	✓	✓	
Gender expression		✓	
Living with parents	✓		
Education, English language proficiency	✓		
Citizenship, immigration status, country of birth, length of time in U.S., languages spoken at home	✓	✓	✓

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

1.5 Response Rates

The overall response rates for CHIS 2019-2020 are composites of the screener completion rate (i.e., success in introducing the survey to a household and randomly selecting an adult to be interviewed) and the extended interview completion rate (i.e., success in getting one or more selected persons to complete the extended interview). For CHIS 2019-2020, the overall household response rate was 12.2 percent (the product of the screener response rate of 16.2 percent and the extended interview response rate at the household level of 75.2 percent). CHIS uses the RR4 type response rate described in the AAPOR (The American Association for Public Opinion Research), 2016 guidelines (see more detailed in *CHIS 2019-2020 Methodology Series: Report 4 – Response Rates*).

The extended interview response rate for the ABS sample varied across the adult (72.0 percent), child (85.7 percent) and adolescent (33.2 percent) interviews. The adolescent rate includes the process of obtaining permission from a parent or guardian.

Multiplying these rates by the screener response rates used in the household rates above gives an overall response rate for each type of interview for 2019-2020 (see Table 1-4b).

Table 1-4a. CHIS response rates - Conditional

Type of Sample	Screener	Household (given screened)	Adult (given screened)	Child (given screened & eligibility)	Adolescent (given screened & permission)
Overall	16.2%	75.2%	72.0%	85.7%	33.2%

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table 1-4b. CHIS response rates - Unconditional

Type of Sample	Screener	Household (given screened)	Adult (given screened)	Child (given screened & eligibility)	Adolescent (given screened & permission)
Overall	16.2%	12.2%	11.6%	13.9%	5.4%

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

After all follow-up attempts to complete the full questionnaire were exhausted, adults who completed at least approximately 80 percent of the questionnaire (i.e., through Section K which covers employment, income, poverty status, and food security), were counted as "complete." At least some responses in the employment and income series, or public program eligibility and food insecurity series were missing from those cases that did not complete the entire interview. They were imputed to enhance the analytic utility of the data.

Proxy interviews were conducted for any adult who was unable to complete the extended adult interview for themselves, in order to avoid biases for health estimates of chronically ill or handicapped people. Eligible selected persons were re-contacted and offered a proxy option. In CHIS 2019-2020, either a spouse/partner or adult child completed a proxy interview for eight adults. A reduced questionnaire, with questions identified as appropriate for a proxy respondent, was administered.

Further information about CHIS data quality and nonresponse bias is available at http://www.chis.ucla.edu/chis/design/Pages/data-quality.aspx.

1.6 Weighting the Sample

To produce population estimates from CHIS data, weights were applied to the sample data to compensate for the probability of selection and a variety of other factors, some directly resulting from the design and administration of the survey. The sample was weighted to represent the noninstitutionalized population for each sampling stratum and statewide. The weighting procedures used for CHIS 2019-2020 accomplish the following objectives:

- Compensate for differential probabilities of selection for addresses (households) and persons within household;
- Reduce biases occurring because non-respondents may have different characteristics than respondents;
- Adjust, to the extent possible, for undercoverage in the sampling frame and in the conduct of the survey; and
- Reduce the variance of the estimates by using auxiliary information

As part of the weighting process, a household weight was created for all households that completed the screener interview. This household weight is the product of the "base weight" (the inverse of the probability of selection of the address) and several adjustment factors. The household weight was used to compute a person-level weight, which includes adjustments for the within-household sampling of

persons and for nonresponse. The final step was to adjust the person-level weight using weight calibration, a procedure that forced the CHIS weights to sum to estimated population control totals simultaneously from an independent data source (see below).

Population control totals of the number of persons by age, race, and sex at the stratum level for CHIS 2019-2020 were created primarily from the California Department of Finance's (DOF) 2019 and 2020 Population Estimates, and associated population projections. The procedure used several dimensions, which are combinations of demographic variables (age, sex, race, and ethnicity), geographic variables (county, Service Planning Area) in Los Angeles County, and Health and Human Services Agency (HHSA) region in San Diego County), and education. One limitation of using DOF data is that it includes about 2.4 percent of the population of California who live in "group quarters" (i.e., persons living with nine or more unrelated persons and includes, for example nursing homes, prisons, dormitories, etc.). These persons were excluded from the CHIS target population and, as a result, the number of persons living in group quarters was estimated and removed from the DOF control totals prior to calibration.

The DOF control totals used to create the CHIS 2019-2020 weights are based on 2010 Census counts, as were those used for the 2017-2018 cycle. Please pay close attention when comparing estimates using CHIS 2019-2020 data with estimates using data from CHIS cycles before 2010. The most accurate California population figures are available when the U.S. Census Bureau conducts the decennial census. For periods between each census, population-based surveys like CHIS must use population projections based on the decennial count. For example, population control totals for CHIS 2009 were based on 2009 DOF estimates and projections, which were based on Census 2000 counts with adjustments for demographic changes within the state between 2000 and 2009. These estimates become less accurate and more dependent on the models underlying the adjustments over time. Using the most recent Census population count information to create control totals for weighting produces the most statistically accurate population estimates for the current cycle, but it may produce unexpected increases or decreases in some survey estimates when comparing survey cycles that use 2000 Census-based information and 2010 Census-based information.

1.7 Imputation Methods

Missing values in the CHIS data files were replaced through imputation for nearly every variable. This was a substantial task designed to enhance the analytic utility of the files. SSRS imputed missing values for those variables used in the weighting process and UCLA-CHPR staff imputed values for nearly every other variable.

Three different imputation procedures were used by SSRS to fill in missing responses for items essential for weighting the data. The first imputation technique was a completely random selection from the observed distribution of respondents. This method was used only for a few variables when the percentage of the items missing was very small. The second technique was hot-deck imputation. The hot-deck approach is one of the most commonly used methods for assigning values for missing responses. Using a hot deck, a value reported by a respondent for a specific item was assigned or donated to a "similar" person who did not respond to that item. The characteristics defining "similar" vary for different variables. To carry out hot-deck imputation, the respondents who answered a survey item formed a pool of donors, while the item non-respondents formed a group of recipients. A recipient was matched to the subset pool of donors based on household and individual characteristics. A value for the recipient was then randomly imputed from one of the donors in the pool. SSRS used hot-deck imputation to impute the same items that have been imputed in all CHIS cycles since 2003 (i.e., race, ethnicity, home ownership, and education). The last technique was external data assignment. This method was used for geocoding variables such as strata, Los Angeles SPA, San Diego HSSA region, and zip where the respondent provided inconsistent information. For such cases geocoding information was used for imputation.

UCLA-CHPR imputed missing values for nearly every variable in the data files other than those imputed by SSRS and some sensitive variables for which nonresponse had its own meaning. Overall, item nonresponse rates in CHIS 2019-2020 were low, with most variables missing valid responses for less than 1% of the sample. Questions that go to fewer overall respondents or that ask about more sensitive topics can have higher nonresponse.

The imputation process conducted by UCLA-CHPR started with data editing, sometimes referred to as logical or relational imputation: for any missing value, a valid replacement value was sought based on known values of other variables of the same respondent or other sample(s) from the same household. For the remaining missing values, model-based hot-deck imputation without donor replacement was used. This method replaced a missing value for one respondent using a valid response from another respondent with similar characteristics as defined by a generalized linear model with a set of control variables (predictors). The link function of the model corresponded to the nature of the variable being imputed (e.g. linear regression for continues variables, logistic regression for binary variables, etc.). Donors and recipients were grouped based on their predicted values from the model.

Control variables (predictors) used in the model to form donor pools for hot-decking always included standard measures of demographic and socioeconomic characteristics, as well as geographic region; however, the full set of control variables varies depending on which variable is being imputed.

Most imputation models included additional characteristics, such as health status or access to care, which are used to improve the quality of the donor-recipient match.

Among the standard list of control variables, gender, age, race/ethnicity, educational attainment and region of California were imputed by SSRS. UCLA-CHPR began their imputation process by imputing household income so that this characteristic was available for the imputation of other variables. Sometimes CHIS collects bracketed information about the range in which the respondent's value falls when the respondent will not or cannot report an exact amount. Household income, for example, was imputed using the hot-deck method within ranges defined by a set of auxiliary variables such as bracketed income range and/or poverty level.

The imputation order of the other variables generally followed the questionnaire. After all imputation procedures were complete, every step in the data quality control process was performed once again to ensure consistency between the imputed and non-imputed values on a case-by-case basis.

2. WEIGHTING ADJUSTMENTS

Researchers apply analysis weights to survey responses to produce estimates for the target population. The weights are designed to produce estimates with minimal biases and maximal precision (i.e., relatively small standard errors). This section provides an overview of the weighting methodology used for the CHIS 2019 and CHIS 2020 one-year weights and the 2019-2020 two-year weights.

Specifically, the approach to weighting CHIS data is provided in Section 2.1. Base weights and adjustments are combined to form the CHIS analysis weights. The weight components are listed in Section 2.2, along with a link to the section of this report where details are provided. Differences in the CHIS 2019-2020 nonresponse adjustments from prior years are also discussed. This chapter concludes in Section 2.3 with a brief discussion of quality assurance procedures.

2.1   Weighting Approach

The weighting approach used for CHIS 2019-2020 follows the paradigm set in prior rounds of the study. Specifically, the methods to construct the weights follow standard design-based techniques. The use of multiple frames—landline, cell, and surname— had been used consistently from CHIS 2009 to 2018 to ensure coverage of the residential California population with ABS samples used occasionally to reach specific small geographies (e.g., North Imperial county). In CHIS 2019 and 2020, a single address-based sample (ABS) was used for the entire sample.

The weighting procedures described in this report resulted in a set of unified analysis weights applicable for all analyses. For example, these weights are used to generate estimates at the state-level as well as sub-state estimates at the county level.

One set of weights was produced for all CHIS person-level interviews: adult, child and adolescent. Each weight was constructed to address the following nuances of the design and data collection actualities attributed to each interview:

- Differential selection probabilities of sampled households across design strata, and for persons within the selected households;
- Reduce bias that may occur in the estimates when nonrespondents differ from their respondent counterparts;

- Reduce coverage bias associated with differences of the respondent distributions from the intended target population; and

- Improve the precision of CHIS estimates (i.e., small standard errors) by adjusting to population information and adjusting any outlier weights.

An overview of the specific weight components is provided in Section 2.2

As discussed in Chapter 9, estimates for the target population are produced only if analyses account for the CHIS sampling design and the weights. Ignoring either the sampling design or the analysis weights is not recommended.

2.2   Weighting Adjustments

CHIS one-year and two-year analysis weights were developed for adult, child and adolescent completed interviews. The weights were constructed as a function of an initial base weight (inverse selection probability within design stratum) multiplied by a sequential series of adjustments to address nonresponse, subsampling, unknown eligibility, and differential coverage from the intended target population. The adjustments are summarized in Section 2.2.1, followed by a comparison of nonresponse adjustment methods for CHIS 2019-2020 and prior years (Section 2.2.2).

2.2.1   Components of the CHIS Analysis Weights

Details of the one-year weight components are provided in Chapters 3 through 6, beginning with the household weight (Chapter 3).

The weight associated with the selected household was derived as the product of the following components:

- base weights defined by design stratum (Section 3.1)
- residential status adjustment for household eligibility (Section 3.2)
- adjustment for nonresponse to the CHIS household screener (Section 3.3)
- calibration to Census Planning Database Low Response Score (Section 3.4)

The final household weight was used as the basis for three analysis weights (adult, child and adolescent) corresponding to extended interviews. The adult analysis weight (Chapter 4) was constructed as the final household weight multiplied by the following adjustments:

- inverse selection probability of one adult within each household with a completed screener (Section 4.1)
- adjustment for adult nonresponse (Section 4.2)
- pre-calibration trimming (Section 4.3)
- adjustment to align the weight sums to adult population counts by geographic area within California, demographic characteristics, and other such information (Section 4.4)

Like the adult weights, the child analysis weights (Chapter 5) were constructed as the final household weight multiplied by the following adjustments:

- adjustment to account for differing probabilities of selection based on the number of adults, parents and children in the household as well as the age of the children (Section 5.1)
- adjustment for child nonresponse (Section 5.2)
- pre-calibration trimming (Section 5.3)
- adjustment to align the weight sums to child population counts by geographic area within California, demographic characteristics, and other such information (Section 5.4)

The adolescent analysis weights (Chapter 6) were constructed in a similar fashion as the product of the final household weight and the following adjustments:

- adjustment to account for differing probabilities of selection based on the number of adults, parents and teens in the household with a completed screener (Section 6.1)
- adjustment for nonresponse linked to the parental permission or to the adolescent (Section 6.2)
- pre-calibration trimming (Section 6.3)
- adjustment to align the weight sums to adolescent population counts by geographic area within California, demographic characteristics, and other such information (Section 6.4)

A calibration adjustment (Kott, 2006; Valliant et al., 2013), such as those discussed for the adult weights in Sections 4.4, was applied to align the CHIS weights to population counts, also referred to as calibration controls or control totals. Because control totals for the CHIS target population by key covariates (e.g., design stratum) did not exist, the population counts needed to be estimated from existing information. The procedures to calculate the estimated control totals followed those used in prior rounds of CHIS and are detailed in Chapter 7.

Analysis weights address bias associated with unit nonresponse that occurs when a sample member either declines to participate or when they do not provide sufficient information for analyses. A CHIS sample member needed to complete the interview at least through the end of Section K to be classified as a respondent. Some respondents, however, declined to provide information to critical items needed for the creation of the analysis weights. This missing information was supplied through various imputation procedures detailed in Chapter 8 after the data were processed (see *CHIS 2019-2020 Methodology Series: Report 3 - Data Processing Procedures*).

Chapter 9 contains a discussion on variance estimation for CHIS 2019-2020. This includes Taylor Series linearization calculated with a single set of analysis weights, and Jackknife variance estimation calculated with a series of (replicate) weights. Software to calculate estimated standard errors are also discussed.

This report contains two supplementary appendices. Appendix A consists of a series of tables with frame counts, sample sizes, and base weights by the design strata. Appendix B provides summary statistics for each component discussed above.

2.2.2   Raking vs. Model-based adjustments for Nonresponse

In past CHIS cycles, a weighting class adjustment, much like those discussed previously, was used to account for screener and extended-interview nonresponse. Weighting classes (i.e., groups) were formed by combining binary, categorical, or categorized continuous variables thought to be associated with response and preferably also with characteristics of importance from the study. As noted in Kim et al., (2007), use of many variables can result in too many or even small (empty) weighting classes that hinder the calculation of an efficient nonresponse-adjusted weight. Determining an effective mechanism for collapsing small cells can be a time-consuming process, yielding minimal gains in precision (via reduced variations in weights) and possibly limiting the reduction of bias attributable to nonresponse. Consequently, incorporating only a few variables limits the capacity to reduce nonresponse bias, the true goal of this weight adjustment. Therefore, in CHIS 2019-2020, a model-based approach was implemented with the SUDAAN® WTADJUST procedure (RTI, 2012).

2.3   Quality Checks

A series of quality control procedures was implemented at each step to ensure the accuracy of survey weights. A few examples are provided below.

First, the weight sums by stratum were compared before and after each adjustment, and after all the weighting steps, against external counts such as those tabulated from the American Community Survey. Large differences would have indicated either errors or potential problems in model-based adjustments.

Statistics of the weights (e.g., variance, minimum, maximum, unequal weighting effect) were compared before and after an adjustment. Large differences have signaled a need for further review. For example, a large relative change in an unequal weighting effect (UWE; i.e., design effect associated with the weights) calculated by important domains (e.g., race/ethnicity or geographic location) would be evaluated to determine if additional variables should be used for the weight-adjustment model or if WTADJUST bounds on the adjustments should be tightened.

The weights were also examined for outliers (see, e.g., Chen et al., 2014). Outliers were subject to trimming only after a thorough review of the weight components.

At each stage of the weighting process, sums of the replicate weights (Chapter 9) were compared against the corresponding value for the linear weights; this step ensured that approximately half of the replicate values were at or below the linear value. Estimated standard errors using linear and replicate weights were evaluated where large differences would require further evaluation of both sets of weights.

3. HOUSEHOLD WEIGHTING

The first stage of selection for CHIS 2019-2020 as in prior years was the household by way of a sampled address from an address-based sample (ABS). Additional details on the CHIS sample design is available in *CHIS 2019-2020 Methodology Series: Report 1—Sample Design*.

Weights generated at this stage in the process are called "household weights" to keep with the historic CHIS label. These weights by themselves, however, should not be used to generate estimates for the household population in California. Primarily, they do not incorporate important adjustment factors related to nonresponse within the household nor calibration to the number of households by county.

In this chapter, we detail the steps used to calculate the household-level weight. Differences by year within CHIS 2019-2020 are noted where appropriate. The finalized household-level weight is used as the basis for the person-level analysis weights—adult, child (proxy), and adolescent—discussed in the subsequent chapters of this report.

Specifically, we define the initial base weight in Section 3.1 that accounts for sampling at the household level. Section 3.2 contains an adjustment for unknown residential status and non-residential address. Weights for those with unknown residential status and non-residential address were then set to zero. Next, we applied an adjustment for household-level nonresponse defined as households without a completed screener (Section 3.3). The final adjustment in the household weighting was to calibrate to the low response score from the Census Planning Database (Section 3.4). The final household weight is defined in Section 3.5.

Frame size, sample size and base weight by sampling frame and design stratum are provided in Appendix A. Statistics for the adjustments and the final weight are provided in Table B-1 in Appendix B.

3.1   Base Weights

A base weight, also referred to as a "design weight" or "sampling weight", adjusts only for the specific process of sampling from the sampling frame. The base weight was calculated as the inverse of the selection probability for each sampled address from the ABS frame. Base weights were computed within each combination of 88 geographic strata and 8 modeled strata. The base weight (BW_i) for each piece of sample drawn from stratum i is computed as:

$$BW_i = \frac{N_i}{n_i} \qquad\qquad (3.1)$$

where N_i is the total number of ABS records in stratum i and n_i is the amount of sample drawn from stratum i.

3.2   Residential Status Adjustment

Addresses with unknown residential status are those that cannot be classified as either residential or not residential at the end of data collection. They are sample addresses where no contact was ever made with a household member and no information was provided by the post office as to whether the address was eligible for the survey.

The proportion of eligible residential addresses (p_{res}) was computed following the AAPOR recommendation as the proportion of the resolved or observed sample units that are residential. Since addresses are sampled with different selection probabilities, the base-weighted number of cases rather than the unweighted number of cases was be used to compute p_{res}. Different values of p_{res} were computed based on urban status and whether there was a telephone number appended to the sample.

The values of p_{res} are outlined in the following table. All sampled addresses were sent to have telephone numbers appended. Of all the address sampled, 71 percent had a telephone number appended, either landline or cell. These cases were eligible to be called for non-response follow-up. Thus, the final residential status for each piece of sample was based on either [a] the final postal code if no phone number was appended or the phone number was never dialed or [b] the final call disposition if a phone number was appended and that number was dialed.

Table 3.1 shows p_{res} by urban status and phone append status for the 2019 and 2020 weightings.

Table 3.1 p_{res} by urban status and phone append status

Urban status	Phone Append		No Phone Append	
	2019	2020	2019	2020
Center of city and MSA	0.918	0.966	0.698	0.735
Outside center city of MSA but in county of center city	0.932	0.970	0.738	0.753
Inside suburban county of MSA	0.937	0.977	0.763	0.800
MSA with no center city	0.915	0.963	0.735	0.737
Not in an MSA	0.925	0.959	0.713	0.647

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

The residential status adjusted weight, $HHA1W_i$, is the product of the base weight and a residential status adjustment.

$$HHA1W_i = HHA1F_i \times BW_i. \tag{3.2}$$

The residential status adjustment, $HHA1F_i$, is computed as follows:

$$HHA1F_i = \begin{cases} \left(\sum_{i \in RES} BW_i + \sum_{i \in UNK\_RES} p_{res} \times BW_i \right) / \sum_{i \in RES} BW_i \,, & \text{if } i \in \text{RES} \\ 0, & \text{if } i \in \text{UNK\_RES, NON\_RES} \end{cases} \tag{3.3}$$

where RES denotes addresses identified as residential, UNK_RES denotes addresses with unknown residential status, and NON_RES denotes non-residential addresses. BW_i is the base weight described in Section 3.1 and p_{res} is the proportion of eligible residential addresses.

3.3 Household Nonresponse Adjustment

In this step, the household weights were adjusted to account for households that did not complete the household screener.

This weight, $HHA2W_i$, is computed as:

$$HHA2W_i = HHA2F_i \times HHA1W_i \tag{3.4}$$

where $HHA2F_i$ is the household nonresponse adjustment factor computed as follows:

$$HHA2F_i = \begin{cases} \sum_{i \in HR,HNR} HHA1W_i \times \delta_i(c) \Big/ \sum_{i \in HR} HHA1W_i \times \delta_i(c) \,, & \text{if } i \in \text{HR} \\ 0, & \text{if } i \in \text{HNR} \end{cases} \tag{3.5}$$

where HR is the set of household respondents and HNR is the set of household nonrespondents. Household respondents are cases where household status was confirmed and a screener was completed. Household nonrespondents are cases where household status was confirmed, but no screener was completed. $\delta_i(c)$ defines the household nonresponse adjustment groups. $\delta_i(c) = 1$ if the household is in cell c and $\delta_i(c) = 0$ otherwise. Two sets of variables were considered for defining the nonresponse adjustment groups. The first set of variables included variables similar to those used in the past cycles of CHIS. These variables included urban status, detailed phone append status (landline phone number appended, cell phone number appended and no phone appended) and language of mailing materials (Hispanic dominant, Asian dominant and English). A classification and regression tree (CART) analysis was run to identify which of these variables would make good nonresponse adjustment cell definitions.

Only detailed phone append status was significant in the model, so that variable was used to define the household nonresponse adjustment cells.

A second CART analysis was run using variables from the Census Planning Database at the block group level. The variables included in the CART analysis were low response score, percent Hispanic, percent non-Hispanic white, percent language other than English spoken at home, percent college educated, percent poor, and percent with no health insurance. The variables that were most significant in the CART analysis were used to define the household non-response groups. They included percent college educated, percent Hispanic, percent White and percent language other than English spoken at home.

In total, five variables were used to define the household nonresponse adjustment cells.

1. Detailed phone append status
    a. No phone appended
    b. Landline phone appended
    c. Cell phone appended
2. Percent college educated
    a. Less than 20.59% college graduates
    b. 20.59%+ college graduates
3. Percent Hispanic
    a. Less than 24.25% Hispanic
    b. 24.25%+ Hispanic
4. Percent non-Hispanic White
    a. Less than 25.40% non-Hispanic White
    b. 25.40%+ non-Hispanic White
5. Percent language other than English spoken at home
    a. Less than 34.12% language other than English spoken at home
    b. 34.12%+ language other than English spoken at home

3.4   Calibration to Low Response Score from the Census Planning Database

At this point the household weights were calibrated to match the low response score (LRS) from the Census Planning Database. A five-category variable was created that divided census block groups into quintiles based on the LRS. Then the household weights were calibrated to match the occupied household distribution from the Census Planning Database.

This weight, $HHA3W_i$, is computed as:

$$HHA3W_i = HHA3F_{gi} \times HHA2W_i \tag{3.6}$$

where $HHA3F_{gi}$ is the low response score calibration adjustment is computed as:

$$HHA3F_{gi} = N_g / \sum_{i \in g} HHA2W_i \tag{3.7}$$

where g denotes the low response score quintile and N_g is the number of occupied housing units in quintile g.

3.5   One-Year Household Weight

The final one-year household weight is a product of the base weight and the three adjustment factors:

$$HHW_i = BW_i \times HHA1F_i \times HHA2F_i \times HHA3F_i = HHA3W_i \tag{3.8}$$

4. ADULT WEIGHTING

A final weight was created for each adult extended interview. Below, we detail the approach used to calculate an analysis weight for adults. Specifically, we define the initial base weights for the randomly selected adult within the household in Section 4.1. Nonresponse to the adult interview request is addressed next (Section 4.2), followed by pre-calibration trimming (Section 4.3). The weights for the entire sample are then calibrated to estimated population projections (Section 4.4). The final adult analysis weight is summarized in Section 4.5. Statistics for the adjustments and the final adult weights are provided in Appendix B.

4.1   Number of Adults Adjustment

The first adjustment in the adult weighting adjusts for the number of adults in the household. One adult was selected with equal probability from all those residing in the household. Thus, the number of adults adjustment is simply equal to the number of adults in the household.

As a result, the number of adults base weight, $ADA0W_i$, is defined as the product of the total household weight, HHW_i, and the number of adults adjustment factor, AD_i:

$$ADA0W_i = AD_i \times HHW_i \qquad (4.1)$$

where AD_i is the number of adults in the household for respondent i. Consistent with past renditions of CHIS, values greater than three were truncated to an upper bound of three to limit the variation in the weights.

4.2   Adult Nonresponse Adjustment

Some households completed the screener interview, but the sampled adult did not complete the extended adult interview. To account for sampled adults who did not complete the extended interview, we include an adjustment for extended interview nonresponse. This was accomplished via a standard weighting class correction by specified groups.

A CART model was run to determine which variables best predicted adult response. The variables included in the model were those that were language (English, Spanish, other language) and adult screener respondent (sampled adults was screener respondent, or not). Adults screener respondent was the only significant variable in the CART model. The non-response adjustment cells were defined as

screener respondent by geographic stratum. Cells were collapsed within stratum if cell sizes were less than 25.

The adult nonresponse adjustment weight, $ADA1W_i$ is the product of the number of adults adjustment weight, $ADA0W_i$, and the adult nonresponse adjustment factor, $ADA1F_i$.

$$ADA1W_i = ADA1F_i \times ADA0W_i \tag{4.2}$$

The adjustment factor was a simple cell-based response propensity:

$$ADA1F_i = \begin{cases} \left(\sum_{i \in R,NR} ADA0W_i \times \delta_i(c)\right) \Big/ \sum_{i \in R} ADA0W_i \times \delta_i(c), & \text{if } i \in \text{R} \\ 0, & \text{if } i \in NR \end{cases} \tag{4.3}$$

where R denotes eligible respondents who completed the extended adult interview and NR denotes nonrespondents. $\delta_i(c) = 1$ if the adult is in cell c and $\delta_i(c) = 0$ otherwise.

4.3   Pre-Calibration Trimming

The adult weight to this point is a product of the base weight from section 3 and the adjustments noted in Sections 4.1 and 4.2. This resulting weight was trimmed at the 2nd and 98th percentiles within strata. For 2019, a total of 849 weights were trimmed across the 22,160 cases. For 2020, a total of 795 weights were trimmed across the 21,949 cases.

4.4   Calibration Adjustment to Department of Finance Projections

We calibrated the trimmed base weights to adjusted values of population projections supplied by the State of California's Department of Finance. Population estimates associated with California residents living in group quarters (e.g., nursing homes, prisons) and others who were not eligible for CHIS was estimated and excluded from the population controls, using techniques documented in Chapter 7 of this report. The calibrated weight was calculated as:

$$ADA2W_i = ADA1W_i \times AA1_i \tag{4.4}$$

where $AA1_i$ is the calibration adjustment from the WTADJUST procedure.

Calibration variables, calculation of the estimated calibration control totals, and information associated with the calibration procedure are detailed in Chapter 7. The model covariates and interactions mirrored those used in prior rounds of CHIS (see Section 7.2).

4.5   Adult One-Year Analysis Weight

The resulting adult weights, $ADA2W_i$, is the final one-year adult weight. There was no trimming done after the WTADJUST procedure was run.

5. CHILD WEIGHTING

Children, ages 11 years and younger, of the randomly chosen adult in households participating in CHIS were also eligible for the study. Information on the children and interview responses were collected either from the adult participant or, if relevant, from the other legal parent who completed the screener.

Below, we describe how the child (proxy interview) analysis weights were calculated. The weighting steps follow those discussed for the adult weights. Specifically, we define the base weight for the child weights in Section 5.1 that were then adjusted to account for nonresponse in Section 5.2. These weights were then trimmed (Section 5.3) and calibrated to population projections (Section 5.4). The child one-year analysis weight is shown in Section 5.5. Statistics for the adjustments and the final child weights are provided in Appendix B.

5.1   Base Weights

The child base weights are necessary to account for the disproportionate sampling of children by age group within household. Specifically, children ages 0-5 were given twice the likelihood of selection than children 6-11 by study design. If $n1$ is the number of children age 0-5 of the sampled adult in the household and $n2$ is the number of children 6-11 of the sampled adult in the household, then probability that a child is sampled, $CHA0_i$, is defined as:

$$CHA0_i = \begin{cases} 2/[(2 \times n1) + n2], & 0-5 \ sampled \\ 1/[(2 \times n1) + n2], & 6-11 \ sampled \end{cases} \qquad (5.1)$$

However, during review of the weights, an error was found in the programming of the child selection process that was introduced during the 2019 collection. Within the programing, in order to select a child in a household with multiple children, an array is created within the program that contains each child's household roster position. All 0-5 year-olds in the household are loaded into the array first followed by any 6-11 year-olds. For households with children in both age groups, 0-5 and 6-11, the number of elements in the array are doubled for all 0-5 year-olds in order to double their probability of selection compared to any 6-11 year-old. For example, using age instead of roster number, the array for a household with children aged 7, 4, and 2, added to the roster in that order, would be [4, 2, 4, 2, 7]. Next, a random number between 0 and 1 is generated. That random number is then multiplied by the length of the array, n, and the result is rounded down to the nearest integer. Since the array indexing begins at 0, each element has an equally likely probability of selection. Due to a programming error, the random number was unintentionally multiplied by $(n-1)$ rather than of n so the last element of the array could never be

selected. Thus, the actual probability that a child was sampled in 2019 and 2020, $CHA0actual_i$, is defined as:

$$CHA0actual_i = \begin{cases} 1/(n1+n2), & n1=0 \text{ or } n2=0 \\ 2/(2n1+n2-1), & n1>0 \text{ and } n2>0 \text{ and } 0-5 \text{ sampled} \\ (n2-1)/[n2\times(2n1+n2-1)], & n1>0 \text{ and } n2>0 \text{ and } 6-11 \text{ sampled} \end{cases}$$

Because all 0-5 year-olds are added to the array before any 6-11 year-olds, this means that in households with one 6-11 year-old and one or more 0-5 year-old, the 6-11 year old was never selected by the program. This is reflected in a probability of selection of zero when n2=1 in the last expression above.

The child base weight also needs to account for the different probability of child selection across households based on the number of adults and parents in the households. Households with two parents have twice the probability of selecting a parent than households with only one parent (and other adults in the household). If we let P_i be the number of parents in household i, and AD_i the number of the adults in the household (capped at 3), then the resulting child-level base weight is defined as:

$$CHW0_i = {HHW_i}\Big/{CHA0actual_i \times \left(P_i/AD_i\right)} \tag{5.2}$$

where HHW_i is the household weight defined in Section 3.5.

5.2 Child Nonresponse Adjustment

We calculate a child nonresponse adjustment in the same manner as the adult nonresponse adjustment described in Section 4.2. This weighting adjustment accounts for households that have an eligible child, but no child interview is completed, either because of adult nonresponse or child nonresponse. The adjustment cells are defined by sex within sampling stratum. Small cells were collapsed within stratum to increase the number of respondents in each cell.

$$CHA1W_i = CHA1F_i \times CHW0_i \tag{5.3}$$

The adjustment factor, $CHA1F_i$, is:

$$CHA1F_i = \begin{cases} {\sum_{i\in CHR,CHNR} CHW0_i \times \delta_i(c)}\Big/{\sum_{i\in CHR} CHW0_i \times \delta_i(c)}, & \text{if } i \in CHR \\ 0, & \text{if } i \in CHNR \end{cases} \tag{5.4}$$

where CHR are child-interview respondents and CHNR are child interview non-respondents. We define c as the child nonresponse adjustment cell defined using sex of child and geographic stratum. $\delta_i(c) = 1$ if the case is in the adjustment cell and $\delta_i(c) = 0$ otherwise.

5.3   Pre-Calibration Trimming

The child weight to this point is a product of the base weight from Chapter 3 and the adjustments noted from Sections 5.1 and 5.2. The child weights were trimmed at the 2nd and 98th percentiles within region. For 2019, a total of 109 cases had child weights trimmed. For 2020, a total of 148 cases had child weights trimmed.

5.4   Calibration Adjustment to Department of Finance Projections

The child data was calibrated to target population parameters like the adult data. The calibrated weight was calculated as:

$$CHA2W_i = CHA1W_i \times AA2_i \qquad (5.5)$$

where $AA2_i$ is the calibration adjustment from the WTADJUST procedure.

Calibration variables, calculation of the estimated calibration control totals, and information associated with the calibration procedure are detailed in Chapter 7. The model covariates and interactions mirrored those used in prior rounds of CHIS (see Section 7.2).

5.5   Child One-Year Analysis Weight

The resulting child weight, $CHA2W_i$, is the final one-year child weight. There was no trimming done after the WTADJUST procedure was run.

6. ADOLESCENT WEIGHTING

Adolescent children, ages 12 to 17, of the randomly chosen adult were eligible for the study. In contrast to the child (proxy) interview, one randomly chosen adolescent was recruited to conduct an interview only after receiving permission from a parent.

Below, we describe our approach calculating an adolescent analysis weight for analyzing an annual CHIS data file. Steps to calculate the adolescent weight follow those specified for the child weight. Specifically, we define the adolescent base weight in Section 6.1. We describe in Section 6.2 nonresponse adjustments applied to the weights. Weight trimming is described in Section 6.3. We constructed a calibration adjustment to population projections (Section 6.4). Statistics for the adjustments and the final adolescent weights are provided in Appendix B.

6.1   Base Weights

As in the child weighting, the initial weights for the adolescents incorporate the probability of sampling the adult and the probability of sampling an adolescent among all adolescents associated with the sampled adult. The initial weight, $TNW0_i$, is computed as

$$TNW0_i = HHW_i \times TCNT_i \Big/ \left(P_i \big/ AD_i \right) \tag{6.1}$$

where P_i is the number of parents in household i, AD_i is the number of adults in the household (capped at 3), and $TCNT_i$ is the number of eligible adolescents of the sampled parent. HHW_i is the household weight defined in Section 3.5.

6.2   Adjustment for Adolescent Nonresponse

An adolescent nonresponse adjustment is made in the same manner as the adult and child nonresponse adjustments described in Sections 4.2 and 5.2. This weighting adjustment accounts for households that have an eligible adolescent, but no adolescent interview was completed.

$$TNA1W_i = TNA1F_i \times TNW0_i \tag{6.2}$$

The adjustment factor, $TNA1F_i$, is:

$$TNA1F_i = \begin{cases} \left(\sum_{i \in TNR,TNNR} TNW0_i \times \delta_i(c) \right) \Big/ \sum_{i \in TNR} TNW0_i \times \delta_i(c), & \text{if } i \in TNR \\ 0, & \text{if } i \in TNNR \end{cases} \tag{6.3}$$

where TNR are adolescent interview respondents and TNNR are adolescent interview non-respondents. We define c as the adolescent nonresponse adjustment cell defined using sampling stratum. $\delta_i(c) = 1$ if the case is in the adjustment cell and $\delta_i(c) = 0$ otherwise.

6.3   Pre-calibration Trimming

The adolescent weight to this point is a product of the base weight from Chapter 3 and the adjustments noted from Section 6.1 and 6.2. Weights were trimmed at the 5th and 95th percentiles within region. For 2019, a total of 78 cases had adolescent weights trimmed. For 2020, a total of 130 cases had adolescent weights trimmed.

6.4   Calibration Adjustment to Department of Finance Projections

The adolescent data was calibrated to target population parameters like the adult data. The calibrated weight was calculated as:

$$TNA2W_i = TNA1W_i \times AA3_i \qquad (6.4)$$

where $AA3_i$ is the calibration adjustment from the WTADJUST procedure.

Calibration variables, calculation of the estimated calibration control totals, and information associated with the calibration procedure are detailed in Chapter 7. The model covariates and interactions mirrored those used in prior rounds of CHIS (see Section 7.2).

6.5   Adolescent One-Year Analysis Weight

The resulting weight, $TNA2W_i$, is the final one-year adolescent weight.

7. CALIBRATION CONTROL TOTALS

Calibration to population values is an important attribute of the CHIS weights. Section 7.1 contains an overview of weight calibration and highlights the many benefits of such efforts. Section 7.2 contains the dimensions used in the final calibration models, along with steps to address small sample size for certain dimensions. Population sources accessed for key information are detailed in Section 7.3. Steps to convert the population information into usable calibration control totals are discussed in Section 7.4.

7.1   Calibration Procedure

Calibration is a weight adjustment method where survey-estimated population counts are constrained to equal their corresponding population control totals. If the population characteristics are associated with a survey characteristic, then the estimated characteristic will have a smaller standard error with calibration compared to its size with unadjusted analysis weights (Kott, 2006; Valliant et al., 2013). Poststratification and raking are types of weight calibration. With poststratification, characteristics are interacted (e.g., sex crossed with levels of race/ethnicity) to form a relatively large number of weighting cells (classes). Using too many characteristics could result in cells with a small amount of sample, resulting in an increase in the variability of the weights and consequently a reduction in precision for estimates using these weights. Small cells are generally collapsed with larger cells to improve precision but sometimes the ad hoc collapsing can increase bias in the estimates (Kim et al., 2007). Raking (Kalton & Flores-Cervantes, 2003), in its traditional form, only using the marginal control totals and no interactions, thereby including more covariates than poststratification but excluding finer adjustments that could benefit the survey estimates.

Calibration using the WTADJUST procedure in SUDAAN (Section 2.2.2) combines the benefits of poststratification and raking by allowing many controls with constraints on the adjustment to control decrease in precision. Specifically, calibration allows a combination of marginal control (e.g., design strata) and interactions (e.g., region by sex by race/ethnicity).

Calibration adjustments were implemented to align the weight sums to person-level estimates by several characteristics. Information for the adult, child and adolescent adjustments are discussed in Sections 4.4, 5.4, and 6.4, respectively. The control totals used in the calibration models are detailed in the next section (Section 7.2). Because population totals required for the adjustment did not exist, needed population estimates were generated from population information that was available. The control total

sources for the two calibration adjustments are listed in Section 7.3. Estimation methods for the CHIS control totals are detailed in Section 7.4.

In 2017, we ran 11 different calibrations to align weight sums to population estimates. We ran an untrimmed calibration along with calibrations that trimmed the weight at 1%, 2%,…,10%. We computed mean squared errors on a series of variables to decide on a final trimming.[2] There was no one trimming that resulted in a minimum mean squared error across all of the variables and differences among the trimmings were subtle. We used the 1% trim as it minimized the MSE for the majority of the variables used in the analysis. We have utilized the same 1% trim for all calibrations since 2017.

7.2   Calibration Model Dimensions

The 12 weight calibration dimensions used in CHIS 2019 are shown in Table 7-1. These dimensions follow those specified in prior years of the study to maximize continuity. Specifically, Dimensions 1-8 and 11 involve combinations of demographic characteristics (age, sex, race/ethnicity) and reported geography (county, region, state). Regions of the state are shown in Table 7-2. Note that the number of groups is provided in parentheses, such as age groups (3) = under 12 years, 12 to 17 years, and 18 years or older shown for Dimension 1. Dimension 9 includes education of the responding adult crossed with region and Dimension 10 includes number of adults in the household crossed by primary age crossed by region. Dimension 12 interacts household tenure by region.

Levels within the dimensions were collapsed for situations where there were fewer than 50 respondents in a cell. Table 7.1 shows the 12 calibration dimensions along with the total number of categories for each. The last columns of the table show the number of categories that were used in the single-year and multi-year calibrations after collapsing. Table 7.2 shows the definition of all the variables that were used to create the 12 dimensions.

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[2] The variables used in the trimming analysis were DISTRESS, AB1, ASTCUR (adult), AB22, AH16, AH22, AI8, CA6, ASTCUR (child), TB1, and ASTCUR (adolescent).

Table 7-1. Dimensions used in Weight Calibration

Dimension	Variables (categories)	Total categories[1]	Categories after collapsing for 2019 and/or 2020 data	Categories after collapsing for combined 2019-2020 data
1	Region (7) by primary age 1 (3) by sex (2)	42	36	42
2	Region (7) by secondary age (9)	63	61	63
3	Detailed age (13) by sex (2)	26	26	26
4	Geography (14) by primary age 1 (3) plus remainder (1)	43	27	36
5	Primary age 2 (2) by race/ethnicity (7) by region (7)	98	53	63
6	Primary age 1 (3) by race/ethnicity (7) by sex (2)	42	27	32
7	Asian groups (7) by primary age 1 (3)	21	17	18
8	Stratum (44) by race (3) by primary age 2 (2)	264	110	169
9	Region (7) by education (6)	42	33	36
10	Region (7) by primary age 1 (3) adults in household (3)	63	44	56
11	Stratum (44) by primary age 1 (3)	132	72	97
12	Household tenure (2) by region (7)	14	14	14

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] The total number of categories for each dimension is simply the product of the individual variables used to create the dimension, plus any remainder categories (dimensions 4 and 14).

Table 7-2 details the variables used the 12 calibration dimensions. The number of categories is listed in parenthesis followed by a list of the dimensions that use the variable.

Table 7-2. Detailed variable definitions used in calibration dimensions

Variable	Dimensions	Categories	
Region (7)	1,2,5,9,10,12	*Northern & Sierra Counties*: Butte, Shasta, Humboldt, Lake, Mendocino, Yuba, Nevada, Sutter, Colusa, Glenn, Tehama, Del Norte, Lassen, Modoc, Plumas, Sierra, Siskiyou, Trinity, Alpine, Amador, Calaveras, Inyo, Mariposa, Mono, Tuolumne counties	
		Greater Bay Area: Santa Clara, Alameda, Contra Costa, San Francisco, San Mateo, Sonoma, Solano, Marin, Napa counties	
		Sacramento Area: Sacramento, Placer, Yolo, El Dorado counties	
		San Joaquin Valley: Fresno, Kern, San Joaquin, Stanislaus, Tulare, Merced, Kings, Madera counties	
		Central Coast: Ventura, Santa Barbara, Santa Cruz, San Luis Obispo, Monterey, San Benito counties	
		Los Angeles: Los Angeles County	
		Other Southern California: San Diego, Orange, San Bernardino, Riverside, Imperial counties	
Primary age 1 (3)	1,4,6,7,10,11	0-17 years 18-64 years 65+ years	
Sex (2)	1,3,6	Male Female	
Secondary age (9)	2	0-5 years	30-39 years
		6-11 years	40-49 years
		12-17 years	50-64 years
		18-24 years	65+ years
		25-29 years	
Detailed age (13)	3	0-3 years	31-37 years
		4-7 years	38-45 years
		8-11 years	46-53 years
		12-14 years	54-64 years
		15-17 years	65-77 years
		18-24 years	78+ years
		25-30 years	

(continued)

Table 7-2. Detailed variable definitions used in calibration dimensions (continued)

Variable	Dimensions	Categories
Geography (14)	4	Los Angeles County – Antelope Valley
		Los Angeles County – San Fernando Valley
		Los Angeles County – San Gabriel Valley
		Los Angeles County – Metro
		Los Angeles County – West
		Los Angeles County – South
		Los Angeles County – East
		Los Angeles County – South Bay
		San Diego County – North Coastal
		San Diego County – North Central
		San Diego County – Central
		San Diego County – South
		San Diego County – East
		San Diego County – North Inland
Primary age 2 (2)	5,8	0-17 years
		18+ years
Race/ethnicity (7)	5,6	Latino
		White, not Latino
		Black, not Latino
		American Indian, not Latino
		Asian, not Latino
		Native Hawaiian, not Latino
		Two or more races, not Latino
Asian groups (6)	7	Not Latino Chinese
		Not Latino Korean
		Not Latino Filipino
		Not Latino Vietnamese
		Not Latino Japanese
		Not Latino South Asian
		Not Latino other Asian
Stratum (44)	8,11	Refer to Table 1-1 for strata definitions
Race (3)	8	Latino
		Not Latino, White
		Not Latino, other race
Education (6)	9	Under 18 and parent less than HS graduate
		Under 18 and parent HS graduate
		Under 18 and parent some college+
		18+, less than HS graduate
		18+, HS graduate
		18+, some college+

Table 7-2. Detailed variable definitions used in calibration dimensions (continued)

Variable	Dimensions	Categories
Number of adults in household (3)	10	One adult
		Two adults
		Three or more adults
Household tenure (2)	12	Home owner
		Renter

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

7.3 Sources for Population Control Totals

No individual source was available to address the calibration control total needs for CHIS. In keeping with prior rounds of the study, multiple government databases were combined to produce estimated population values used in the calibration. We describe the sources below.

7.3.1 California Department of Finance Population Predictions and Estimates

As in prior years of CHIS, the California Department of Finance (DOF) population projections was the primary source for calculating estimated control totals used in weight calibration. Population counts by county and person-level characteristics (Table 7-3) were provided for 2019 and 2020. The CHIS 2019 file adjustments utilized the 2019 counts, while the CHIS 2020 and CHIS 2019-2020 file adjustments utilized the 2020 counts. This sole source by year produced estimates for adult, child and adolescent weight because projections are provided by single year of age up to 100 years. Additional information on the history of the DOF projections is provided in the *CHIS 2013-2014 Methodology Series: Report 5 – Weighting and Variance Estimation*.

Table 7-3. Definition of counts available in 2020 California DOF population files

Category	Levels
County (58)	Alameda, Alpine, …, Yolo, Yuba
Age groups (101)	Age less than 1 year
	Age 1 year, …, Age 100 years or more (by single year of age)
Sex (2)	Male
	Female
Race/ethnicity (12)	Latino White alone
	Latino African American alone
	Latino American Indian/Alaska Native alone
	Latino Asian alone
	Latino Native Hawaiian and other Pacific Islander alone
	Latino Two or more races
	Non-Latino White alone
	Non-Latino African American alone
	Non-Latino American Indian/Alaska Native alone
	Non-Latino Asian alone
	Non-Latino Native Hawaiian and other Pacific Islander alone
	Non-Latino Two or more races

Source: 2020 California Department of Finance projections.

The DOF projections, however, were not in perfect alignment with CHIS and additional adjustments were required. First, DOF projections followed the U.S. Office of Management and Budget (OMB) modified race definition and as shown in Table 7-4 did not include an "other race" group (OMB, 1997). With CHIS, respondents could designate one or more of five main racial categories—White, Black/African American, American Indian/Alaska Native, Asian, or Native Hawaiian/Other Pacific Islander. All open-end responses that could not be collapsed into a single or multi-race using this groups were classified as "other" and for the purposes of weighting were imputed as one of the OMB categories. (See discussion of OMBSRREO in Section 8.4.2)

DOF projections also included California residents who live in group quarters, a population that was ineligible for CHIS. Census 2010 files were used to estimate the proportion of persons in group quarters; these values were subtracted from the DOF projections, and these proportions were removed from the DOF estimates (see Section 7.4.1).

Additionally, the person characteristics on the DOF file did not allow the estimate of population counts for all calibration dimensions. Therefore, additional sources were required for this purpose as discussed below.

7.3.2   Census 2010 Files

As in prior years, data from the 2010 Census was used as source information for CHIS in three ways:

- The proportion of CHIS-ineligible residents living in group quarters was estimates from the 2010 Census Summary File 1 (SF1; U.S. Census Bureau, 2012a). Section 7.6.1 describes the details of this process. Information available from the SF1 is provided in Table 7-4.
- The SF1 was adjusted by information on the 2010 Census Modified Race File (U.S. Census Bureau, 2012b) to calculate population counts for the "other race" group.
- The SF1 was also used for producing population distributions for Dimension 4 by Service Planning Areas (SPAs) within Los Angeles County and by Health and Human Services Agency (HHSA) regions within San Diego County, which were then applied to the DOF population total for that county.

Table 7-4. Definition of variables available on the 2010 Census Summary File

Category	Levels
Stratum (44)[1]	
Sex (2)	Male Female
Age groups (3)	Less than 18 years old 18-64 years old 65 years old or older
Ethnicity (3)	Latino Non-Latino, White alone Other
Race (7)	White alone African American alone American Indian/Alaska Native alone Asian alone Native Hawaiian and Other Pacific Islander alone Other race alone Two or more races

Source: U.S. Census Bureau, Census 2010.

[1] Design strata (44) are defined in Table 1-1.

7.3.3 American Community Survey for California

American Community Survey (ACS) public-use one-year micro data files (PUMS) were accessed for Dimensions 7, 9, 10 and 12. These data were used to estimate the proportions of the population by Asian groups, education, household tenure, and number of adults in the household (Table 7-2). The 2018 ACS PUMS file was used for CHIS 2019 and 2020 one-year weights as well as the two-year weights.

7.4 Producing the Control Totals

As mentioned previously, the population control totals were estimated and not directly drawn from available sources. The procedures to calculate the estimates follow methods develop for previous rounds of the study and are detailed below. The process begins with estimating and then removing population estimates linked with those living in group quarters (Section 7.4.1) and completes with the final calculations for the 12 calibration dimensions (Section 7.4.2).

7.4.1 Removing the Population Living in Group Quarters

Population control totals were not available and instead were estimated from the source information described previously. The procedures followed those originally developed for CHIS 2003 to maintain consistency across years. All control totals were derived from the same adjusted DOF projections to maintain consistency across dimensions. The general steps are described below.

Tabulated Population Projections. The DOF population counts were tabulated into groups defined by the cross-tabulation design stratum (44), ethnicity (Latino, Non-Latino), age group (18), race (6) and gender (2). The six levels for race in the DOF file are shown in Table 7-3 and the 18 age levels required for the calibration dimensions are shown in Table 7-5. For convenience, let T_{d6}^{DOF} represent the cross-tabulated counts for the DOF file, where year is suppressed for convenience and the race grouping (6) excluding "other".

Table 7-5. Age levels used to summarize California DOF data file

Age group	Description	Age group	Description
1	0 to 3 years old	10	30
2	4 to 5	11	31 to 37
3	6 to 7	12	38 to 39
4	8 to 11	13	40 to 45
5	12 to 14	14	46 to 49
6	15 to 17	15	50 to 53
7	18 to 24	16	54 to 64
8	25	17	65 to 77
9	26 to 29	18	78 years and older

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.
Note: DOF = Department of Finance.

Estimated Group Quarters. The estimated proportion of group quarters was estimated from the 2010 Census SF1. As shown in Table 7-4, however, not all characteristics required for CHIS were available (e.g., single year of age). Consequently, assumptions were required: 1) the proportion in group quarters by single year of age within each age group (less than 18 years old, 18 to 64 years old, and 65 years old or older) was the same; and 2) the proportion in group quarters within racial group was the same across ethnicity (Latino or non-Latino).

Three sets of estimated control totals excluding group quarters were calculated from the 2010 Census SF1 by different groups. The first total set was defined as

$$D_{1m}^{SF1.\overline{GQ}} = D_{1m}^{SF1} - D_{1m}^{SF1.GQ} \tag{7.1}$$

where D_{1m}^{SF1} was the total population of California within group m, $D_{1m}^{SF1.GQ}$ was the corresponding population living in group quarters, and m was defined as cells created by crossing strata (44), race (7), age group (3) and sex (2). The levels of these variables are shown in Table 7-4.

The second set of control totals were defined as

$$D_{2p}^{SF1.\overline{GQ}} = D_{2p}^{SF1} - D_{2p}^{SF1.GQ} \tag{7.2}$$

where D_{2p}^{SF1} was the total population of California within group p, $D_{2p}^{SF1.GQ}$ was the corresponding population living in group quarters, and p was defined as cells created by crossing strata (44), ethnicity (3), age group (3) and sex (2).

The third set of controls were calculated as

$$D_{3q}^{SF1.\overline{GQ}} = D_{3q}^{SF1} - D_{3q}^{SF1.GQ} \tag{7.3}$$

where D_{3q}^{SF1} was the total population in California within group q, $D_{3q}^{SF1.GQ}$ was the corresponding population living in group quarters, and q was defined as cells created by the cross of strata (44) and age group (less than 18 years old, 18 years and older).

Using the similarity assumptions above and the three sets of control totals – $D_{1m}^{SF1.\overline{GQ}}$ in (7.1), $D_{2p}^{SF1.\overline{GQ}}$ in (7.2) and $D_{3q}^{SF1.\overline{GQ}}$ in (7.3) – that all excluded group quarters, 2010 Census SF1 counts with group quarters removed were estimated as

$$T_{d7}^{sf1.\overline{GQ}} = T_{mp}^{SF1} \times a_{mp} \tag{7.4}$$

where T_{mp}^{SF1} were the 2010 Census SF1 population counts within cross-classified groups defined in Table 7-5, a_{mp} was the adjustment applied based on raking the counts to the control totals, and $d7$ identifies the groups defined by the cross-classification of design stratum (44), ethnicity (Latino, Non-Latino), age group (18), race (7) including "other" and gender (2). The corresponding methodology was applied with the total population counts including group quarters to derive T_{d7}^{SF1}. Thus, the proportion of group quarters in cell d was calculated as

$$p_{d7}^{SF1.\overline{GQ}} = \left. T_{d7}^{SF1.\overline{GQ}} \middle/ T_{d7}^{SF1} \right. \tag{7.5}$$

This proportion was then applied to the yearly DOF files where ratios associated with the "other" category were assumed to be equivalent to a combination of information from the other racial groups (see, for example, *CHIS 2013-2014 Methodology Series: Report 5 – Weighting and Variance Estimation* for the justification). Thus,

$$T_{d6}^{DOF.\overline{GQ}} = p_{d7}^{SF1.\overline{GQ}} \times T_{d6}^{DOF} \tag{7.6}$$

The estimated residential population, excluding group quarters, within cells defined by stratum (44), ethnicity (Latino, Non-Latino), age group (13), race (6) and gender (2). The estimated proportion of the California residential population that live in grouped quarters was 2.3%.

7.4.2   Computing the Control Totals

Values calculated with (7.6) were tabulated across the estimation cells to form the non-group quarters control totals for calibration dimensions 1-3, 5, 6, 8 and 11. Census tract information was used to align the 2010 Census SF1 file to SPA and San Diego HSSA region to form subarea-specific proportions. These were applied to the Los Angeles and San Diego adjusted counts for tabulate control totals for Dimension 4. For Dimension 7, the proportion by ethnicity group (Latino, non-Latino) for the Asian population was tabulated from 2018 ACS PUMS data and applied to the adjusted DOF counts. ACS data were also used for Dimensions 9 (adult's education) and 10 (number of adults in the household).

8. IMPUTATION PROCEDURES

Item nonresponse occurs when a sample member should have but does not provide a response to a question. This excludes items that are skipped because of responses to prior routing questions. Item nonresponse also results if a response is deemed infeasible based on quality reviews and removed. Imputation replaces the missing values with valid responses, thereby enabling complete-case analysis and analysis weight creation. Imputation procedures were used for a select set of variables for CHIS 2019-2020.

This chapter describes the magnitude of item nonresponse by year for variables critical to producing the CHIS analysis weights, along with methods to address the missing information. Section 8.1 contains a preview of the variables subject to imputation, along with details of the methods used to supply the missing information. Identification of the methods used is communicated to the user community through a set of imputation indicator variables accompanying the data. Section 8.2 summarizes the imputation results for variables associated with the geographic location of the sampled households. Information on imputed values for household characteristics relevant to all interviews within the household (adult, adolescent, and child) is given in Section 8.3. Section 8.4 concludes this chapter with a discussion of the person-level variables important not only for the weights but also subgroup estimation with the CHIS data.

8.1   Imputed Variables and Methods

Table 8-1 lists by type the variables critical to the creation of CHIS analysis weights that were examined for imputation. The questionnaire response variables used to generate the initial values are provided. The response variables are listed in priority order, where priority was based on response source. For example, we assigned self-reported age (SRAGE) for adults the value from adult interview (AAGE); if this information was missing, then information was obtained from the corresponding screener variable (SC62_AGE, SCE2_AGE).

Table 8-1. Description of imputed variables by year

Variable Type	Variable Name	Variable Description	Response Variables
Geographic	SR_COUNTY_FIPS	County	None, Geographic variables were based on ABS sample
	SRZIP	ZIP Code	
	SRSTRATA	Stratum	
	SR_LASPA	Los Angeles Service Planning Area (SPA)	
	SR_HR	San Diego Health Service Region (HSR)	
Household	SRTENR	Household tenure	AK25, KAK25
	ELIG_KID_0_5	Number of interview-eligible kids ages 0-5	SC13A2_01 –SC13A2_20, SC15A_1 – SC15A_20, SC14A1, SC14A_01-SC14A_20, SC14B_01 –SC14B_20, ADULT_INDEX, TEEN_INDEX, CHILD_INDEX
	ELIG_KID_6_11	Number of interview-eligible kids ages 6-11	SC13A2_01 –SC13A2_20, SC15A_1 – SC15A_20, SC14A1, SC14A_01-SC14A_20, SC14B_01 –SC14B_20, SC14C_01-SC14C_20, ADULT_INDEX, TEEN_INDEX, CHILD_INDEX
	ELIG_TEEN	Number of interview-eligible adolescents	SC13A2_01 –SC13A2_20, SC15A_1 – SC15A_20, SC14A1, SC14A_01-SC14A_20, SC14B_01 –SC14B_20, SC14C_01-SC14C_20, ADULT_INDEX, TEEN_INDEX, CHILD_INDEX
	PARENT_CHILD_HH	Number of parents for the selected child	SC14A_01-SC14A_20, SCB_01-SC14B_20, SC14C_01-SC14C_20, PERSNUM_CHILD
	PARENT_TEEN_HH	Number of parents for the selected adolescent	SC14A_01-SC14A_20, SCB_01-SC14B_20, SC14C_01-SC14C_20, PERSNUM_TEEN

(continued)

Table 8-1. Description of imputed variables by year (continued)

Variable Type	Variable Name	Variable Description	Response Variables
Person	SRAGE	Age	AAGE, CAGE, TAGE, SC62, SC6E2
	SRSEX	Sex	AD66B, CA1, TA21
	SREDUC	Educational Attainment	AH47, KAH47
	SRH	Self-Reported Latino	AA4, CH1, TI1
	SRW	Self-Reported White	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRAA	Self-Reported African American	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRAS	Self-Reported Asian	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRAI	Self-Reported American Indian/Alaska Native	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRPI	Self-Reported Native Hawaiian and Other Pacific Islander	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRO	Self-Reported Other	AA5A_A - AA5A_G, CH3_A - CH3_G, TI2_a – TI2_G
	SRCH	Self-Reported Chinese	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	SRPH	Self-Reported Filipino	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	SRKR	Self-Reported Korean	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	SRJP	Self-Reported Japanese	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	SRVT	Self-Reported Vietnamese	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	SRASO	Self-Reported Other Asian	AA5E_A – AA5E_G, CH7_A – CH7_G, TI2D_A – TI2D_G
	OMBSRREO	OMB Race/ Ethnicity Group	SRH, SRO, SRW2, SRAA2, SRAS2, SRAI2, SRPI2
	OMBSRASO	OMB non-Latino Asian Group	SRH, SRAS, SRCH, SRPH, SRKR, SRJP, SRVT, SRASO

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

The type and item nonresponse rate of each variable dictated the imputation methodology. The various methods used for CHIS are shown in Table 8-2, along with the codes for the imputation indicator (flag) created for each weighting variable.

Table 8-2. Description of imputation indicators

Imputation Flag	Definition
0	Reported data; no imputation
1	Missing data; deterministic (i.e., logical) imputation[1]
2	Inconsistent data removed; deterministic (i.e., logical) imputation[1]
3	Missing data; random assignment[2]
4	Inconsistent data; random assignment[2]
5	Missing data; hot-deck imputation[3]
6	Inconsistent data; hot-deck imputation[3]
7	Missing data; external data source assignment
8	Inconsistent data; external data source assignment

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.
[1] Values assigned based on other information in the interview
[2] Values randomly assigned from distribution of all possible values
[3] Values randomly obtained from donor record with reported data

A brief description of the imputation methods is as follows.

- *Deterministic imputation* uses responses to other variables within the respondent interview to assign a value. An example of deterministic imputation is imputing a female gender when the respondent has indicated a past pregnancy.
- *Random assignment* consists of randomly populating a value in place of the missing information based on the distribution of responses for that variable. One example of a random assignment is imputing a missing age based on the distribution of respondent ages in a stratum. Only variables with very few missing responses were imputed using deterministic or random assignment. While the item nonresponse may be related to other variables in the dataset, we assumed that any bias introduced through deterministic or random assignment would be negligible.
- *Hot-deck imputation* was used when the concerns about estimated bias from item nonresponse outweighed the applicability of the two imputation methods previously discussed. In hot-deck imputation, records with missing values are given values from

randomly selected donors that were in the same imputation class as the recipient (RTI 2012; Andridge and Little, 2010; Brick and Kalton, 1996). Imputation classes are ideally formed through the cross-classification of covariates (variables) associated with the weighting variables in the group and with patterns of item nonresponse. We used results from classification and regression tree (CART) models to create imputation classes (Breiman et al., 1984) with input variables shown in Table 8-3.

- *External data source assignment*: We imputed missing values using a *data source external to CHIS*, including population patterns derived from administrative data.

Table 8-3. Input variables for CART models to create imputation classes

Variable	Definition
SC5A	Number of adults in the household
CHLD_INDEX	Presence of children in the household
CREGION	California region
ELIG_KID_0_5	Number of children aged 0-5 years related to the selected adult
ELIG_KID_6_11	Number of children aged 6-11 years related to the selected adult
ELIG_TEEN	Number of adolescents aged 12-17 years related to the selected adult
POVERTY	Poverty status
SRAGE	Self-reported age
SREDUC	Self-reported educational attainment
SRH	Self-reported Latino
SRRACE	Self-reported race
SRSEX	Self-reported sex
SRSTRATA	Self-reported stratum
SRTENR	Self-reported tenure
TEEN_INDEX	Presence of adolescents in the household

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Several quality evaluations were conducted on the data before and after imputation. For example, data were subjected to an extensive cleaning process to ensure consistency of the responses within an interview (internal response consistency) and across interviews within a household (external response consistency) for the donor cases. Once completed, we examined the imputed response for internal and external consistency.

8.2   Geographic Characteristics

With the transition to ABS sample with CHIS 2019-2020, none of the geographic variables required imputation. Records were geocoded to specific latitude and longitude coordinates based on the sampled address.

8.3   Household Characteristics

To calculate the household weights, the foundation for the person-level analysis weight, all participating households must have data for certain characteristics. This section outlines the imputation methodology for these household variables.

8.3.1   Household Tenure

Missing values for household tenure (SRTENR) were imputed using hot-deck imputation. CART created imputation classes using household poverty (POVERTY). Table 8-4 shows the item nonresponse distribution for this variable.

Table 8-4. Item nonresponse for self-reported household tenure

Variable and Source of Data	All Modes	
	n	pct[1]
SRTENR (Household tenure)		
Reported values	43,016	97.5
Imputed values	1,093	2.5
Total	44,109	100.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of cases within variable.

8.3.3   Household Composition

Number of Eligible Children by Age Group

The number of children related to the adult respondent was required for household and child-level weights. Because children in different age groups had different probabilities of selection, we separated the number of eligible children by age group. Missing values were imputed using hot-deck imputation with reported stratum, the type of respondents (adult, child, or adolescent) in each household and the parent's race/ethnicity as imputation covariates. The item nonresponse for the two age-group variables is shown in Table 8-5.

Table 8-5. Item nonresponse for number of study-eligible children by age group

Variable and Source of Data	All Modes	
	n	pct[1]
ELIG_KID_0_5 (Self-reported number of eligible children age 0-5)		
Reported values	43,841	99.4
Imputed values	268	0.6
Total	44,109	100.0
ELIG_KID_6_11 (Self-reported number of eligible children age 6-11)		
Reported values	43,841	99.4
Imputed values	268	0.6
Total	44,109	100.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of cases within variable.

Number of Eligible Adolescents

The number of adolescents related to the adult respondent was required for the household and adolescent-level weights. The item nonresponse for this variable is shown in Table 8-6.

Table 8-6. Item nonresponse for number of study-eligible adolescents

Variable and Source of Data	All Modes	
	n	pct[1]
ELIG_TEEN (Self-reported number of adolescents)		
Reported values	44,105	100.0
Imputed values	4	0.0
Total	44,109	100.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of cases within variable.

Number of Parents of Selected Child or Adolescent

The number of parents in the household for the selected child and adolescent were used to construct the corresponding person-level weight. As there were no missing values in these variables, they were not imputed.

8.3.4 Poverty Status

Poverty status was used in the CART models to develop imputation classes for other variables. This variable was not used in the weighting process. As with the previous CHIS cycles, data for adult

respondents who answered "unknown" to the household income questions were left unchanged. There were no other missing value requiring imputation.

8.4 Person-level Characteristics

Person-level weights are used to calculate population estimates for CHIS. However, the person-level variables contained item nonresponse among those classified as study respondents (Table 8-7). This section describes the imputation procedures used for each variable needed for weighting and their item nonresponse rates.

Table 8-7. Respondents by person type

| | All Modes |
Person Type	n
Adult	44,109
Child	6,557
Adolescent	2,212

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of respondents by person type.

8.4.1 Sex and Age

Self-reported sex (SRSEX) and self-reported age (SRAGE) were derived from a combination of screener and interview variables for each respondent. Table 8-8 shows the item nonresponse for SRSEX and SRAGE for each type of respondent. Because the nonresponse rates were low for SRSEX, missing values were imputed using random assignment from the distribution of responses within the associated reported stratum. SRAGE was imputed by hot-deck imputation using stratum and screener age group classification as imputation classes.

Table 8-8. Item nonresponse for self-reported sex and age by person type

| Variable and Source of Data | All Modes | |
	n	pct[1]
SRSEX (Self-reported sex)		
Adult	360	0.8
Child	6	0.1
Adolescent	40	1.8
SRAGE (Self-reported age)		
Adult	319	0.7
Child	0	0.0
Adolescent	0	0.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

8.4.2   Race and Ethnicity

Single Race and Ethnicity

The seven self-reported race and ethnicity variables were created after upcoding all responses to the associated questions. Missing values for all variables were imputed by an iterative hot-deck imputation process using stratum and previously hot-decked race and ethnicity variables as the imputation class. Table 8-9 shows the response patterns by variable grouping for respondents missing at least one self-reported race or ethnicity value. Table 8-10 shows the response patterns for the self-reported race variables.

Table 8-9. Item nonresponse for any self-reported race value and ethnicity

Variable and Source of Data	n	pct[1]
One or more imputed Race values		
Adult	1,813	4.1
Child	422	6.4
Adolescent	105	4.7
SRH (Self-reported Latin ethnicity)		
Adult	223	0.5
Child	67	1.0
Adolescent	4	0.2

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of imputed records among respondents in Table 8-9 by person type.

Table 8-10. Item nonresponse for single-response self-reported race by person type

Variable and Source of Data	All Modes	
	n	pct[1]
SRW (Self-reported race: White)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6
SRAA (Self-reported race: African American)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6
SRAI (Self-reported race: American Indian)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6
SRAS (Self-reported race: Asian)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6
SRPI (Self-reported race: Pacific Islander)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6
SRO (Self-reported race: Other)		
Adult	1,701	3.9
Child	395	6.0
Adolescent	102	4.6

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of imputed records among respondents in Table 8-10 by person type.

OMB Race/Ethnicity Variable

     The weighting algorithm calibrated the survey weights to match the California Department of Finance (DOF) population estimates for race and ethnicity. Since the DOF race and ethnicity estimates were based on the revised Office of Management and Budget (OMB) 1997 standards for data collection, only five race categories are available: White, African American, Asian, American Indian, and Pacific Islander. The 2010 Census race estimates included an additional category called "Other Race" for respondents who did not report their races in one of the five categories. To match the OMB standards, the U.S. Census Bureau created a Modified Race Data Summary file (MRDSF) that recodes the "Other" respondents into one of the five OMB race codes. CHIS collected race data for the six Census race categories; therefore, the "Other" respondents need to be recoded into the five race categories. These race categories are coded into the variable OMBSRREO.

Table 8-11 shows the race classification for OMBSRREO. There are also classifications for respondents who identify as Latino and respondents who identify as belonging to multiple races. These last two classifications were included to reduce the number of records that require imputation for OMBSRREO.

Table 8-11. Classification codes for OMB self-reported race/ethnicity

OMBSRREO Code	Description
1	Latino
2	Non-Latino White Only
3	Non-Latino African American Only
4	Non-Latino American Indian Alaskan Native Only
5	Non-Latino Asian Only
6	Non-Latino Pacific Islander Native Hawaiian Only
7	Non-Latino Two or More Races

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

The same coding and imputation procedure consistent with prior years of CHIS was used to classify all records into the five OMB race categories. The imputed self-reported race and ethnicity variables (SRH, SRW, SRAA, SRAS, SRAI, SRPI, and SRO) were used for the coding process.

Another indicator variable, MULTIRACE, was created to identify records that reported two or more races. All respondents who self-identified as Latino (SRH = 1) were coded as such regardless of any other race indications. Non-Latino respondents who either self-identified as one of the OMB race categories or "Other" (SRO = 1), and one of the OMB race categories were assigned to that race category. Non-Latino respondents who reported two or more races (MULTIRACE = 1) or who only reported multiple instances of "Other" were classified as having two or more races. Non-Latino respondents who only reported "Other" were required to have an imputed OMB race.

The hot-deck imputation procedure required temporary race variables (SRW2, SRAA2, SRAI2, SRAS2, and SRPI2) created from the self-reported single race variables. Non-Latino respondents who only reported "Other" had these variables set as missing. No other types of records were marked to be imputed. Hot-deck imputation proceeded on these variables. Adult, child and adolescent records used reported stratum, SRH, and previously imputed race and ethnicity variables as iterative imputation classes. Records were then classified into the OMB races based on the imputed data. Table 8-12 shows the results of the hot-deck procedure by person type and OMBSRREO value.

Table 8-12. Item nonresponse for office and management and budget self-reported race/ethnicity by
     person type

OMBSRREO Value, Person Type	All Modes	
	n	pct[1]
Latino		
Adult	45	<0.1
Child	28	0.4
Adolescent	2	0.1
Non-Latino White Only		
Adult	244	0.6
Child	64	1
Adolescent	7	0.3
Non-Latino African American Only		
Adult	13	<0.1
Child	4	0.1
Adolescent	1	<0.1
Non-Latino American Indian Alaskan Native Only		
Adult	2	<0.1
Child	0	0
Adolescent	0	0
Non-Latino Asian Only		
Adult	46	0.1
Child	15	0.2
Adolescent	1	<0.1
Non-Latino Pacific Islander Native Hawaiian Only		
Adult	1	<0.1
Child	0	0
Adolescent	0	0
Non-Latino Two or More Races		
Adult	18	<0.1
Child	8	0.1
Adolescent	0	0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview
Survey.

[1] Unweighted percent of imputed records among respondents in Table 8-12 by person type.

OMB Asian Ethnicity Group

Records identified as Asian by the temporary variable SRAS2 were then further classified by Asian ethnicity in the variable OMBSRASO. The seven classes in OMBSRASO are listed in Table 8-13.

Table 8-13. Classification codes for office and management and budget self-reported non-Latino Asian ethnicity

OMBSRASO Code	Asian Ethnicity Indicator Variable	Description
-1	*N/A*	Latino or Non-Asian
1	SRCH	Chinese Only
2	SRKR	Korean Only
3	SRPH	Filipino Only
4	SRVT	Vietnamese Only
5	SRASO	Other Asian Ethnicity
6	SRJP	Japanese Only

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

N/A = not applicable.

After imputation for SRAS2, six Asian ethnicity indicator variables were created based on their responses to the Asian ethnicity questions. Hot-deck imputation proceeded on these temporary variables. Adult, child and adolescent records used reported region, SRH, and SRAS2 as imputation classes. Table 8-14 shows the results of the hot-deck procedure on the single-race Asian ethnicity variables by person type.

Records were then coded into OMBSRASO based on their imputed Asian ethnicity variables. Table 8-15 shows the results of the hot-deck procedure by person type and OMBSRASO value.

Table 8-14. Item nonresponse for single-response self-reported non-Latino Asian ethnicity by person type

Single race, Person Type	All Modes	
	n	pct[1]
SRCH (OMB Asian ethnicity: Chinese)		
Adult	171	0.4
Child	39	0.6
Adolescent	6	0.3
SRKR (OMB Asian ethnicity: Korean)		
Adult	171	0.4
Child	39	0.6
Adolescent	6	0.3
SRPH (OMB Asian ethnicity: Filipino)		
Adult	171	0.4
Child	39	0.6
Adolescent	6	0.3
SRVT (OMB Asian ethnicity: Vietnamese)		
Adult	171	0.4
Child	39	0.6
Adolescent	6	0.3
SRASO (OMB Asian ethnicity: Asian Other)		
Adult	180	0.4
Child	45	0.7
Adolescent	11	0.5
SRJP (OMB Asian ethnicity: Japanese)		
Adult	171	0.4
Child	39	0.6
Adolescent	6	0.3

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of imputed records among respondents in Table 8-14 by person type.

Table 8-15. Item nonresponse for office and management and budget self-reported non-Latino Asian ethnicity by person type

OMBSRASO, Person Type	All Modes	
	n	pct[1]
Chinese only		
Adult	21	<0.1
Child	8	0.1
Adolescent	0	0
Korean only		
Adult	6	<0.1
Child	0	0
Adolescent	0	0
Filipino only		
Adult	10	<0.1
Child	1	0
Adolescent	0	0
Japanese only		
Adult	5	<0.1
Child	1	0
Adolescent	0	0
Vietnamese only		
Adult	4	<0.1
Child	0	0
Adolescent	0	0
Other Asian ethnicity		
Adult	125	0.3
Child	27	0.4
Adolescent	5	0.2

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of imputed records among respondents in Table 8-15 by person type.

8.4.3　Educational Attainment

Missing values for the educational attainment of the selected adult (SREDUC) were imputed using a hot-deck method (Table 8-16). A CART analysis identified the imputation covariates as POVERTY, SRH and OMBSRREO.

Table 8-16. Item nonresponse for self-reported educational attainment of the adult by person type

Variable and Source of Data	All Modes	
	n	pct[1]
SREDUC (Self-reported educational attainment)		
Reported values	43,778	99.2
Imputed values	331	0.8
Total	44,109	100.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

[1] Unweighted percent of cases within variable

9. VARIANCE ESTIMATION

Weights detailed in Chapters 4-6 are used to generate point estimates from CHIS data. In this chapter, we discuss the calculation of precision for those estimates, most notably quantified through a standard error or the square root of the sampling variance. Section 9.1 summarizes the precision for a select number of analysis variables from the adult, child, and teen analysis files. Section 9.2 discusses two types of variance estimation methods that may be used for CHIS—linearization and replication. We detail the creation of the values needed for replication variance estimation in Section 9.3. This chapter concludes in Section 9.4 with information relevant for calculating estimates with standard commercial and open-source software that properly account for the CHIS sampling design.

9.1   Design Effects

Point estimates are only part of the story for any survey. Measures of precision, most notably the sampling error, quantify the confidence one has that a point estimate is a good representation of the true (but unknown) population parameter. For example, estimates with a small standard error (and consequently relatively high precision) are viewed more variably than those with low precision because they enable tests of significance. Though point estimates appear to be substantively different, their large standard errors may result in an insignificant statistical test of those differences.

There are several statistics for quantifying precision of an estimate. They include:

- the standard error, or SE, defined as the square root of the sampling variance for an estimate that is specific to the survey design;
- the coefficient of variation, or CV, defined as the SE of the estimates divided by the point estimate;
- the relative variance, or relvariance, defined as squared CV;
- the confidence interval calculated as the range of values from the lower bound (the point estimate minus a specified multiple of SE) to the upper bound (the point estimate plus the specified multiple of SE used for the lower bound); and
- the design effect, described below.

The design effect (DEFF) was developed by Leslie Kish (1965). DEFF typically quantifies the increase in a SE for an estimate from a complex sample design above the SE calculated for a single stage stratified design (stsrs) with sample proportionally allocated to strata as distributed in the population. A

stsrs design is considered optimal for small SEs; deviations from this design are generally implemented to meet analytic objectives such as relatively equal sample across strata in CHIS.

DEFF for an estimate $\hat{\theta}$ is calculated as

$$DEFF = \frac{\text{var}_\pi(\hat{\theta})}{\text{var}_{stsrs}(\hat{\theta})} \qquad (9.1)$$

where $\text{var}_\pi(\hat{\theta})$ is the variance estimate for the appropriate CHIS sample design, and $\text{var}_{stsrs}(\hat{\theta})$ is the variance for the stsrs design. Variance for the CHIS sample design, $\text{var}_\pi(\hat{\theta})$, accounts for the following aspects of the survey design using replication methods discussed in this chapter:

- **Design strata**. Mutually exclusive stratification variables for CHIS were county or county group within California drawn from multiple sampling frames (landline, cell, surname and ABS).
- **Clustering**. Analyses involving the combination of adult with child or teen interviews would result in household-clustered estimates.
- **Over- and under-sampling of sample members**. Deviations from sampling proportional to the distribution in the population will result in either over- or under-sampling of subgroups in the population. Geographic strata were sampled at different rates to provide valid estimates in most counties and in groups of counties with smaller populations. Within the geographic strata, modeled strata were also sampled at different rates. The modeled strata were created to target households likely to contain specific subgroups of interest. These subgroups include: Asians, including Koreans and Vietnamese; Hispanics; people with low educational attainment; non-US citizens and children.
- **Within-Household Subsampling**. Subsampling within CHIS households occurred for those with multiple adult residents contacted through a randomly chosen address, for households with multiple eligible children, and for households with multiple eligible teens.
- **Base weight and weight Adjustments**. As discussed in the previous sections of this report, base weights and differential weight adjustments were applied to account for differing selection probabilities across geographic and modeled strata and to reduce nonresponse bias and additional coverage bias not addressed through the nonresponse adjustments.

Design effects were computed using SPSS Complex Samples which provides summary statistics and standard errors for complex sample designs. In prior iterations of CHIS, design effects were computed using SUDAAN. In days past, DEFF was used to adjust estimates from software that could

only calculate SEs for a stsrs design. Specialized software for analyzing survey data obtained through a complex, multistage design is widely available now. Hence, DEFF is most effectively used to compare before and after a weight adjustment is applied (as implemented for CHIS 2019-2020) or across multiple rounds of a survey using the same sampling design. Thus, differences in DEFF between CHIS 2019-2020 and prior rounds of the study cannot be easily explained as changes to the sampling design, weighting methodology, differential response, and the like will result in different precision estimates.

As in past rounds, CHIS DEFFs calculated for specific variables of interest will generally have values greater than one. This is typical for surveys with complex designs and weighting schemes, and with over- and under-sampling to achieve analytic objectives. The degree of deviations from one will differ by the type of estimate. For example, characteristics that are linearly associated with the calibration controls used in the CHIS final weighting step will have lower DEFFs than those with weaker associations (see, e.g., Valliant et al., 2013).

Because precision differs by questionnaire item, tables below summarize DEFF for a series of variables from the adult, teen and child questionnaires. Specifically, the average, maximum and minimum DEFFs are shown by person interview overall and by reported stratum are shown. Because the distribution of DEFFs are known to be non-symmetric, the median values are also provided. Finally, the average square root of DEFF, denoted as DEFT, is listed along with the other measures. DEFT aligns with SE (instead of variance as with DEFF) and also provides some measure of smoothing if the DEFFs from the set of questionnaire items analyzed vary widely.

Tables 9-1, 9-2, and 9-3 contain DEFFs and DEFTs for items selected from the adult, child and teen questionnaires, respectively. Each table contains the average, median, maximum and minimum DEFF along with the average DEFT, overall and by reported stratum. All calculations used the final person-level linear weights described in the previous chapters.

A total of 24 variables were chosen for the adult DEFF analyses (Table 9-1). The variables include health characteristics such as general health rating, diagnosis (asthma, diabetes, high blood pressure, heart failure/congestive, heart disease, blind/deaf, felt nervous), lifestyle (smoking, number of sexual partners, skipped meals, feel safe), preventive medicine (delayed medical care, usual source of healthcare, number of doctor visits), health insurance (Medicare/Medi-CAL, employer health insurance, other government health plan, prescription coverage), and socioeconomic and demographic variables (income, sexual orientation, marital status, education attainment, U.S. citizenship status). The average

DEFT for CHIS 2019 was 1.93 overall and ranging from 0.46 to 2.10 across the reported strata. These values are similar for CHIS 2020 – 1.76 overall and ranging from 0.51 to 1.96 across reported stratum.

A total of 15 variables were chosen for the child DEFF analyses (Table 9-2). These variables include health characteristics such as general health rating, diagnosis (asthma, child visited emergency room), lifestyle (go to the park, park safety concerns), preventive medicine (usual healthcare location, doctor visits, delayed medical care/medication, access to childcare), and socioeconomic and demographic variables (servings of fruit and vegetables, age). The average DEFT for CHIS 2019 was 1.77 overall and ranged from 0.45 to 1.97 across the reported strata. These values are similar for CHIS 2020 – 1.78 overall and ranging from 0.34 to 1.94 across reported stratum.

A total of 24 variables were chosen for the teen DEFF analyses (Table 9-3). These variables include health characteristics such as general health rating, diagnosis (asthma, teen visited emergency room, felt nervous, had psychological or emotional counseling), lifestyle (smoking, alcohol use, e-cigarette use, had THC, go to the park, park/neighborhood safety concerns, sexually active, walk/bike/skateboard home from school), preventive medicine (usual healthcare location, doctor visits, delayed medical care/medication, physical activity), and socio economic and demographic variables (servings of fruit, vegetables, soda, juice, water). The average DEFT for CHIS 2019 was 1.41 overall and ranged from 0.39 to 1.58 across the reported strata. These values are slightly higher for CHIS 2020 – 1.62 overall and ranging from 0.37 to 1.96 across reported stratum. Note that design effect estimates are only provided for strata with 10 or more teen interviews.

Table 9-1. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the adult interviews, overall and by reported stratum within study year

	CHIS 2019					CHIS 2020				
	Design effect (DEFF)				DEFT	Design effect (DEFF)				DEFT
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
State	3.79	3.85	1.15	6.63	1.93	3.17	3.28	0.91	5.30	1.76
1 Los Angeles	3.96	4.25	0.68	6.90	1.96	3.15	3.32	0.10	4.90	1.75
2 San Diego	2.46	2.51	0.27	5.39	1.53	2.33	2.32	0.15	4.45	1.48
3 Orange	4.57	4.65	0.29	10.03	2.08	3.48	3.65	0.28	8.71	1.81
4 Santa Clara	4.00	3.89	1.24	10.89	1.96	3.59	3.61	0.17	7.59	1.84
5 San Bernardino	4.68	4.78	0.37	10.55	2.10	3.55	3.68	0.16	6.10	1.84
6 Riverside	4.26	4.43	0.37	10.71	1.99	3.57	3.80	0.33	6.33	1.86
7 Alameda	3.92	3.88	0.13	9.65	1.92	3.60	3.62	0.80	8.04	1.86
8 Sacramento	4.08	4.13	0.22	10.96	1.97	3.13	3.16	0.48	6.59	1.72
9 Contra Costa	4.00	3.97	0.63	10.34	1.94	3.61	3.21	0.50	10.18	1.84
10 Fresno	3.47	3.50	0.21	7.25	1.79	4.09	4.23	0.19	9.95	1.96
11 San Francisco	3.56	3.61	0.40	9.10	1.83	2.49	2.35	0.48	8.05	1.53
12 Ventura	3.92	4.28	0.26	9.15	1.88	3.71	4.06	0.00	9.42	1.82
13 San Mateo	3.68	3.35	0.41	13.47	1.84	3.88	3.68	0.48	10.71	1.88
14 Kern	3.27	3.35	0.23	7.19	1.77	3.22	3.57	0.27	7.68	1.72
15 San Joaquin	4.14	4.30	0.68	8.71	1.98	3.57	3.81	0.15	8.23	1.80
16 Sonoma	3.28	2.98	0.15	8.67	1.73	3.08	2.89	0.26	8.89	1.68
17 Stanislaus	3.35	3.39	0.12	8.03	1.75	3.83	3.94	0.53	8.02	1.91
18 Santa Barbara	3.23	3.25	0.19	10.74	1.69	3.41	3.51	0.00	7.84	1.73
19 Solano	2.48	2.36	0.25	8.70	1.49	2.86	2.78	0.46	10.11	1.61
20 Tulare	4.02	4.16	0.24	10.63	1.93	2.13	2.29	0.17	3.67	1.41
21 Santa Cruz	3.02	2.52	0.13	10.54	1.61	1.59	1.67	0.17	3.61	1.21
22 Marin	2.25	1.27	0.12	9.54	1.33	2.38	1.49	0.13	9.08	1.39
23 San Luis Obispo	1.56	1.28	0.01	4.38	1.16	1.40	1.21	0.14	5.70	1.12
24 Placer	2.22	2.07	0.13	6.49	1.42	1.24	1.20	0.00	3.23	1.08

Table 9-1. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the adult interviews, overall and by reported stratum within study year (continued)

	CHIS 2019					CHIS 2020				
	Design effect (DEFF)				DEFT	Design effect (DEFF)				DEFT
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
25 Merced	2.08	1.88	0.09	4.64	1.35	1.41	1.26	0.04	8.42	1.11
26 Butte	1.30	1.28	0.18	3.61	1.11	0.88	0.94	0.02	2.13	0.89
27 Shasta	1.00	0.84	0.10	4.35	0.95	0.80	0.71	0.11	2.97	0.85
28 Yolo	2.08	1.67	0.03	9.20	1.34	1.11	1.11	0.09	2.26	1.01
29 El Dorado	1.03	0.92	0.11	4.91	0.96	0.91	0.92	0.00	3.98	0.91
30 Imperial	0.85	0.75	0.06	2.47	0.88	0.91	0.86	0.00	2.45	0.93
31 Napa	1.15	0.98	0.08	3.88	1.01	1.06	0.67	0.02	5.37	0.93
32 Kings	1.06	0.96	0.05	3.23	0.97	0.91	0.94	0.00	2.04	0.91
33 Madera	0.87	0.81	0.03	3.50	0.88	1.28	1.31	0.05	3.69	1.07
34 Monterey	2.69	2.31	0.12	6.51	1.52	2.79	2.70	0.00	10.33	1.56
35 Humboldt	0.73	0.66	0.08	2.30	0.83	0.79	0.68	0.08	3.94	0.84
36 Nevada	0.54	0.43	0.09	1.95	0.70	0.59	0.54	0.05	1.94	0.73
37 Mendocino	0.62	0.55	0.05	1.90	0.75	0.43	0.41	0.05	1.20	0.62
38 Sutter	0.53	0.52	0.07	1.26	0.70	0.58	0.56	0.04	2.11	0.72
39 Yuba	0.37	0.35	0.03	1.12	0.58	0.73	0.53	0.04	2.64	0.79
40 Lake	0.33	0.31	0.03	0.68	0.55	0.28	0.28	0.03	0.69	0.51
41 San Benito	0.23	0.21	0.03	0.60	0.46	0.48	0.50	0.00	1.42	0.66
42 Colusa, et al.	0.72	0.64	0.00	2.42	0.80	0.89	0.84	0.09	2.33	0.90
43 Del Norte, et al.	0.47	0.46	0.08	1.23	0.67	1.15	0.85	0.04	5.62	0.99
44 Amador, et al.	1.07	0.88	0.01	4.23	0.96	1.53	1.25	0.18	5.84	1.15

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table 9-2. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the child interviews, overall and by reported stratum

| | CHIS 2019 | | | | | CHIS 2020 | | | | |
| | Design effect (DEFF) | | | | DEFT | Design effect (DEFF) | | | | DEFT |
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
State	3.20	3.28	0.69	4.53	1.77	3.20	3.29	1.22	5.47	1.78
1 Los Angeles	3.50	3.67	0.77	5.37	1.84	3.19	3.33	1.22	4.52	1.77
2 San Diego	2.56	2.58	0.14	5.57	1.53	2.34	2.30	1.04	4.28	1.50
3 Orange	2.77	2.97	0.60	4.91	1.60	3.14	3.20	1.17	6.86	1.74
4 Santa Clara	2.97	3.33	0.84	5.35	1.67	2.48	2.11	0.59	5.61	1.52
5 San Bernardino	3.48	3.86	0.45	7.92	1.78	3.22	3.70	0.96	4.45	1.76
6 Riverside	3.40	3.49	0.55	6.94	1.78	3.92	4.16	0.66	6.96	1.94
7 Alameda	3.16	3.86	0.79	8.97	1.71	3.05	2.88	0.57	7.24	1.66
8 Sacramento	2.64	2.99	0.10	4.84	1.55	3.44	3.22	0.69	9.43	1.78
9 Contra Costa	2.80	2.37	0.62	7.32	1.61	2.49	2.55	0.38	5.17	1.50
10 Fresno	2.42	1.79	0.79	7.50	1.49	3.52	4.13	0.22	8.02	1.77
11 San Francisco	2.58	1.91	0.19	6.71	1.49	2.78	2.54	0.06	7.96	1.51
12 Ventura	4.07	3.68	1.17	9.89	1.97	3.21	1.99	0.01	8.07	1.62
13 San Mateo	1.88	2.03	0.28	3.15	1.34	1.78	1.89	0.73	2.62	1.31
14 Kern	2.15	2.02	0.65	5.76	1.41	3.78	3.08	0.96	8.54	1.89
15 San Joaquin	2.53	2.08	0.14	6.94	1.46	2.85	2.84	0.41	6.92	1.63
16 Sonoma	0.88	0.86	0.35	2.45	0.91	2.87	1.95	0.19	9.45	1.49
17 Stanislaus	2.30	2.02	0.63	6.38	1.47	2.09	1.92	0.63	4.73	1.41
18 Santa Barbara	2.19	2.07	0.21	7.75	1.37	1.77	1.80	0.26	4.22	1.27
19 Solano	2.56	2.51	0.20	5.44	1.51	3.22	3.71	0.36	6.64	1.67
20 Tulare	1.93	2.05	0.25	3.84	1.32	1.92	1.82	0.40	4.89	1.32
21 Santa Cruz	0.39	0.39	0.09	0.62	0.60	0.87	0.42	0.08	2.54	0.83
22 Marin	0.97	0.55	0.12	2.24	0.90	0.59	0.56	0.02	1.62	0.68
23 San Luis Obispo	1.70	1.48	0.01	5.09	1.14	1.05	0.80	0.08	4.17	0.93
24 Placer	1.87	1.40	0.52	4.89	1.29	0.68	0.65	0.20	1.43	0.81

(continued)

Table 9-2. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the child interviews, overall and by reported stratum (continued)

| | CHIS 2019 | | | | | CHIS 2020 | | | | |
| | Design effect (DEFF) | | | | DEFT | Design effect (DEFF) | | | | DEFT |
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
25 Merced	1.01	0.94	0.36	2.05	0.98	1.41	1.54	0.16	3.04	1.11
26 Butte	0.70	0.66	0.04	1.24	0.79	0.53	0.38	0.09	1.56	0.69
27 Shasta	0.76	0.76	0.04	1.79	0.82	0.90	1.00	0.01	1.17	0.93
28 Yolo	0.79	0.72	0.11	1.51	0.85	1.16	1.14	0.00	3.05	0.96
29 El Dorado	0.41	0.46	0.04	0.70	0.61	0.65	0.48	0.19	1.36	0.76
30 Imperial	0.96	0.52	0.18	3.04	0.89	0.86	0.95	0.06	1.56	0.90
31 Napa	0.56	0.46	0.07	1.42	0.68	0.13	0.11	0.02	0.44	0.34
32 Kings	0.68	0.50	0.05	1.61	0.77	0.46	0.48	0.02	0.74	0.66
33 Madera	0.71	0.51	0.13	2.30	0.77	1.40	1.09	0.06	4.16	1.05
34 Monterey	2.79	2.78	0.06	5.41	1.57	2.19	1.47	0.29	5.65	1.39
35 Humboldt	0.52	0.45	0.15	0.95	0.70	0.48	0.52	0.10	0.63	0.68
36 Nevada	0.36	0.37	0.07	0.68	0.58	0.40	0.25	0.07	1.62	0.58
37 Mendocino	0.56	0.62	0.29	0.84	0.73	0.52	0.38	0.10	1.37	0.67
38 Sutter	0.25	0.16	0.02	0.92	0.45	0.54	0.59	0.12	0.92	0.71
39 Yuba	0.31	0.34	0.02	0.68	0.52	0.22	0.15	0.03	0.54	0.44
40 Lake	0.43	0.40	0.12	0.84	0.63	0.41	0.21	0.04	1.26	0.57
41 San Benito	1.09	0.66	0.14	3.37	0.95	0.30	0.30	0.09	0.45	0.53
42 Colusa, et al.	0.32	0.31	0.04	0.68	0.54	0.98	1.15	0.15	1.27	0.97
43 Del Norte, et al.	0.47	0.43	0.01	0.86	0.65	0.71	0.59	0.16	1.94	0.79
44 Amador, et al.	0.70	0.72	0.18	1.22	0.82	0.67	0.69	0.12	0.86	0.81

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table 9-3. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the teen interviews, overall and by reported stratum within study year

	CHIS 2019					CHIS 2020				
	Design effect (DEFF)				DEFT	Design effect (DEFF)				DEFT
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
State	2.02	2.03	1.11	3.70	1.41	2.65	2.74	0.77	4.29	1.62
1 Los Angeles	2.56	2.52	0.74	5.22	1.58	2.84	3.02	0.77	3.56	1.67
2 San Diego	1.68	1.65	0.43	2.79	1.28	1.85	1.94	0.20	3.16	1.32
3 Orange	2.08	2.39	0.36	4.37	1.40	2.94	2.91	1.13	5.82	1.67
4 Santa Clara	1.86	1.93	0.03	4.60	1.29	2.35	2.10	1.20	4.05	1.50
5 San Bernardino	2.17	2.37	0.18	3.90	1.42	2.88	2.84	0.32	5.92	1.65
6 Riverside	1.92	1.77	0.47	3.38	1.37	2.42	2.63	0.26	4.94	1.52
7 Alameda	2.45	2.77	0.06	5.65	1.42	2.64	2.85	0.35	6.21	1.55
8 Sacramento	1.88	2.08	0.10	3.83	1.31	4.03	4.26	0.47	5.99	1.96
9 Contra Costa	0.89	0.66	0.02	2.45	0.84	1.99	1.40	0.12	5.32	1.30
10 Fresno	1.73	1.47	0.18	3.80	1.28	1.70	1.72	0.30	5.54	1.24
11 San Francisco	0.66	0.65	0.25	0.94	0.80	0.72	0.67	0.21	1.45	0.83
12 Ventura	1.40	1.40	0.02	3.53	1.09	1.34	1.22	0.54	3.59	1.13
13 San Mateo	1.24	0.99	0.22	2.56	1.06	2.20	2.02	0.34	6.45	1.42
14 Kern	1.31	1.31	0.43	2.25	1.12	3.70	3.84	0.21	6.66	1.80
15 San Joaquin	1.65	1.43	0.26	3.77	1.20	1.21	1.12	0.01	2.53	1.04
17 Stanislaus	*	*	*	*	*	2.57	1.96	0.33	5.43	1.54
18 Santa Barbara	*	*	*	*	*	1.11	1.11	0.24	2.31	1.00
20 Tulare	1.83	1.92	0.32	2.83	1.32	1.70	1.74	0.42	3.87	1.26
21 Santa Cruz	*	*	*	*	*	0.32	0.28	0.04	0.91	0.53
22 Marin	0.73	0.63	0.35	1.47	0.83	0.56	0.58	0.03	1.21	0.73
23 San Luis Obispo	*	*	*	*	*	1.18	1.28	0.21	3.25	1.03
24 Placer	0.84	0.76	0.06	1.94	0.86	0.83	0.56	0.25	2.00	0.86

(continued)

Table 9-3. Design effect (DEFF) and square root DEFF (DEFT) statistics for estimates from the teen interviews, overall and by reported stratum (continued)

| | CHIS 2019 | | | | | CHIS 2020 | | | | |
| | Design effect (DEFF) | | | | DEFT | Design effect (DEFF) | | | | DEFT |
Stratum	Average	Median	Minimum	Maximum	Average	Average	Median	Minimum	Maximum	Average
25 Merced	1.53	1.54	0.27	2.68	1.20	1.60	1.55	0.07	4.20	1.19
26 Butte	*	*	*	*	*	0.55	0.66	0.09	1.14	0.70
27 Shasta	*	*	*	*	*	0.71	0.84	0.04	1.43	0.80
28 Yolo	0.25	0.26	0.01	0.48	0.48	0.32	0.33	0.03	0.78	0.53
29 El Dorado	*	*	*	*	*	0.70	0.59	0.13	2.01	0.80
30 Imperial	0.23	0.25	0.02	0.49	0.44	0.46	0.32	0.08	1.21	0.65
31 Napa	*	*	*	*	*	0.33	0.30	0.09	0.69	0.56
32 Kings	0.31	0.26	0.10	0.72	0.54	0.57	0.44	0.03	1.51	0.71
33 Madera	*	*	*	*	*	0.23	0.22	0.04	0.47	0.47
34 Monterey	1.26	0.93	0.09	3.04	1.03	1.90	1.66	0.26	4.61	1.33
35 Humboldt	0.28	0.29	0.00	0.52	0.51	0.35	0.27	0.07	0.71	0.57
36 Nevada	*	*	*	*	*	0.90	1.26	0.04	1.55	0.87
37 Mendocino	*	*	*	*	*	0.26	0.29	0.03	0.43	0.50
38 Sutter	*	*	*	*	*	0.19	0.15	0.00	0.53	0.40
39 Yuba	0.17	0.13	0.02	0.36	0.39	0.29	0.33	0.02	0.59	0.52
40 Lake	*	*	*	*	*	0.15	0.16	0.00	0.25	0.37
41 San Benito	*	*	*	*	*	0.18	0.17	0.02	0.45	0.39
42 Colusa, et al.	0.32	0.30	0.01	0.47	0.56	0.37	0.30	0.07	0.91	0.57

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Note. Design effect estimates are only provided for strata with 10 or more teen interviews.

9.2 Methods for Variance Estimation

Variance estimation for CHIS comes in two forms. The first is referred to as Taylor Series linearization or *linearization* for short. The analysis weights described in Chapters 4-6 along with the design stratum indicator and survey analysis software (e.g., SUDAAN, Stata, SAS/Survey, R) are used to generate (weighted) linearization variance estimates. Design effects (variance given the design divided by the variance under a simple random sample) and coefficients of variation (standard error divided by the estimated average) can be calculated to assess the relative precision of any particular estimate.

The second form of variance estimation is replication. There are several benefits noted for replication variance estimation, including the ability to capture the random nature of the adjustments applied throughout the weighting process. Replicate point estimates (e.g., mean) are generated from replicate weights and used in the following general formula to calculate the associated variance for the point estimate:

$$v(\hat{\theta}) = a \sum_{r=1}^{R} (\hat{\theta}_{(r)} - \hat{\theta})^2 \qquad (9.2)$$

where $\hat{\theta}_{(r)}$ is the estimate generated from the rth replicate; $\hat{\theta}$ is the full-sample estimate of a specific form that depends on the variance estimator chosen (e.g., estimate generated using the full-sample analytic weight); and a is a constant depending on the replication method chosen. Replicate weights were formed by first adjusting the base weights for the subsampling and then administering all adjustments applied to the full-sample weight to the replicates weights. See Wolter (2007) for a detailed discussion of variance estimation.

CHIS 2019-2020 employed similar methodology as in past rounds of CHIS—a paired-unit grouped jackknife (GJK) replication with R=80 replicates (see, e.g., Valliant et al., 2008). Details of the CHIS replicates are provided in the next section.

9.3 Design of Replicates

Replicate variance estimation requires a set of weights that capture components associated with the sample design and weight adjustments applied to the full-sample weight (Chapters 3-6). The sections below describe the methods for calculating the replicate weights for the one-year estimates (Section 9.3.1) and the two-year estimates (Section 9.3.2).

9.3.1   One-Year Replicates

A paired jackknife replication method (JK2) was used for computing variances in CHIS 2019-2020 to maintain consistency with prior years of the study. The benefits of a replication method include, for example, the ability to reflect all components of the design and the survey weights into the estimates of precision without the need to know such information. For example, Chapters 3-6 detailed a several adjustments applied to the weights to address sampling and subsampling for nonresponse and to limit biases associated with nonresponse and coverage. The replicate weights were constructed to capture variability in the adjustments.

Construction of the JK2 replicate weights follows procedures developed previously for CHIS. A total of 80 replicates were created to maintain the same degrees of freedom as in CHIS 2017-2018[3]. Construction of the replicates followed the following procedures:

1) Sampled addresses were sorted within sample design strata (both geographic and modeled strata) in the same order as when they were initially selected . Sampled addresses are referred to as sample units in the discussion below.

    2)   The ordered sample units were paired within the list and assigned to one of 80 variance strata in a circular fashion (in the JK2 method, the number of replicates is equal to the number of variance estimation strata). Once the 80th pair was assigned to variance stratum 80, the next pair was assigned to variance stratum 1 and so on. As a result, each variance stratum had approximately the same number of sample units.

3) Each sample unit in the pair was randomly assigned to variance unit (1 or 2 within each variance stratum, resulting in 2 variance units per variance stratum, each with approximately the same number of sample units.

The replicate weights were then created within each of the 80 strata that contained a random subsample of respondents, nonrespondents, ineligibles and those with unknown eligibility status. The first step was to form the replicate base weights by modifying the final base weights shown in Equations (3.1), (3.2) and (3.3):

---

[3] The construction of the 2019-2020 replicate weights deviated slightly from the procedures used in 2015-206 and 2017-2018. While all years created 80 replicate weights, using the paired jackknife method, the prior years created 80 replicates from 40 variance strata. Due to the special nature of JK2 (relative to other delete-n Jackknife methods), creating 80 variance strata allows for the same precision one would achieve with 160 variance strata under the JKn methodology. This procedure is in line with the replcate weight methodology used in CHIS prior to 2015.

$$
BW_i^{(r)} =
\begin{cases}
2 \times BW_i, & \text{if sample unit } i \text{ in variance stratum } s \text{ and variance unit } 1 \\
0, & \text{if sample unit } i \text{ in variance stratum } s \text{ and variance unit } 2 \\
BW_i, & \text{if sample unit } i \text{ not in variance stratum } s
\end{cases}
\tag{9.3}
$$

where $s = 1,2,\dots,80$ to index the replicate variance strata.

The same sequence of weighting adjustments used in the full sample weight is then applied to the replicate base weights to create the final replicate weights. Thus, all of the different components of the weighting process are fully reflected in the replicate weights, ranging from household adjustments (nonresponse, adjustment for household noncoverage, and adjustment to control totals) to person adjustments (nonresponse and raking).The final step was to calibrate the weights to the DoF population estimates used for the full sample. Thus, the weight sums for the replicates and full sample estimate the size of the CHIS target population and should match apart from rounding or deviations from the full-sample calibration model.

9.3.2 Two-Year Replicates

The creation of two-year replicate weights followed the same process described in Section 9.3.1. The first replicate from 2019 was combined with the first replicate from 2020 using a composite factor specific to that replicate to compute a two-year adjusted base weight. The two-year adjusted base weight for respondent j in replicate i, RBW_{1920ij}, will be calculated as:

$$
RBW_{1920ij} =
\begin{cases}
RBW_{19ij} \times \lambda_{19i} & \text{for 2019 respondents in replicate i} \\
RBW_{20ij} \times (1 - \lambda_{19i}) & \text{for 2020 respondents in replicate i}
\end{cases}
\tag{9.4}
$$

Where RBW_{19ij} is the final 2019 adjusted replicate base weight for respondent j in replicate i and RBW_{20ij} is the final 2020 adjusted replicate base weight for respondent j in replicate i. λ_{19i} is the proportion of all respondents in replicate i who responded in 2019.

A final adjustment was made to ensure that each replicate's base weight sums to exactly the target population size of 38,848,807 that was used for the 2020 weighting.

$$
FRBW_i = RBW_{1920i} \times \frac{38,848,807}{\sum_i RBW_{1920i}}
\tag{9.5}
$$

Each replicate was then calibrated to the population control totals that were used for the combined 2019-2020 full-sample weighting.

9.4 Software for Computing Variances

As mentioned in Chapter 2 of this report, researchers must account for the CHIS sampling design and use analysis weights to produce design unbiased population estimates. The focus of this section is a discussion of example software packages to properly accomplish this goal. Choice of software is generally user preference because they produce similar or even equivalent estimates.

- **WesVar, Version 5.1** (Westat, 2007) is provided free of charge from Westat. WesVar is an interactive software program with a graphical interface that includes replication methods to compute variance estimates. Analytic capabilities include descriptive statistics, as well as multivariate linear and logistic regression.
  WesVar requires (1) the identification of the CHIS full-sample and replicate weights provided on the data file, and (2) the specification of the replication method JK2. This allows the software to properly account for the sample design and the analysis weights.
- **SUDAAN®, Version 11** (RTI, 2012) is software developed by RTI International to analyze correlated data such as those from a survey. Estimated standard errors are available for Taylor series approximation (linearization) or for replication methods. Replication methods are recommended for CHIS to properly account for the complex nature of the analysis weights.
  SUDAAN contains several procedures for analyzing correlated data. For example, descriptive statistics for categorical and continuous variable are calculated with the CROSSTAB and DESCRIPT procedures, respectively. As with WesVar, SUDAAN requires (1) the identification of the CHIS linear weights (WEIGHT statement) and replicate weights (JACKWGTS statement) provided on the data file, and (2) the specification of the replication method using the DESIGN=JACKKNIFE option.
- **SAS®, Version 9.4** (SAS, 2015) also includes various procedures to analyze complex survey data and provide either linearization or replication variance estimates. The latter methodology is invoked with a REPWEIGHTS statement. For example, PROC SURVEYFREQ is used for categorical variables. VARMETHOD=JACKKNIFE requests the appropriate variance estimation method for CHIS.
- **Stata, Version 15** (StataCorp, 2017) is another option for analyzing CHIS data. Stata contains a list of survey procedures accessed via svy commands to analyze data from sample surveys. For example, "svy mean" and "svy total" produce estimated means and totals, respectively. Replication variance estimates are requested with "svyset" by identifying the

linear weights with the "pw" option, the replicate weights with the "jkrweight" option, and the design as "vce(jack)."

- **R, Version 3.4.1** (Venables et al., 2017) is the last software commented on in this short discussion. R is a free software and contains several packages that house procedures for analyzing survey data such as "survey" (Lumley, 2017) and "PracTools" (Valliant et al., 2017). As with the other packages, R will generate either linearization or replication variance estimates for a variety of statistics. Design objects are first specified via the "svydesign" command to define the type of variance estimation required; "svrepdesign" is needed specifically for replication variances. Functions such as "svymean" and "svytable" then operate on the design objects to produce the associated estimates.

Replication variance estimates are recommended. However, the CHIS data files contain two variables that enable calculation of Taylor-series linearization standard errors.

- TSVARSTR (Taylor's series variance stratum) – identifies the variance strata. This variable was created by sequentially numbering the design strata separately by sampling frame and year. TSVARSTR must be specified in the software packages when linearization standard errors are desired.
- TSVRUNIT (Taylor's series unit) – identifies the household cluster for those with multiple person interviews. This variable was created by sequentially numbering participating households within design stratum. In contrast to TSVARSTR, TSVRUNIT is needed only for analyses involving multiple respondents per household (adult and child/teen, child and teen, or adult, child and teen).

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APPENDIX A – Frame Sizes, Sample Sizes, and Base Weights

Appendix A includes supplemental information on the CHIS 2019-2020 sample design directly related to calculation of the base weights (inverse probability of selection).

Table A-1a and Table A-1b contain estimated ABS frame counts across geographic and modeled strata. Table A-2a and Table A-2b show the amount of sample released across strata and Table A-3a and Table A-3b show the resulting base weights.

Table A-1a. 2019 ABS Estimated Frame Sizes

Sample Stratum	Total	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles	3,441,913	1,469,875	64,674	43,837	222,840	584,102	270,549	177,319	608,717
2 San Diego	1,161,947	653,569	6,150	12,049	32,881	72,834	58,580	104,320	221,563
3 Orange	1,094,194	512,573	21,959	47,995	93,592	54,018	59,774	91,274	213,008
4 Santa Clara	664,828	264,203	11,537	35,610	121,339	28,143	48,496	43,201	112,299
5 San Bernardino	655,721	324,646	5,859	7,785	29,701	85,115	56,825	50,993	94,798
6 Riverside	756,544	406,371	4,013	5,306	24,799	83,059	54,357	61,373	117,265
7 Alameda	597,022	287,382	6,040	11,949	76,590	20,827	41,940	42,408	109,887
8 Sacramento	563,151	330,835	3,716	9,619	25,847	16,980	34,502	46,872	94,780
9 Contra Costa	412,564	231,335	3,032	2,904	19,837	24,899	28,573	35,871	66,114
10 Fresno	316,576	159,353	1,566	2,525	11,908	34,067	25,413	22,828	58,917
11 San Francisco	375,295	156,362	4,878	5,436	55,076	12,118	22,406	17,326	101,693
12 Ventura	280,108	144,522	1,262	1,419	12,273	23,180	11,695	26,702	59,054
13 San Mateo	272,283	125,357	3,027	3,003	32,960	14,561	17,374	19,662	56,339
14 Kern	277,180	131,736	1,002	762	6,520	41,445	21,350	20,575	53,790
15 San Joaquin	238,603	125,970	921	2,680	5,891	21,684	20,354	19,740	41,363
16 Sonoma	189,093	116,039	308	875	1,703	10,930	9,226	17,057	32,955
17 Stanislaus	176,696	102,122	381	565	1,468	17,924	12,504	14,127	27,605
18 Santa Barbara	150,351	82,194	353	276	1,028	13,315	7,225	11,551	34,408
19 Solano	158,444	99,344	336	672	1,878	9,231	9,923	13,540	23,522
20 Tulare	138,409	72,985	212	131	719	20,643	9,668	9,864	24,187
21 Santa Cruz	95,965	60,789	198	156	678	5,517	3,733	9,250	15,643
22 Marin	104,294	64,236	289	381	815	4,983	3,760	12,029	17,801
23 San Luis Obispo	109,783	65,833	172	133	384	8,456	4,056	10,285	20,464
24 Placer	147,176	89,682	467	449	917	11,359	6,524	18,853	18,925
25 Merced	81,922	43,202	194	242	765	10,747	6,400	6,110	14,262
26 Butte	80,085	48,789	149	130	400	4,678	3,804	5,831	16,303
27 Shasta	70,809	45,913	136	40	192	3,104	3,064	5,713	12,647

(continued)

Table A-1a. 2019 ABS Estimated Frame Sizes (continued)

Sample Stratum	Total	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	75,935	44,116	415	431	1,652	5,216	5,111	6,860	12,134
29 El Dorado	69,288	46,085	139	87	442	2,581	2,598	8,011	9,345
30 Imperial	49,562	17,938	82	62	171	14,737	3,464	2,763	10,345
31 Napa	53,421	28,403	106	106	627	6,010	3,173	4,288	10,708
32 Kings	43,089	20,613	62	48	150	7,428	3,207	3,006	8,575
33 Madera	46,135	23,970	65	33	154	6,554	3,072	3,044	9,244
34 Monterey	129,616	66,319	321	348	1,150	16,162	8,114	8,649	28,554
35 Humboldt	50,781	31,721	98	57	227	1,106	2,099	3,355	12,118
36 Nevada	42,608	29,829	52	16	152	1,077	1,182	3,409	6,891
37 Mendocino	29,575	18,394	36	14	165	1,325	1,659	1,863	6,118
38 Sutter	33,044	18,428	53	58	822	1,877	2,894	2,665	6,247
39 Yuba	25,251	14,297	62	102	282	1,287	2,206	1,912	5,104
40 Lake	23,063	14,028	13	17	200	424	1,679	1,311	5,391
41 San Benito	17,900	10,011	26	26	52	1,818	1,106	1,514	3,347
42 Tehama, etc.	40,440	23,127	52	24	74	3,261	3,485	2,610	7,806
43 Del Norte, etc.	47,670	30,145	18	34	114	1,429	2,738	2,971	10,221
44 Tuolumne, etc.	64,771	44,826	105	32	156	1,593	2,811	4,223	11,027

Source: UCLA Center for Health Policy Research, 2019 California Health Interview Survey.

Table A-1b. 2020 ABS Estimated Frame Sizes

Sample Stratum	Total	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles	3,441,913	1,449,566	58,941	42,095	208,379	509,368	287,856	172,121	713,587
2 San Diego	1,161,947	629,252	4,941	13,852	32,938	59,943	61,797	97,437	261,786
3 Orange	1,094,194	512,099	21,764	48,886	67,582	50,809	56,659	84,641	251,754
4 Santa Clara	664,828	237,866	10,450	36,469	140,113	15,310	42,619	40,426	141,575
5 San Bernardino	655,721	310,026	3,548	5,416	14,059	95,614	67,549	40,684	118,824
6 Riverside	756,544	397,025	3,005	4,853	7,858	90,697	56,095	56,888	140,123
7 Alameda	597,022	262,920	5,670	11,174	96,593	12,912	35,343	34,764	137,647
8 Sacramento	563,151	337,433	2,806	11,266	17,569	8,979	28,749	41,785	114,564
9 Contra Costa	412,564	233,190	2,972	3,668	23,728	14,394	22,102	40,351	72,158
10 Fresno	316,576	139,617	1,257	2,177	4,997	42,339	31,854	20,510	73,825
11 San Francisco	375,295	143,241	4,252	5,500	70,254	1,080	16,939	12,215	121,814
12 Ventura	280,108	152,640	1,073	1,155	3,384	25,543	11,802	26,740	57,771
13 San Mateo	272,283	114,190	2,380	2,339	44,355	5,375	13,171	20,803	69,671
14 Kern	277,180	126,061	484	484	1,139	45,561	24,119	18,538	60,795
15 San Joaquin	238,603	121,561	685	3,040	6,711	16,873	21,885	18,489	49,359
16 Sonoma	189,093	124,378	147	516	1,069	3,392	5,384	14,123	40,083
17 Stanislaus	176,696	99,273	468	441	992	17,909	14,851	12,564	30,198
18 Santa Barbara	150,351	78,909	597	329	866	11,469	7,198	8,572	42,411
19 Solano	158,444	104,332	519	597	2,724	2,646	11,388	13,593	22,646
20 Tulare	138,409	52,292	84	201	618	31,201	15,275	6,768	31,970
21 Santa Cruz	95,965	57,956	238	99	417	4,962	3,454	8,197	20,642
22 Marin	104,294	67,063	463	308	951	565	3,058	11,254	20,633
23 San Luis Obispo	109,783	72,629	187	117	163	653	3,151	10,549	22,335
24 Placer	147,176	100,303	363	302	1,058	876	4,624	20,127	19,523
25 Merced	81,922	31,952	133	495	885	14,582	9,490	3,931	20,454
26 Butte	80,085	50,559	45	178	327	416	3,540	5,295	19,724
27 Shasta	70,809	48,426	126	23	264	0	2,696	4,968	14,306

(continued)

Table A-1b. 2020 ABS Estimated Frame Sizes (continued)

Sample Stratum	Total	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	75,935	43,059	830	614	1,860	2,925	6,174	6,499	13,974
29 El Dorado	69,288	48,502	130	130	502	93	1,672	8,842	9,418
30 Imperial	49,562	8,931	81	50	125	21,273	4,156	1,352	13,594
31 Napa	53,421	32,080	85	162	1,054	1,292	2,185	4,328	12,235
32 Kings	43,089	18,435	45	55	60	6,818	4,200	2,855	10,620
33 Madera	46,135	19,744	35	17	70	8,605	3,682	2,569	11,413
34 Monterey	129,616	55,690	528	415	981	23,083	7,204	5,752	35,964
35 Humboldt	50,781	33,035	60	24	107	24	1,766	2,888	12,877
36 Nevada	42,608	31,053	28	0	19	0	819	2,859	7,831
37 Mendocino	29,575	18,187	47	6	83	1,060	1,433	1,380	7,379
38 Sutter	33,044	17,917	50	69	1,487	881	2,575	2,564	7,500
39 Yuba	25,251	13,892	78	88	264	474	2,391	1,707	6,357
40 Lake	23,063	12,915	14	14	28	139	1,709	981	7,264
41 San Benito	17,900	8,660	17	22	28	2,403	1,107	1,447	4,217
42 Tehama, etc.	40,440	22,850	27	17	18	2,092	3,685	2,207	9,545
43 Del Norte, etc.	47,670	29,812	38	0	57	55	2,001	2,329	13,378
44 Tuolumne, etc.	64,771	45,199	0	54	73	13	2,057	3,668	13,707

Source: UCLA Center for Health Policy Research, 2020 California Health Interview Survey.

Table A-2a. 2019 Sample Sizes

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles	22,357	1,548	815	3,010	18,893	5,116	7,060	3,468
2 San Diego	14,004	234	330	697	2,581	1,452	5,957	1,535
3 Orange	5,820	444	774	1,183	839	757	2,720	734
4 Santa Clara	3,095	242	570	1,372	488	643	1,327	396
5 San Bernardino	4,698	146	158	447	1,694	867	1,862	456
6 Riverside	5,822	110	109	424	1,567	828	2,296	517
7 Alameda	3,122	101	166	747	327	499	1,181	383
8 Sacramento	3,485	72	131	336	301	418	1,334	300
9 Contra Costa	2,530	60	45	212	427	365	985	218
10 Fresno	2,936	56	68	272	746	449	1,127	315
11 San Francisco	2,070	105	98	740	245	332	592	493
12 Ventura	1,279	21	23	171	259	120	557	172
13 San Mateo	1,459	58	48	335	277	242	595	177
14 Kern	2,055	31	16	176	684	308	866	228
15 San Joaquin	2,152	26	61	103	529	363	807	271
16 Sonoma	1,493	9	16	27	221	138	588	131
17 Stanislaus	1,959	11	17	33	450	233	712	167
18 Santa Barbara	1,389	10	7	17	318	145	541	152
19 Solano	2,175	12	20	46	250	222	685	173
20 Tulare	1,439	8	4	15	427	168	510	142
21 Santa Cruz	1,466	10	7	19	165	117	590	107
22 Marin	1,339	9	11	17	189	99	626	135
23 San Luis Obispo	714	3	3	7	312	91	330	79
24 Placer	1,156	10	8	12	315	114	483	114
25 Merced	1,591	12	11	28	487	232	584	185
26 Butte	1,336	6	5	11	252	127	445	132
27 Shasta	1,121	7	2	6	201	107	392	96

(continued)

Table A-2a. 2019 Sample Sizes (continued)

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	1,083	13	15	33	241	134	437	106
29 El Dorado	1,263	7	5	14	153	94	565	89
30 Imperial	1,666	13	6	16	1,161	269	667	225
31 Napa	1,301	9	7	27	449	169	514	158
32 Kings	2,196	12	8	19	1,030	317	792	295
33 Madera	1,835	8	3	12	651	243	598	231
34 Monterey	1,511	11	9	27	415	203	523	196
35 Humboldt	1,345	9	4	15	110	111	355	181
36 Nevada	1,239	4	2	10	106	76	342	124
37 Mendocino	1,315	6	2	16	145	141	386	136
38 Sutter	1,974	11	8	64	312	300	738	181
39 Yuba	1,928	13	18	41	259	304	668	215
40 Lake	1,805	4	4	33	96	223	473	206
41 San Benito	1,446	7	6	9	252	180	510	142
42 Tehama, etc.	1,870	5	4	6	387	303	500	241
43 Del Norte, etc.	1,269	3	3	3	99	126	332	142
44 Tuolumne, etc.	1,732	8	1	3	83	106	383	139

Source: UCLA Center for Health Policy Research, 2019 California Health Interview Survey.

Table A-2b. 2020 Sample Sizes

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles	15,427	1,073	664	2,307	12,003	3,846	4,797	2,675
2 San Diego	9,612	123	283	468	1,627	1,083	3,810	1,305
3 Orange	4,495	339	608	625	612	524	1,950	694
4 Santa Clara	2,006	157	434	1,240	176	377	895	378
5 San Bernardino	4,193	85	103	200	1,772	957	1,447	506
6 Riverside	4,338	59	75	91	1,359	646	1,638	482
7 Alameda	2,321	90	140	899	155	329	808	381
8 Sacramento	2,829	42	132	156	103	255	919	303
9 Contra Costa	1,778	41	40	189	150	179	814	173
10 Fresno	1,645	25	37	61	683	396	641	274
11 San Francisco	1,598	83	87	821	17	198	358	418
12 Ventura	1,325	18	15	31	302	109	610	154
13 San Mateo	1,012	38	29	414	66	124	485	194
14 Kern	1,611	12	10	14	799	324	625	244
15 San Joaquin	1,616	16	57	94	306	304	645	207
16 Sonoma	1,235	3	8	10	46	57	373	127
17 Stanislaus	1,299	10	10	12	323	205	432	126
18 Santa Barbara	965	13	8	11	192	93	279	160
19 Solano	1,456	15	12	39	51	167	498	100
20 Tulare	1,147	4	8	13	935	354	391	222
21 Santa Cruz	1,039	8	4	9	121	65	387	117
22 Marin	933	12	7	14	12	44	412	90
23 San Luis Obispo	1,144	6	5	2	16	52	435	112
24 Placer	1,174	8	7	14	14	56	622	72
25 Merced	1,223	9	26	35	767	383	397	248
26 Butte	1,254	3	7	8	16	93	347	156
27 Shasta	1,559	6	2	8	0	93	424	145

(continued)

Table A-2b. 2020 Sample Sizes (continued)

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	858	29	18	40	82	130	342	89
29 El Dorado	915	6	4	10	4	32	437	56
30 Imperial	518	9	6	8	1,689	255	207	249
31 Napa	1,374	7	11	48	77	100	491	163
32 Kings	1,347	6	7	5	679	323	546	247
33 Madera	1,232	4	2	4	737	240	422	224
34 Monterey	1,086	18	13	19	615	148	293	220
35 Humboldt	1,018	4	2	3	2	58	236	127
36 Nevada	1,232	3	0	1	0	34	297	96
37 Mendocino	1,165	5	1	5	94	96	230	150
38 Sutter	1,726	9	11	151	116	263	645	225
39 Yuba	1,517	15	13	30	69	274	490	217
40 Lake	1,413	3	3	3	21	196	283	251
41 San Benito	1,416	4	4	5	466	180	495	403
42 Tehama, etc.	1,292	3	2	0	184	219	336	176
43 Del Norte, etc.	1,101	4	0	0	6	86	200	247
44 Tuolumne, etc.	1,107	0	3	0	5	57	215	132

Source: UCLA Center for Health Policy Research, 2020 California Health Interview Survey.

Table A-3a. 2019 Base weights

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles*	65.75	41.78	53.79	74.03	30.92	52.88	25.12	175.52
2 San Diego*	46.67	26.28	36.51	47.17	28.22	40.34	17.51	144.34
3 Orange	88.07	49.46	62.01	79.11	64.38	78.96	33.56	290.2
4 Santa Clara	85.36	47.67	62.47	88.44	57.67	75.42	32.56	283.58
5 San Bernardino	69.1	40.13	49.27	66.44	50.24	65.54	27.39	207.89
6 Riverside	69.8	36.48	48.68	58.49	53.01	65.65	26.73	226.82
7 Alameda	92.05	59.8	71.98	102.53	63.69	84.05	35.91	286.91
8 Sacramento	94.93	51.61	73.43	76.93	56.41	82.54	35.14	315.93
9 Contra Costa	91.44	50.53	64.52	93.57	58.31	78.28	36.42	303.28
10 Fresno	54.28	27.97	37.13	43.78	45.67	56.6	20.26	187.04
11 San Francisco	75.54	46.45	55.47	74.43	49.46	67.49	29.27	206.27
12 Ventura	113	60.07	61.7	71.77	89.5	97.46	47.94	343.34
13 San Mateo	85.92	52.18	62.56	98.39	52.57	71.79	33.04	318.3
14 Kern	64.11	32.32	47.6	37.05	60.59	69.32	23.76	235.92
15 San Joaquin	58.54	35.41	43.93	57.2	40.99	56.07	24.46	152.63
16 Sonoma	77.72	34.17	54.71	63.09	49.46	66.86	29.01	251.56
17 Stanislaus	52.13	34.64	33.21	44.48	39.83	53.67	19.84	165.3
18 Santa Barbara	59.17	35.28	39.45	60.46	41.87	49.83	21.35	226.37
19 Solano	45.68	28	33.6	40.82	36.92	44.7	19.77	135.96
20 Tulare	50.72	26.54	32.66	47.91	48.34	57.55	19.34	170.33
21 Santa Cruz	41.47	19.81	22.35	35.68	33.44	31.91	15.68	146.2
22 Marin	47.97	32.14	34.66	47.95	26.36	37.98	19.22	131.86
23 San Luis Obispo	92.2	57.43	44.18	54.91	27.1	44.57	31.17	259.04
24 Placer	77.58	46.73	56.16	76.38	36.06	57.23	39.03	166.01
25 Merced	27.15	16.14	22.01	27.32	22.07	27.59	10.46	77.09
26 Butte	36.52	24.8	26.04	36.36	18.56	29.95	13.1	123.51
27 Shasta	40.96	19.38	19.95	31.92	15.44	28.64	14.57	131.74

(continued)

Table A-3a. 2019 Base weights (continued)

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	40.73	31.93	28.75	50.06	21.64	38.14	15.7	114.47
29 El Dorado	36.49	19.8	17.32	31.55	16.87	27.64	14.18	105
30 Imperial	10.77	6.31	10.26	10.69	12.69	12.88	4.14	45.98
31 Napa	21.83	11.73	15.08	23.21	13.39	18.78	8.34	67.77
32 Kings	9.39	5.17	5.97	7.91	7.21	10.12	3.8	29.07
33 Madera	13.06	8.16	10.88	12.82	10.07	12.64	5.09	40.02
34 Monterey	43.89	29.17	38.62	42.58	38.94	39.97	16.54	145.68
35 Humboldt	23.58	10.91	14.22	15.16	10.06	18.91	9.45	66.95
36 Nevada	24.08	13.07	7.84	15.16	10.16	15.55	9.97	55.58
37 Mendocino	13.99	5.98	7.18	10.32	9.14	11.76	4.83	44.99
38 Sutter	9.34	4.79	7.25	12.85	6.02	9.65	3.61	34.51
39 Yuba	7.42	4.74	5.66	6.88	4.97	7.26	2.86	23.74
40 Lake	7.77	3.26	4.35	6.06	4.42	7.53	2.77	26.17
41 San Benito	6.92	3.75	4.37	5.83	7.21	6.14	2.97	23.57
42 Tehama, etc.*	12.37	9.79	4.6	11.36	8.43	11.5	5.22	32.39
43 Del Norte, etc.*	23.75	5.86	8.47	34.6	14.43	21.73	8.95	71.98
44 Tuolumne, etc.*	25.88	13.07	10.41	30.9	19.19	26.52	11.03	79.33

Source: UCLA Center for Health Policy Research, 2019 California Health Interview Survey.

*Note: Geographic strata 1, 2, 42, 43 and 44 were divided into geographic substrata. The base weights presented in Table A-3 are averages across all substrata.

Table A-3b. 2020 Base weights

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
1 Los Angeles*	93.96	54.93	63.40	90.32	42.44	74.85	35.88	266.76
2 San Diego*	65.47	40.17	48.95	70.38	36.84	57.06	25.57	200.60
3 Orange	113.93	64.20	80.41	108.13	83.02	108.13	43.41	362.76
4 Santa Clara	118.58	66.56	84.03	112.99	86.99	113.05	45.17	374.54
5 San Bernardino	73.94	41.74	52.58	70.30	53.96	70.58	28.12	234.83
6 Riverside	91.52	50.92	64.71	86.35	66.74	86.83	34.73	290.71
7 Alameda	113.28	63.00	79.81	107.44	83.30	107.43	43.02	361.28
8 Sacramento	119.28	66.81	85.35	112.62	87.17	112.74	45.47	378.10
9 Contra Costa	131.15	72.48	91.71	125.54	95.96	123.48	49.57	417.10
10 Fresno	84.87	50.28	58.83	81.92	61.99	80.44	32.00	269.43
11 San Francisco	89.64	51.23	63.22	85.57	63.52	85.55	34.12	291.42
12 Ventura	115.20	59.61	77.03	109.15	84.58	108.27	43.84	375.14
13 San Mateo	112.84	62.63	80.65	107.14	81.44	106.22	42.89	359.13
14 Kern	78.25	40.34	48.41	81.36	57.02	74.44	29.66	249.16
15 San Joaquin	75.22	42.80	53.34	71.39	55.14	71.99	28.66	238.45
16 Sonoma	100.71	49.17	64.53	106.94	73.75	94.45	37.86	315.61
17 Stanislaus	76.42	46.84	44.08	82.66	55.45	72.44	29.08	239.67
18 Santa Barbara	81.77	45.95	41.07	78.74	59.73	77.40	30.72	265.07
19 Solano	71.66	34.59	49.72	69.84	51.88	68.19	27.29	226.46
20 Tulare	45.59	20.89	25.07	47.56	33.37	43.15	17.31	144.01
21 Santa Cruz	55.78	29.77	24.81	46.31	41.01	53.13	21.18	176.43
22 Marin	71.88	38.54	44.05	67.91	47.11	69.49	27.32	229.25
23 San Luis Obispo	63.49	31.12	23.34	81.68	40.84	60.59	24.25	199.42
24 Placer	85.44	45.33	43.17	75.55	62.60	82.57	32.36	271.15
25 Merced	26.13	14.81	19.04	25.29	19.01	24.78	9.90	82.48
26 Butte	40.32	14.87	25.50	40.91	26.03	38.07	15.26	126.43
27 Shasta	31.06	21.03	11.47	32.98	0.00	28.99	11.72	98.66

(continued)

Table A-3b. 2020 Base weights (continued)

Sample Stratum	Residual	Korean	Vietnamese	Asian	Hispanic	Less than HS/Not Citizen	Child/ Adolescent present	No Match
28 Yolo	50.18	28.64	34.10	46.49	35.67	47.50	19.00	157.01
29 El Dorado	53.01	21.67	32.51	50.15	23.22	52.24	20.23	168.18
30 Imperial	17.24	9.04	8.34	15.65	12.60	16.30	6.53	54.59
31 Napa	23.35	12.15	14.69	21.96	16.78	21.85	8.81	75.06
32 Kings	13.69	7.55	7.91	12.09	10.04	13.00	5.23	43.00
33 Madera	16.03	8.74	8.74	17.48	11.68	15.34	6.09	50.95
34 Monterey	51.28	29.34	31.91	51.61	37.53	48.68	19.63	163.47
35 Humboldt	32.45	14.92	11.93	35.80	11.93	30.45	12.24	101.40
36 Nevada	25.21	9.31	0.00	18.62	0.00	24.10	9.62	81.57
37 Mendocino	15.61	9.48	5.92	16.58	11.28	14.93	6.00	49.19
38 Sutter	10.38	5.54	6.27	9.85	7.60	9.79	3.98	33.33
39 Yuba	9.16	5.19	6.77	8.81	6.87	8.73	3.48	29.29
40 Lake	9.14	4.62	4.62	9.25	6.60	8.72	3.47	28.94
41 San Benito	6.12	4.18	5.57	5.57	5.16	6.15	2.92	10.46
42 Tehama, etc.*	17.69	6.87	8.60	-	11.37	16.83	6.57	54.24
43 Del Norte, etc.*	27.08	9.61	-	-	9.13	23.26	11.65	54.16
44 Tuolumne, etc.*	40.83	-	17.91	-	2.55	36.09	17.06	103.84

Source: UCLA Center for Health Policy Research, 2020 California Health Interview Survey.

*Note: Geographic strata 1, 2, 42, 43 and 44 were divided into geographic substrata. The base weights presented in Table A-3 are averages across all substrata

APPENDIX B – Summary Statistics for Weights and Weight Adjustments

Appendix B includes summary statistics on the CHIS 2019-2020 base weights, analysis weights, and the weight adjustments by person interview (adult, child and adolescent).

Table B-1 contains summary statistics for the household weight (Chapter 3) used as the basis for the person-level weights.

Table B-2, Table B-3, and Table B-4 includes summary information for the adult weights (Chapter 4), child weights (Chapter 5) and adolescent weights (Chapter 6).

Table B-1. Screener interview (households) weighting adjustments

Survey Weight Statistics	2019	2020
1. Base weight		
1.1 Sample size	254,845	190,425
1.2 Sum of weights	13,452,988	13,452,951
1.3 Coefficient of variation	87.7	88.8
2. Unknown residential status		
2.1 Sample size		
a. Known residential	152,223	92,160
b. Unknown residential	102,622	98,265
2.2 Sum of weights	11,549,926	11,996,432
2.3 Coefficient of variation	93.7	135.3
2.4 Mean non-zero	1.62	1.95
3. Screener nonresponse		
3.1 Sample size		
a. Screener respondents	30,072	30,234
b. Screener nonrespondents	104,075	160,191
3.2 Sum of weights	11,549,926	11,996,432
3.3 Coefficient of variation	96.3	90.2
3.4 Mean non-zero	4.41	2.91
4. Calibration to Low Response		
4.1 Sample size	30,072	30,234
4.2 Sum of weights	12,888,128	12,888,128
4.3 Coefficient of variation	99.1	95.3

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table B-2. Extended adult interview weighting adjustments

Survey Weight Statistics (Adult table)	2019	2020
1. Number of Adults Adjustment		
1.1 Sample size	30,072	30,234
1.2 Sum of weights	25,304,802	25,631,508
1.3 Coefficient of variation	110.3	104.5
1.4 Mean non-zero adjustment	1.97	2.03
2. Adult nonresponse adjustment		
2.1 Sample size		
a. Adult respondents	22,160	21,949
b. Adult nonrespondents	7,912	8,285
2.2 Sum of weights	25,304,802	25,631,508
2.3 Coefficient of variation	124.8	112.5
2.4 Mean non-zero adjustment	1.40	1.40
3. Pre-calibration trimming		
3.1 Number of records trimmed	849	795
3.2 Sum of weights	24,218,796	24,682,498
3.3 Coefficient of variation	97.7	90.1
4. Final Calibration Adjustment		
4.1 Sample size	22,160	21,949
4.2 Sum of weights	29,669,427	29,684,882
4.3 Coefficient of variation	172.3	153.9
4.4 Mean weight	1338.9	1352.4

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table B-3. Extended child interview weighting adjustments by sample type

Survey Weight Statistics (Child table)	2019	2020
1. Base weight		
1.1 Sample size	3,757	4,456
1.2 Sum of weights	3,123,787	3,195,101
1.3 Coefficient of variation	176.2	187.4
2. Child nonresponse adjustment		
2.1 Sample size		
a. Child respondents	3,009	3,548
b. Child nonrespondents	748	908
2.2 Sum of weights	3,123,787	3,195,101
2.3 Coefficient of variation	146.7	194.0
2.4 Mean non-zero adjustment	1.33	1.29
3. Pre-calibration trimming		
3.1 Number of records trimmed	114	148
3.2 Sum of weights	2,940,237	2,832,119
3.3 Coefficient of variation	110.4	111.5
4. Final Calibration Adjustment		
4.1 Sample size	3,009	3,548
4.2 Sum of weights	6,059,755	6,020,873
4.3 Coefficient of variation	151.2	149.6
4.4 Mean weight	2,013.9	1,697.0

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.

Table B-4. Extended adolescent interview weighting adjustments by sample type

Survey Weight Statistics (Adolescent table)	2019	2020
1. Base weight		
1.1 Sample size	3,042	3,695
1.2 Sum of weights	2,237,470	2,331,943
1.3 Coefficient of variation	120.3	156.1
2. Adolescent nonresponse adjustment		
2.1 Sample size		
a. Adolescent respondents	847	1,365
b. Adolescent nonrespondents	2.195	2,330
2.2 Sum of weights	2,237,470	2,331,943
2.3 Coefficient of variation	110.7	151.9
2.4 Mean non-zero adjustment factor	4.1706	2.85
3. Pre-calibration trimming		
3.1 Number of records trimmed	78	130
3.2 Sum of weights	2,107,237	2,062,429
3.3 Coefficient of variation	93.2	98.6
4. Final Calibration Adjustment		
4.1 Sample size	847	1,365
4.2 Sum of weights	3,134,657	3,143,052
4.3 Coefficient of variation	118.0	141.3
4.4 Mean weight	3,700.9	2,302.6

Source: UCLA Center for Health Policy Research, 2019-2020 California Health Interview Survey.