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**Abstract:**

This report was produced by RTI International for BJS under award number 2020-85-CX-K017. The purpose of the research described in this report is to (1) examine the presence and impact of outlier cases in the National Crime Victimization Survey data, (2) develop a strategy for identifying these cases and mitigating their effects, and (3) evaluate the impact of this strategy on annual estimates, the precision of estimates, and trends in victimization over time. This work was conducted as part of BJS's active research program on weighting, designed to improve the quality and accuracy of NCVS estimates.

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# National Crime Victimization Survey: Assessment of Outlier Weights

## Identifying and Adjusting for Extreme Cases

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## CONTENTS

<u>Section</u>	<u>Page</u>
Executive Summary	1
Introduction	3
Section 1. Phase I–Evaluation of Person and Household Weights	7
Section 2. Phase II–Evaluation of Victimization Weights	10
Section 3. Phase III–Framework for Limiting the Impact of Outlier Cases	13
3.1 Outlier Case Mitigation Considerations .....	13
3.1.1 Level of Adjustment .....	13
3.1.2 Focus of the Adjustment .....	15
3.1.3 Adjustment Specificity .....	16
3.2 Requirements for an Appropriate Adjustment.....	17
3.3 A Hybrid Adjustment Formulation.....	20
Section 4. Phase IV–Evaluation of Hybrid Adjustment Approach	22
4.1 Development of Hybrid Adjustment Thresholds.....	22
4.2 Evaluation of Hybrid Adjustment Thresholds.....	24
4.2.1 Number of Cases Identified as Outliers .....	24
4.2.2 Magnitude of the Hybrid Adjustment for Outlier Cases.....	25
4.2.3 Impact on Population Totals .....	27
4.2.4 Impact on Annual Victimization Estimates and Precision.....	28
4.2.5 Impact on Trends in Victimization Estimates Over Time .....	32
Section 5. Summary and Recommendations	36
Appendix A: Supplemental Tables	38

## LIST OF TABLES

<b>Number</b>		<b>Page</b>
Table 1.	NCVS Analysis Weights and Components .....	4
Table 2.	Characteristics by Level of Adjustment Options.....	15
Table 3.	Hybrid Adjustment Thresholds .....	24
Table 4.	Number of Person- and Household-level Victims Identified as Outliers by Hybrid Approach Threshold and Year .....	25
Table 5.	Average Size of Hybrid Adjustment Factor for Person- and Household-level Outliers by Threshold and Year .....	26
Table 6.	Decrease in Person and Household Population Totals from Hybrid Adjustment Approach by Threshold and Year and Population of Households and Persons Age 12 or Older.....	27
Table 7.	Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors, 2019 .....	29
Table 8.	Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors by Characteristics of Persons and Households, 2019 .....	31
Table 9.	Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors for Crimes Reported to Police, 2019 .....	32

## LIST OF FIGURES

<b><u>Number</u></b>		<b><u>Page</u></b>
Figure 1.	Distribution of Standardized NCVS Person-level Weights by Year.....	8
Figure 2.	Distribution of Standardized Interview-level Contributions for Total Violent Crime by Year .....	11
Figure 3.	Contribution of Single Interview to RSA Victimization Rate by Year.....	12
Figure 4.	The Interaction of Base Weight and Victimization Count with Respect to Potential for Extremity .....	18
Figure 5.	Distribution of the Number of Victimization Reported by Crime Type, 2008–2019 .....	23
Figure 6.	Impact of Hybrid Adjustment Approach and Reallocation Methods on Trends in Violent Crime Victimization Rates, 2008–2019 .....	34
Figure 7.	Impact of Hybrid Adjustment Approach and Reallocation Methods on Trends in Property Crime Victimization Rates, 2008–2019 .....	35

## EXECUTIVE SUMMARY

The primary objective of the Bureau of Justice Statistics' (BJS) National Crime Victimization Survey (NCVS) is to provide accurate and reliable estimates of the criminal victimization of persons age 12 or older and households in the United States. To achieve this goal, a sample of eligible households and persons is interviewed each year. During these interviews, respondents are asked to report incidents of criminal victimization they experienced in the prior 6 months. This sample is then weighted to be representative of the population of interest, and respondents' reported incidents are classified and aggregated to estimate victimization rates and totals within this inferential population. However, the NCVS weighting process does not consider a respondent's victimization profile, which allows for the possibility that a given respondent's experience with victimization is misaligned with the number of persons in the population they represent. In other words, a single person or household could have a disproportionate influence on annual victimization estimates for the United States as a whole or for certain subpopulations of interest. The purpose of the research described in this report is to (1) examine the presence and impact of outlier cases in the NCVS data, (2) develop a strategy for identifying these cases and mitigating their effects, and (3) evaluate the impact of this strategy on annual estimates, the precision of estimates, and trends in victimization over time. Key findings of this work are summarized below.

### Findings

- Respondents with the greatest contribution to annual victimization estimates are those who report a large number of victimizations and have a high person or household weight.
- The top 1% of individual cases (in terms of series-adjusted weighted victimizations) account for 10–15% of the annual victimization estimate for person-level crime types and 5% for household-level crime types in most years.

### Mitigation Strategy

Due to the complex nature of the NCVS methodology and victimization data, a mitigation strategy for limiting the effects of outlier cases in the NCVS data should do the following:

- Account for all incidents reported by a person or household for a given crime type within a single interview and consider all key crime types simultaneously.

- Reduce the population representation of outlier cases by using a hybrid approach that considers two linked factors: 1) individual extremity, in terms of the number of victimizations reported relative to other NCVS respondents and 2) the contribution to annual estimates, by applying an adjustment factor to the person (or household) weight.

### **Recommended Approach**

The recommended thresholds for defining an outlier case include (1) a series-adjusted victimization count of more than 10 incidents reported for a given crime type during a single interview, and (2) a series-adjusted weighted contribution at or above the 97th percentile of the distribution of contributions among all victims for the crime type(s) for which the respondent reported more than 10 incidents. Within a given year, the recommended approach typically classifies as outliers fewer than 10 persons and fewer than 15 households. The adjustment approach typically results in a minor reduction in annual victimization rates and standard errors with no discernable impact on trends in victimization estimates over time.

## INTRODUCTION

Analysis weights in large sample surveys account for differential probabilities of selecting sample members and varying response rates to help ensure estimates produced from a sample are representative of the target population. Generally, the analysis weights consist of the design-based weights<sup>1</sup> adjusted for potential nonresponse and coverage error. As such, these weights play an important role in both the accuracy and precision of estimates calculated from survey data such as the Bureau of Justice Statistics' (BJS) National Crime Victimization Survey (NCVS). Due to the complexity of the NCVS data and the various types of analysis that can be conducted, multiple analysis weights and additional adjustments are required. The household weight corresponds to the number of households in the population represented by each responding housing unit. In the NCVS, this weight is used to form the denominator when calculating rates of property crime. The person weight corresponds to the number of persons age 12 or older in the population represented by each respondent. The person weight is used to form the denominator when calculating personal crime rates. The victimization weight is associated with an incident record and is used to calculate victimization estimates. For annual rates, the victimization weight is used in the calculation of the numerator. The incident weight is associated with incident records and is equal to the victimization weight divided by the total number of persons victimized during the incident.<sup>2</sup> The incident weight is typically used to calculate estimates of the total number of crimes committed against particular demographic groups. The components of each of these weights are shown in *Table 1*.<sup>3</sup> Each weight is created by taking the product of all relevant weight components. For example, the household weight is the product of the base weight, group quarter (GQ) subsampling adjustment, household nonresponse factor, and the ratio adjustment.

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<sup>1</sup> Design-based weights account for the probabilities of selection under the complex survey design including oversampling of geographic areas or subpopulations.

<sup>2</sup> For property crimes, the incident weight is always equal to the victimization weight, as the victim is the entire household.

<sup>3</sup> For more information on the NCVS weighting methodology and a description of the weight components, see *National Crime Victimization Survey, 2016: Technical Documentation* (NCJ 251442).



**Table 1. NCVS Analysis Weights and Components**

Components of the NCVS Weights	Household-level Estimates			Person-level Estimates		
	Household Weight	Victimization Weight	Incident Weight	Person Weight	Victimization Weight	Incident Weight
Base weight	X	X	X	X	X	X
GQ subsampling adjustment	X	X	X	X	X	X
Household nonresponse	X	X	X	X	X	X
Within-household nonresponse				X	X	X
Ratio adjustment	X	X	X	X	X	X
Bounding adjustment		X	X		X	X
Time-In-Sample adjustment		X	X		X	X
Series crime adjustment		X	X		X	X
Multiple victim adjustment						X

Source: National Crime Victimization Survey, 2016: Technical Documentation (NCJ 251442).

The NCVS base weight is the inverse of the probability of selection for a case and incorporates the first- and second-stage selection probabilities. In the first stage of sampling, primary sampling units (PSUs), which are large metropolitan areas, counties, or groups of counties, are selected. Within each selected PSU, housing units and GQs are sampled in the second stage. When a selected GQ is larger than anticipated, subsampling is used and the GQ subsampling adjustment accounts for the change in the probability of selection. The household nonresponse adjustment reallocates the weights of nonresponding occupied housing units to other responding housing units in the sample. Within a responding household, all persons age 12 or older are eligible to complete the survey. To account for eligible persons who are unavailable or refuse to complete the survey, the within-household nonresponse adjustment allocates the weights of nonresponding persons to respondents. The ratio adjustment component protects against coverage bias by ensuring the distribution of demographic characteristics of responding households and persons in the NCVS matches population control totals from the Census Bureau’s American Community Survey and projections from the most recent Census.

For responding households or persons that report crime incidents during the survey, additional weight components are required to produce the victimization and incident weights needed for proper analysis of NCVS data. When a crime incident is reported during the first interview, a bounding adjustment is used to account for telescoping which occurs when a

respondent includes events that occurred outside the 6-month recall period used on the NCVS. The time-in-sample (TIS) adjustment factor is used during special situations, such as the phase-in period for a new sample design which causes the actual TIS to differ from the rotation chart TIS for a large number of cases. The TIS adjustment accounts for the fact respondents tend to report a greater number of incidents in earlier interviews than later interviews.<sup>4</sup> The series crime adjustment ensures that all incidents experienced by a victim are accurately reflected in estimates while limiting respondent burden. Series incidents are victimizations similar in nature but occurring with such frequency the victim is unable to recall the specific details of each event. When a series incident is reported, the respondent provides details on only the most recent incident. The series crime adjustment factor is multiplied by the victimization weight to capture all incidents experienced by the victim up to a maximum of 10. The final weight component, the multiple victim adjustment, only applies to the incident weight and is used when an incident involves more than one victim. If only one victim is present during an incident, the incident weight will equal the victimization weight.

Although efforts are made during the NCVS weighting process to limit the size of weighting adjustment factors (e.g., if ratio adjustment factors are less than 0.5 or greater than 2 then adjustment cells are collapsed), it is still possible for some households or individuals to be assigned a large weight relative to other members of the sample. When these households or persons with large weights also report a large number of victimizations, they can have an undue, or “extreme,” influence on victimization estimates and negatively affect the precision of estimates, particularly for rare crime types or small subpopulations. Due to the extreme nature of these households or persons, these cases can be considered “outliers” relative to other members of the population. The goals of the research described in this report are to complete the following:

1. Examine the degree to which outlier cases exist in the NCVS data and identify the factors contributing to this extremity.
2. Develop methods that could be used to limit the impact of outlier cases on NCVS estimates and precision.

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<sup>4</sup> For more information on TIS bias, see Bureau of Justice Statistics (2014), “National Crime Victimization Survey, Technical Documentation”, United States Department of Justice.

3. Evaluate the effect of these mitigation strategies on annual estimates, precision, and trends in victimization estimates over time.

This evaluation proceeded in four phases using NCVS data from 2008–2019, excluding 2016.<sup>5</sup> The first two stages of the analysis were largely exploratory in nature and focused on how respondents with the largest person and household weights (Phase I) and victimization weights (Phase II) contributed to annual victimization estimates, the precision of annual estimates, and the ability to detect changes in victimization rates over time. In Phase III, the information learned during these exploratory phases was used to develop a strategy for identifying and moderating the effect of outlier cases. In the final step of the analysis, Phase IV, the methods developed in Phase III were applied to the annual NCVS data to evaluate the impact on victimization estimates, precision, and trends in criminal victimization over time.

Throughout this report, analysis weights, the unweighted number of victimizations reported by a respondent, and the contribution to annual estimates (i.e., the number of series-adjusted weighted victimizations) are often discussed in terms of “high/low” or “large/small.” In most instances, the specific value that distinguishes between these designations is relative to the values reported by or assigned to similar cases (e.g., other persons from the same survey year, other victims of the same crime type). For example, the number of person-level respondents in the 2019 NCVS is approximately 85% higher than the number of respondents in 2008. However, the inferential population only increased by approximately 10% between 2008 and 2019. Consequently, the person weights in 2019 are generally smaller than the weights of respondents to the 2008 survey. Similarly, in 2019, fewer than 200 NCVS respondents reported being the victim of rape or sexual assault (RSA), but nearly 1,400 persons reported being the victim of simple assault. As a result, persons reporting RSA will tend to have larger contributions, on average, to annual rates or totals of RSA than an individual reporting simple assault will have to annual rates or totals of simple assault.

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<sup>5</sup> BJS revised estimates by combining data from respondents from 2015 and 2016 following the implementation of the 2016 sample redesign. This combined file has been reweighted and includes replicate weights rather than sample design variables which could affect the evaluation of high weights. As such, 2016 was excluded from all analyses. For more information, see *Criminal Victimization, 2016 Revised* (NCJ 252121).

## SECTION 1. PHASE I—EVALUATION OF PERSON AND HOUSEHOLD WEIGHTS

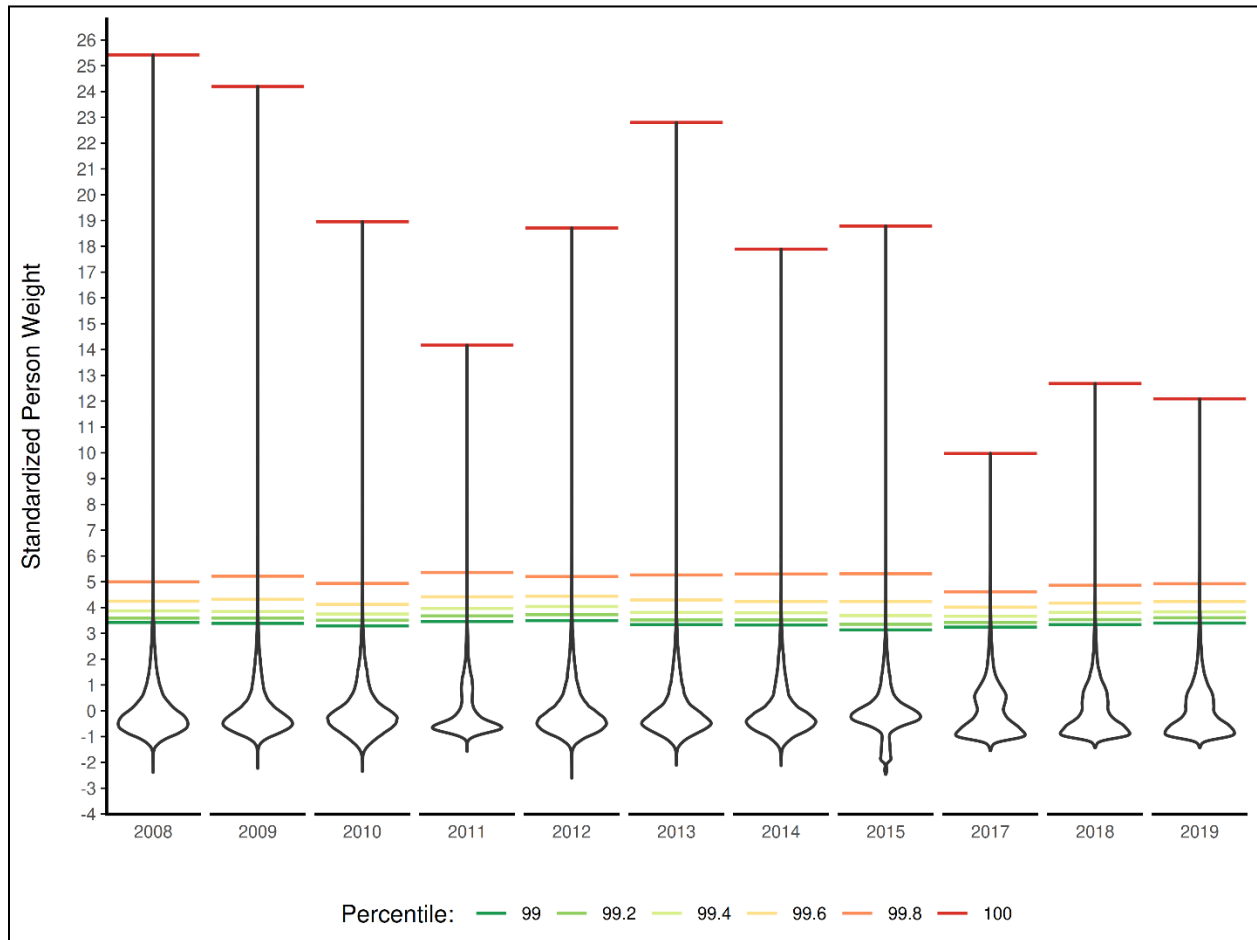
In the first phase of the examination, the distribution of household- (WGTHHCY) and person-level (WGTPERCY) weights were evaluated, as were the impact of high weights on victimization rates and totals, estimate precision, and significance testing across years.<sup>6</sup>

To identify potential thresholds for defining what constitutes a “high” weight, the weights were standardized (i.e., mean=0, standard deviation=1) and the distribution of these standardized weights was examined by year (see *Figure 1* for the distribution of person-level weights). Between the 99th and 99.6th percentiles, the weight distributions were relatively consistent over time. However, above the 99.6th percentile, a greater amount of variability was observed leading to the choice of both the 99th and 99.6th percentile as thresholds for further evaluation.

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<sup>6</sup> The household and person weights described in *Table 1* correspond to the variables V2116 and V3080, respectively, on NCVS public-use files and are representative of the US population of households and persons age 12 or older at the time of the interview. Since the NCVS sample is interviewed every 6 months, these weights must be adjusted to create annual estimates and to be representative of the average population during the entire reference year. As such, the adjusted household and person weights, WGTHHCY and WGTPERCY, were used for the analyses described in this report.

**Figure 1. Distribution of Standardized NCVS Person-level Weights by Year**



After identifying these thresholds, this phase of the evaluation focuses on understanding how responding persons or households with high weights affected statistics produced with NCVS data. To measure these effects, estimates from the full annual sample are compared to estimates with the high-weight cases excluded. This analysis includes annual victimization rates and totals for major crime types overall (total violent crime, RSA, robbery, aggravated assault, simple assault, violent crime excluding simple assault, overall property crime, burglary, motor vehicle theft, and other household theft). It also includes victimization rates for total violent crime and violent crime excluding simple assault by characteristics of respondents (age, sex, race/ethnicity, and marital status) and characteristics of the incident (victim-offender relationship, presence of a weapon during the incident, injury status of the victim, and whether the victimization was reported to the police).

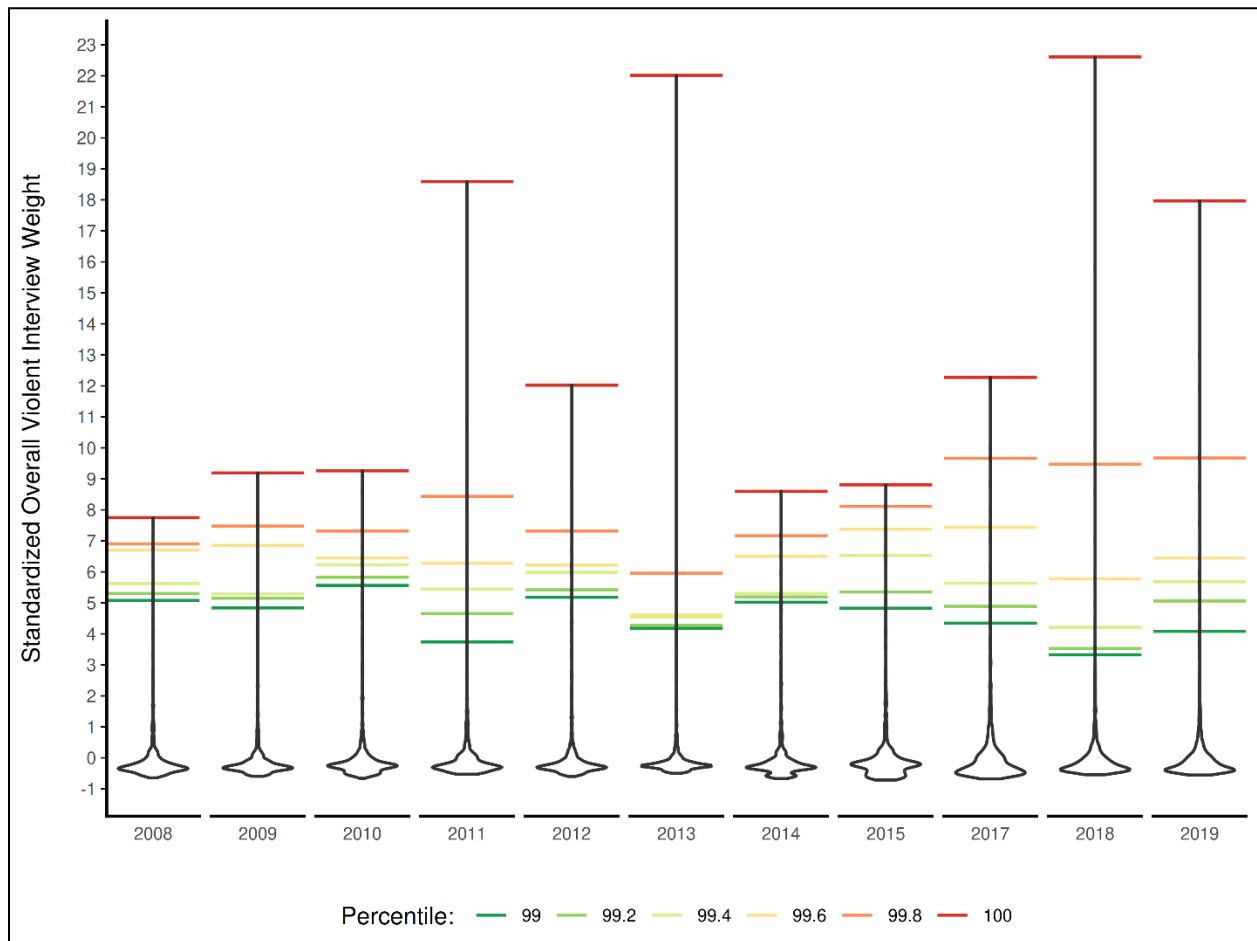
This investigation yielded the following findings:

- The contribution of respondents with high weights to annual victimization totals is typically less than 5% for most crime types for the United States overall and for estimates within population subgroups (e.g., by age group, race/ethnicity category). For total violent crime, respondents with a person weight above the 99th percentile accounted for, on average, 4.1% of the annual total. For overall property crime, households with a weight above the 99th percentile accounted for, on average, 3.0% of the annual total. For some crime types and years, estimates are unaffected because there were no victims of that particular crime type with high weights.
- Removing respondents with high weights has only a minor impact on victimization rates across all crime types and years. Some variation of the impact of high weights on subdomain estimates (e.g., among persons age 12–17 or 18–24; among non-Hispanic black respondents) was observed, suggesting high weights can have differential effects on victimization rates for certain population groups.
- Generally, removing cases with high weights has a minimal effect on standard errors of victimization rates. For person-level crime types, standard errors tended to increase more frequently than decrease, with an average increase of 0.7% across all crime types and years included in the analysis. For household-level crime types, the opposite pattern was observed, with standard errors being more likely to decrease when removing cases with high weights from estimates. For household-level crime types, the average change in standard errors was 1.1% for the crime types and years analyzed.
- Excluding cases with high weights has a minimal impact on the ability to detect significant differences in victimization rates across years. The crime types showing the greatest number of changes in across-year significance testing include total violent crime, simple assault, and household burglary.

## SECTION 2. PHASE II–EVALUATION OF VICTIMIZATION WEIGHTS

For the second phase of the evaluation, the impact of high series-adjusted victimization weights on annual NCVS estimates between 2008–2019 was examined. Although the household and person weights evaluated in Phase I play an important role in the calculation of estimates with NCVS data, annual estimates may be more sensitive to victimization weight outliers. This is due to the small number of victims for some crime types, relative to the total sample size, as well as the additional weight components (e.g., bounding or TIS adjustment factors, series crime adjustment) included in the victimization weights (see *Table 1*). The primary focus of this phase of the evaluation was to quantify the contribution (i.e., the number of series-adjusted weighted victimizations) of cases to annual estimates. NCVS respondents can report multiple incidents, of the same or different crime types, during a single interview. Some persons or households are also interviewed twice within a single data year. Because of these factors, the contribution of reported victimizations to annual estimates was defined and evaluated at three separate levels: (1) contribution of a single incident report (may involve multiple victimizations for series-crime incidents), (2) contribution of all incidents reported within a single interview, and (3) contribution of all incidents reported within a data year by a single person or household. The distribution of the standardized contributions for total violent crime from all incidents reported within a single interview by survey year is shown in *Figure 2*. Although these distributions show less consistency over time, the same thresholds identified in Phase I (i.e., 99th percentile and 99.6th percentile) were used in Phase II.

**Figure 2. Distribution of Standardized Interview-level Contributions for Total Violent Crime by Year**



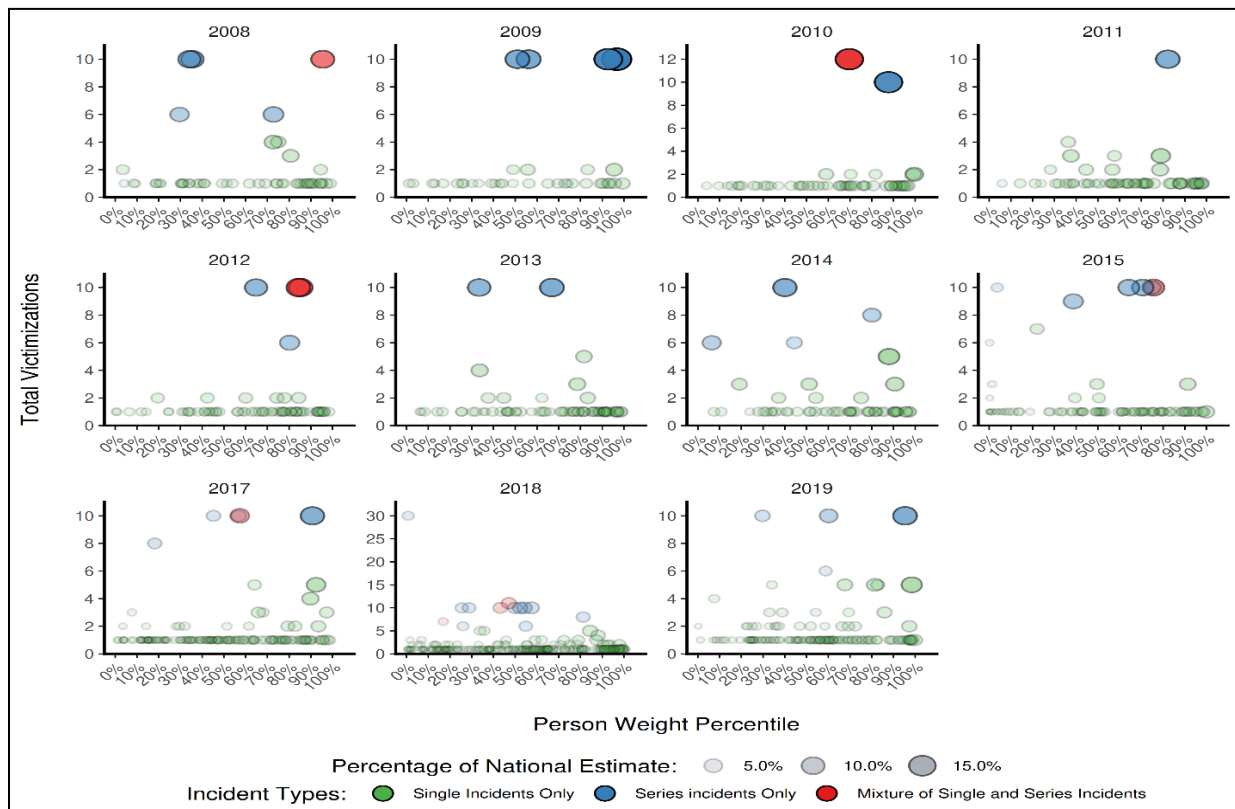
The Phase II analysis included the same crime types and characteristics of victims and incidents analyzed in Phase I although estimates of victimization totals were not included. The key takeaways from this analysis include the following.

- Large contributions from a single incident occur more frequently for person-level crimes than household-level crimes. The crime types for which single incidents contribute the most to national annual estimates include RSA (up to 19.0%), robbery (up to 8.7%), and aggravated assault (up to 5.5%).
- The maximum contribution at the interview level is slightly higher than the maximum contribution at the incident level for some crime types, but, generally, the results are similar for most crime types.
- The contributions of single persons or households, aggregated across multiple interviews within a single data year, were similar to the contribution at the interview level.



- The top 1% of individual cases (in terms of series-adjusted weighted victimizations) account for 10–15% of the annual victimization estimate for person-level crime types and 5% for household-level crime types in most years.
- Excluding the highest contributing cases tends to decrease the standard errors of victimization estimates. For example, the standard error for the violent victimization rate decreases by an average of 25.5% between 2008 and 2019 when excluding the top 1% of cases based on the contribution of all incidents reported during an interview. However, the significance of differences in victimization rates across years was unchanged for most crime types and year groups.
- The impact of a single case (i.e., incident, interview, or person/household) on annual victimization estimates is dependent on both the analysis weight and the number of victimizations reported for a particular crime type.
  - Some respondents can report a large number of incidents during a single interview. However, these do not always result in a large contribution, relative to the contribution of other interviews, due to a smaller person or household weight. For example, as seen in **Figure 3**, a respondent in the 2018 survey reported 30 RSA victimizations during a single interview. However, because of the small person weight assigned to this individual, the overall contribution to the national estimate was similar to other respondents reporting this type of crime.
  - Similarly, victims with a large person or household weight may or may not have a large contribution relative to other victims, depending on the number of victimizations reported.

**Figure 3. Contribution of Single Interview to RSA Victimization Rate by Year**



## SECTION 3. PHASE III–FRAMEWORK FOR LIMITING THE IMPACT OF OUTLIER CASES

### 3.1 Outlier Case Mitigation Considerations

Where Phases I and II of the assessment were devoted to exploratory analyses identifying and describing the factors contributing to and the impacts of the potential extreme weights issue in the NCVS, in Phase III the emphasis shifted to developing specific approaches for identifying and mitigating the impact of outlier cases. At the highest level, mitigation by adjustment of respondent data (as opposed to removal of outlier cases as employed in Phases I and II) was assumed, and three distinct domains were considered for developing an adjustment-based mitigation:

1. Level of adjustment: incident, interview, or data year
2. Data component(s) on which the adjustment focuses: base weight<sup>7</sup> or reported victimization data
3. Adjustment specificity: victimization types that should be used to identify and adjust outlier cases.

#### 3.1.1 Level of Adjustment

Identification and mitigation of outlier cases require first establishing a definition for what constitutes a case for these purposes. Based on research conducted in Phases I and II, three options were identified for evaluation:

1. **Individual incidents:** the information collected regarding a specific crime incident separate from any other crime incidents or person/household information collected during the reporting period
2. **Whole interviews:** all information collected from the person or household during the 6-month reporting period
3. **Complete annual responses for persons or households:** all interviews conducted for the person or household during the calendar year

Defining cases at the individual incident level is the most granular option, which uses the most restrictive criteria for measuring and addressing extremity holistically. Individuals reporting multiple incidents that would collectively be classified as an outlier would go undetected. For example, an individual could report multiple incidents of RSA within a single interview or data year, which, taken together, may have a substantial contribution to the national

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<sup>7</sup> Throughout this report, the term “base weight” is used to refer to WGTPERCY or WGTHHCY. The term “base” is used as these weights are the starting points for the outlier case adjustment process.

RSA rate. By focusing only on the individual incident components of that contribution, such a case could not be identified as an outlier. This misses a key observation about respondents' impact on estimates: high contribution by an individual to an estimate is a function of both the base person or household weight and the aggregate number of incidents reported within a given reporting period and crime type category. Defining cases at the incident level considers only one of these factors and was therefore deemed by BJS, in consultation with RTI, inadequate for identifying outlier cases.

By defining what constitutes a case at a level higher than the individual incident—either by interview or whole annual contribution—the collective impact of multiple incidents can be considered in the assessment of extremity. While the annual case level is more directly tied to the current level of estimation (annual versus semi-annual), this definition has both substantive and practical downsides, especially in future scenarios in which BJS may shift some reporting to a nonannual basis.

From a substantive perspective, aggregating two interviews can have a smoothing effect that may mask extreme interviews. For example, a respondent who reports two series assaults in one interview and none in the second may not look like an outlier on an annual basis, whereas he or she may look like an outlier in the first interview if taken individually. This is a potentially important distinction depending on the mechanism driving extremity. If there is a possibility the extremity was introduced through any source other than actual respondent experience (e.g., measurement or recall error), that source would be more closely tied to the interview than the data year, and mitigation of outlier cases would therefore also be more appropriately tied to the interview.

Defining cases at the interview level also has a practical benefit. Due to the nature of the NCVS weighting process, an individual respondent may have a different weight in each interview. This complicates both the identification and amelioration of extremity with respect to the base person or household weight. For these reasons, the interview level was chosen as the most appropriate level for defining cases in this context. *Table 2* shows how characteristics differ across the three options.

**Table 2. Characteristics by Level of Adjustment Options**

Characteristic	Individual Incidents	Whole Interviews	Annual Responses
Allows identification of extremity across crime types		X	X
Allows identification of extremity across incidents		X	X
Aligns with level of potential measurement or recall error sources	X	X	
Aligns with timeframe for weight creation	X	X	
Would work under semi-annual reporting	X	X	

### 3.1.2 Focus of the Adjustment

Once an outlier case is identified, a mitigating adjustment can be applied to that case’s data to make it less extreme. In the NCVS, multiple components comprise the contribution of any one respondent from a single interview to a given estimate, and an appropriate outlier case adjustment procedure will be clear about which of these components is being adjusted. For person-level crimes, that contribution is defined as:

$$Contribution = w_i * b_i * y_i$$

Where

- $w_i$  = Person or household weight for respondent  $i$  (as described in *Table 1*)
- $b_i$  = Ratio of the victimization weight (WGTVICCY) and the person or household weight (i.e., WGTPERCY or WGTHHCY). This ratio accounts for non-sampling error adjustments (e.g., bounding adjustment, TIS adjustment). When there are no non-sampling error adjustments, the ratio will equal two.
- $y_i$  = The sum of series-weighted incidents within the crime type of interest for respondent  $i$

As previously noted, the product of the base person (or household) weight and the total number of incidents dictates the level of impact. So, although identification of extremity focuses on the entirety of the contribution to an estimate, any adjustment factor that may be applied to ameliorate that extremity would become a new term in the contribution equation shown above, much like the bounding adjustment factor  $b_i$ .

In the case of  $b_i$ , the bounding adjustment is being made to  $y_i$  not to  $w_i$ . This is because the bounding adjustment is correcting for recall error. In other words, the bounding adjustment is meant to specifically deflate the number of incidents reported in unbounded interviews. It has no meaning in the context of the base person weight  $w_i$  because that is a property of the sample

design (and post-collection weight adjustments), which are completely independent of the respondent's reported incident totals. The contribution equation can be rewritten to emphasize this relationship:

$$\textit{Contribution} = w_i * (b_i * y_i)$$

Similarly, any adjustment factor— $e_i$ —meant to correct for extreme reporting would be incorporated into the contribution equation, and multiple interpretations may be considered. In the course of the Phase III analysis, and in consultation with BJS, it was established that outlier cases are not being viewed through the lens of respondent error as in the case of the bounding adjustment. There is no inherent suspicion the number of reported incidents in an outlier case is erroneous. Rather, the base weight in an outlier case is too high in light of the number of reported victimizations (i.e., the sample case represents too large a share of the population relative to other cases with large numbers of victimizations). From this perspective, though possible to consider other mathematically equivalent equations, contribution equation 1 is the natural interpretation of an outlier case adjustment factor—the adjustment is on the design itself and acts through a deflation of the base weight.

$$\textit{Contribution} = (e_i * w_i) * (b_i * y_i) \tag{1}$$

Equation 1 groups  $e_i$  with the base person weight, emphasizing that while the overall weight contribution is being reduced, the focus of the adjustment is on the NCVS design rather than the respondent's reported data.

### 3.1.3 Adjustment Specificity

With the establishment of a framework in which outlier cases are identified and mitigated at the interview level and with an adjustment factor that acts on the base person (or household) weight, the final domain to consider was how distinct crime type(s) would drive identification of outlier cases and how they would determine the level of adjustment.

In the NCVS, some estimates are components of others, so adjusting one but not the other could introduce undesirable inconsistencies. For example, a given respondent may have a contribution to the national RSA estimate that is an outlier while their total violent contribution is not. If adjustment extremity is judged on victimization estimates independently, the person weight would be deflated for the RSA estimate but not for the total violent estimate. Ultimately it

was decided, in consultation with BJS, this type of inconsistency should be avoided, and adjustments would apply to all estimates (within person or household crimes) according to the same factor, while the determination of the adjustment factor would be worked out separately for person and household crimes. For example, if an adjustment factor of 0.5 was determined to be appropriate for an NCVS person record, that factor would apply to that record in the calculation of all person crime estimates, but the corresponding household would not be adjusted unless it was independently determined to be an outlier for one or more household crime type estimates.

The determination of an appropriate adjustment factor for a given case (i.e., person or household interview) should then simultaneously consider each victimization category for which any given case could be viewed as an outlier. An appropriate adjustment factor would be one preventing a respondent from being an extreme contributor to all of those estimates. It was determined for person crimes that the adjustment should prevent excessive contribution to all of the following key crime types at the national level:

- Total violent
- RSA
- Robbery
- Aggravated assault
- Simple assault.

For property—or household—crimes, the following key crime types should be controlled at the national level:

- Total property
- Burglary
- Household theft
- Motor vehicle theft.

### **3.2 Requirements for an Appropriate Adjustment**

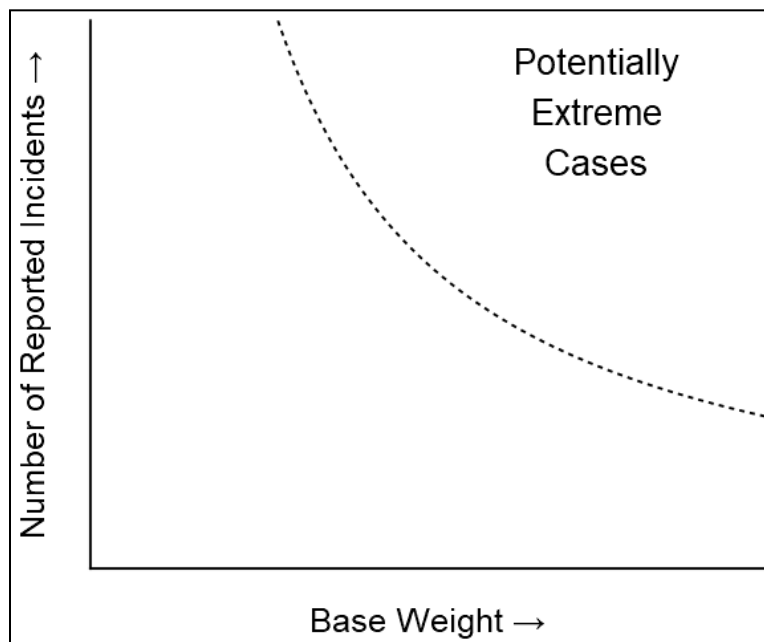
Based on the considerations described above, the following requirements for an appropriate NCVS outlier case adjustment were established:

- Outlier cases should be identified and adjusted at the interview level.
- The level of extremity (and adjustment) should consider the product of the base weight and victimization count (i.e., the contribution).

- Individual adjustment factors for identified cases should act on the base person (or household) weight reflecting an adjustment of the sample design rather than survey participant responses.
- To ensure consistency across crime types, a single factor should be applied across all estimates (within person/household categories) to which an identified respondent contributes.
- The identification of outlier cases should consider all key crime types simultaneously.
- Derivation of the level of the adjustment factor should consider all of those crime types.

On their own, these requirements do not necessarily paint a clear picture of how an appropriate adjustment should be formulated. A given respondent could have a high base weight and/or a high number of victimizations—the interaction of these determines if a case may be an outlier. *Figure 4* lays out this relationship. The border between potential outlier and normal cases (depicted in *Figure 4* by the dashed curve) varies by type of crime and is depicted here only to illustrate the relationship between the base weight and victimization count.

**Figure 4. The Interaction of Base Weight and Victimization Count with Respect to Potential for Extremity**



*Figure 4* shows how cases may become extreme. The following groups are relevant to the analysis of outlier cases:

1. Cases (person or household interviews) with large base weights and large victimization counts

2. Cases with large victimization counts and small base weights
3. Cases with large base weights and small victimization counts
4. Cases with small base weights and small victimization counts

To derive an appropriate formulation of an outlier case adjustment, it helps to consider which of these groups may contain outliers from a qualitative perspective. The following sections consider these groups individually.

### *1. Cases with Large Base Weights and Large Victimization Counts*

Cases in this group are most clearly outliers. The base weight is large, indicating large population representation, but the victimization count is also large—a set of qualities rare among victims. This misalignment between population representation and individual victimization profile results in an inappropriately large contribution to the estimate.

**Outcome:** Adjustments will be needed for these cases.

### *2. Cases with Large Victimization Counts and Small Base Weights*

Cases in this group may also contribute a large proportion of the overall estimate, but they do so because their victimization counts are high while their base weights are not. Although these cases do not represent large proportions of the population, their representation may still be too high, depending on the number of victimizations reported. These cases are not clearly outliers, but may still qualify as such given their high contribution to the estimate.

**Outcome:** These cases may need adjustments, but those adjustments will be smaller relative to cases with equivalent victimization counts and larger base weights.

### *3. Cases with Large Base Weights and Small Victimization Counts*

A case in this group may contribute a substantial proportion of the overall estimate, but it does so purely by way of its base weight and does not exhibit a large number of victimizations. In other words, a case in this group represents a large proportion of the population (it is not a person or household with a rare set of characteristics) with a modest number of victimizations. Viewed in this way, there is little to suggest such a case is an outlier. Its base weight is high because it is typical of the underlying population, and its victimization count is low, as is typical among victims.



**Outcome:** These cases should not be adjusted.

#### 4. Cases with Small Base Weights and Small Victimization Counts

Cases in this group individually contribute little to an estimate and would not be considered outliers.

**Outcome:** These cases should not be adjusted.

Only cases with a large number of victimizations *and* a large estimate contribution should have their base weights adjusted. This means given two cases with equivalent and large contributions to an estimate, one may be adjusted (if it is in the first or second group), whereas the other may not (if it is in the third group). An adjustment that operates in this way makes changes to population representation (through deflation of the base weight) to appropriately reflect the rarity of the case (as reflected in the victimization count). This observation highlights how an approach that focuses only on contribution would not be comprehensive—extremity in the number of victimizations reported in an interview should be a prerequisite. This leads naturally to a *hybrid approach* in which both of two conditions must be satisfied: (1) a case has a victimization count over some threshold indicating individual extremity, and (2) has an outlier contribution to an estimate.

### 3.3 A Hybrid Adjustment Formulation

In order to satisfy the requirements and qualitative considerations described above, the following basic formulation was proposed for the derivation of the outlier case adjustment factor  $e_i$  for respondent-interview (or, case)  $i$ .

$$e_i = \max \left( \mathbb{I}_{v_{i,1} > x} \frac{c_{i,1}}{t_1}, \mathbb{I}_{v_{i,2} > x} \frac{c_{i,2}}{t_2}, \dots, \mathbb{I}_{v_{i,k} > x} \frac{c_{i,k}}{t_k}, 1 \right)^{-1}$$

Where

$\mathbb{I}_{v_{i,k} > x}$  = one if the victimization count  $v$  for case  $i$  in type of crime (TOC)  $k$  is greater than threshold  $x$  and zero otherwise

$t_k$  = the threshold of what constitutes a large contribution to the overall estimate for TOC  $k$

$c_{i,k}$  = the individual contribution to the estimate for TOC  $k$  by respondent-interview case  $i$

The above base formulation satisfies all requirements, but two parameters are left undetermined. The indicator function  $\mathbb{I}_{v_{i,k} > x}$  dictates if a case's victimization count is high enough for it to be considered in the adjustment derivation (i.e., it prevents cases in the third group from being adjusted). Similarly, the TOC-specific estimate contribution thresholds  $t_k$  dictate what is large enough for it to qualify for adjustment. Development of appropriate values for these parameters, including a numerical example, is covered in the following section.

## SECTION 4. PHASE IV–EVALUATION OF HYBRID ADJUSTMENT APPROACH

### 4.1 Development of Hybrid Adjustment Thresholds

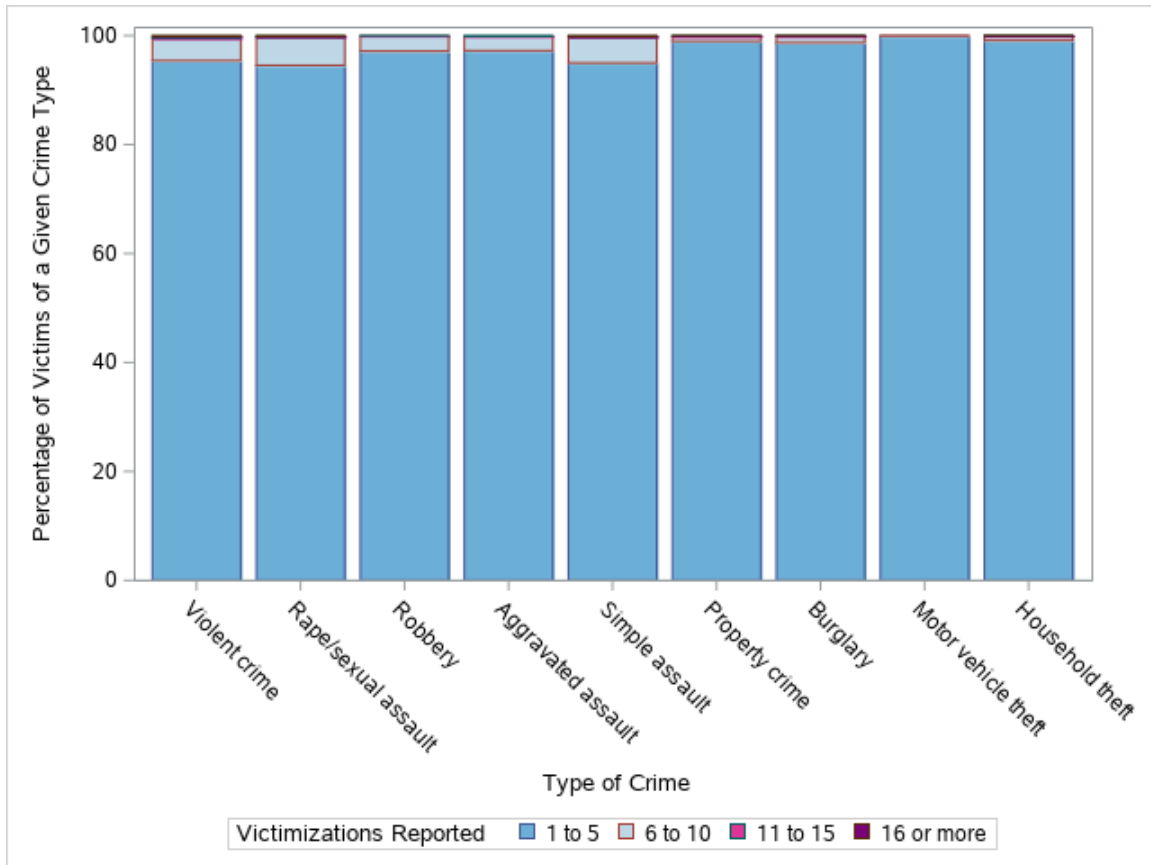
The hybrid adjustment formula requires two parameters ( $x$  and  $t_k$ ) that determine the magnitude of the adjustment factor,  $e_i$ , for an outlier case.<sup>8</sup> These parameters correspond to the two conditions described previously: (1) a case has a victimization count over some threshold indicating individual extremity, and (2) has a contribution to an estimate that is also above some threshold.

**Parameter 1 ( $x$ ) considerations:** To determine the threshold for individual extremity, the distribution of the number of series-adjusted victimizations reported within an interview by victims of each of the major crime types was evaluated. As shown in *Figure 5*, between 2008–2019, the percentage of victims reporting fewer than six victimizations varied between 94.6% for RSA to 99.9% for motor vehicle theft. Less than 0.6% of victims of each of the major crime types reported more than 10 victimizations during the previous 6 months and less than 0.15% reported more than 15 victimizations. These findings suggest respondents reporting more than 10 victimizations for a given crime type within a single interview are relatively rare and these cases should have a population representation (i.e., base person or household weight) that reflects this uniqueness. A victimization count threshold of 10 also aligns with the treatment of series crimes in the NCVS. When respondents report more than 10 incidents in a series, the number of victimizations for that incident is capped at 10 for estimation purposes. However, to ensure any mitigation strategy for outlier cases does not unduly affect victimization estimates produced with the NCVS, two additional victimization count thresholds for defining individual extremity were also evaluated. Therefore, the hybrid adjustment approach was examined using three thresholds for the series-adjusted victimization count parameter: (1)  $x=10$  victimizations, (2)  $x=12$  victimizations, and (3)  $x=15$  victimizations.

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<sup>8</sup> Cases that are not outliers will receive an adjustment factor of one (i.e., no adjustment).

**Figure 5. Distribution of the Number of Victimizations Reported by Crime Type, 2008–2019**



**Parameter 2 ( $t_k$ ) considerations:** The second parameter required for the hybrid approach ( $t_k$ ) corresponds to the size of the individual contribution (i.e., the weighted number of series-adjusted victimizations). Three percentile thresholds were evaluated in coordination with the three series-adjusted victimization count thresholds. These percentile thresholds were determined by examining the contribution of all victims at the victimization count threshold boundaries (e.g., contribution percentile of all victims reporting exactly 10 victimizations when  $x=10$ ). A case exceeding both thresholds for a given crime type suggests the population representation for such a case is misaligned with the distinctive nature of their experience with criminal victimization and should be adjusted accordingly. Contribution thresholds were set at the 97th, 98th, and 99th percentile corresponding to the three victimization count thresholds, as shown in **Table 3**. The contributions corresponding to these percentiles for each of the key crime

types included in the hybrid adjustment approach are provided in *Table A.1* and *Table A.2* in *Appendix A* for person-level crime types and household-level crime types, respectively.

**Table 3. Hybrid Adjustment Thresholds**

Option	Victimization Count Threshold ( $x$ )	Contribution Threshold ( $t_k$ )
1	10 victimizations	97th percentile
2	12 victimizations	98th percentile
3	15 victimizations	99th percentile

## 4.2 Evaluation of Hybrid Adjustment Thresholds

Using the three combinations of victimization count and contribution thresholds shown in *Table 3*, the impact of the hybrid adjustment approach on the NCVS data was evaluated. This examination focused on determining how the different thresholds under consideration would affect the following aspects of the NCVS:

- Number of cases identified as outliers
- Magnitude of the hybrid adjustment for outlier cases
- Impact on population totals
- Impact on annual victimization estimates and precision
- Impact on trends in victimization estimates over time

### 4.2.1 Number of Cases Identified as Outliers

The first step in evaluating the impact of the various thresholds was to determine how many cases would be labeled as an outlier by the hybrid approach using the three sets of parameters. As shown in *Table 4*, using a victimization count threshold of 10 and the 97th contribution percentile, fewer than 10 victims of person-level crimes and fewer than 15 victims of household-level crimes are identified as an outlier in any given year between 2008–2019. As the thresholds are raised, fewer cases are flagged as outliers and, in some years, no cases are labeled as outliers.

**Table 4. Number of Person- and Household-level Victims Identified as Outliers by Hybrid Approach Threshold and Year**

Year	Victims of Person-Level Crimes			Victims of Household-Level Crimes				
	Total Victims	$x=10$ ; $t_k=97$ th Percentile	$x=12$ ; $t_k=98$ th Percentile	$x=15$ ; $t_k=99$ th Percentile	Total Victims	$x=10$ ; $t_k=97$ th Percentile	$x=12$ ; $t_k=98$ th Percentile	$x=15$ ; $t_k=99$ th Percentile
2008	1,142	5	2	2	4,577	8	3	2
2009	1,049	4	1	1	4,476	5	1	1
2010	1,036	4	0	0	4,697	3	1	1
2011	1,151	4	4	2	4,754	10	2	1
2012	1,431	8	2	0	6,037	6	2	1
2013	1,191	8	4	3	5,114	9	2	2
2014	1,132	4	1	0	4,574	5	2	0
2015	1,147	4	1	0	4,757	8	1	0
2017	1,875	8	2	0	7,111	13	2	1
2018	1,944	9	2	2	7,078	14	5	1
2019	1,830	4	2	1	6,697	8	2	0
<b>Total</b>	<b>14,928</b>	<b>62</b>	<b>21</b>	<b>11</b>	<b>59,872</b>	<b>89</b>	<b>23</b>	<b>10</b>

#### 4.2.2 Magnitude of the Hybrid Adjustment for Outlier Cases

Once the outlier cases under each threshold were identified, the next step of the evaluation examined each individual case to determine the size of the adjustment factor,  $e_i$ . As described previously, the adjustment factor will be multiplied by the base person or household weight to decrease the population representation of outlier cases. Thus, for example, a smaller adjustment factor corresponds with a larger adjustment and cases that are not classified as outliers will receive a factor of  $e_i=1$  (i.e., no adjustment). Consider the following example of a household reporting 14 burglaries and 2 thefts during a single interview.

Year	Household Weight	Series-Adjusted Weighted (Unweighted) Victimizations			
		Property	Burglary	Motor Vehicle Theft	Other Theft
2019	1,500	48,000 (16)	42,000 (14)	0	6,000 (2)

With thresholds of  $x=10$  and  $t_k=97$ th percentile, the adjustment factor would be calculated as follows (see *Table A.2* for percentile thresholds for household-level crimes).

$$e_i = \max\left(\mathbb{I}_{v_{i,1}>x} \frac{c_{i,1}}{t_1}, \mathbb{I}_{v_{i,2}>x} \frac{c_{i,2}}{t_2}, \dots, \mathbb{I}_{v_{i,k}>x} \frac{c_{i,k}}{t_k}, 1\right)^{-1} = \max\left(\frac{48,000}{5,891}, \frac{42,000}{5,576}, 0, 0, 1\right)^{-1}$$

$$= \max(8.148, 7.532, 0, 0, 1)^{-1} = \frac{1}{8.148} = 0.123$$

This factor, 0.123, would then be multiplied by the base household weight. The revised household weight and number of victimizations represented by this household would be as follows.

Year	Household Weight	Series-Adjusted Weighted (Unweighted) Victimizations			
		Property	Burglary	Motor Vehicle Theft	Other Theft
2019	184.5	5,904 (16)	5,166 (14)	0	738 (2)

The average adjustment factor for outlier person- and household-level victims by year and threshold is shown in *Table 5*. Generally, the person-level adjustment factors are larger (i.e., a smaller adjustment is applied to the base weight) than the household-level adjustment factors and higher threshold values result in smaller average adjustments. Additional details on the sum of weights and series-adjusted weighted number of victimizations before and after the hybrid adjustment by persons (see *Tables A.3–A.5*) and households (see *Tables A.6–A.8*) identified as outliers can be found in *Appendix A*.

**Table 5. Average Size of Hybrid Adjustment Factor for Person- and Household-level Outliers by Threshold and Year**

Year	Victims of Person-Level Crimes			Victims of Household-Level Crimes		
	$x=10$ ; $t_k=97$ th Percentile	$x=12$ ; $t_k=98$ th Percentile	$x=15$ ; $t_k=99$ th Percentile	$x=10$ ; $t_k=97$ th Percentile	$x=12$ ; $t_k=98$ th Percentile	$x=15$ ; $t_k=99$ th Percentile
2008	0.573	0.642	0.771	0.306	0.298	0.263
2009	0.538	0.591	0.671	0.250	0.342	0.472
2010	0.452	n/a	n/a	0.240	0.277	0.380
2011	0.473	0.633	0.679	0.379	0.335	0.554
2012	0.620	0.973	n/a	0.338	0.274	0.323
2013	0.568	0.568	0.645	0.297	0.208	0.304
2014	0.512	0.912	n/a	0.242	0.330	n/a
2015	0.380	0.458	n/a	0.396	0.208	n/a
2017	0.599	0.628	n/a	0.444	0.312	0.539
2018	0.557	0.464	0.584	0.394	0.404	0.391
2019	0.376	0.505	0.572	0.255	0.268	n/a
<b>Total</b>	<b>0.534</b>	<b>0.628</b>	<b>0.659</b>	<b>0.344</b>	<b>0.313</b>	<b>0.379</b>

### 4.2.3 Impact on Population Totals

Before examining the impact on victimization estimates, it was first necessary to assess the effect of the hybrid adjustment on population totals. Because the adjustment factor is applied to the base person or household weight, the sum of these weights across all NCVS respondents would decrease in any year in which an outlier case was identified. These weight sums represent the number of persons or households in the inferential population. Reducing the number of persons or households represented by the NCVS sample by trimming the outlier weights could introduce coverage bias. The decrease in person and household weight totals caused by the application of the hybrid adjustment to outlier cases by year and threshold, as well as the size of the inferential population, are shown in **Table 6**. These changes are generally small relative to the entire population of persons or households represented by the NCVS sample. For example, in 2019, applying the hybrid adjustment with  $x=10$  and  $t_k=97$ th percentile would reduce the population represented by the sample by 2,696 persons, which is 0.001% of the total inferential population of 276,872,470 persons age 12 or older. However, it is also possible these effects could be concentrated within certain subgroups.

**Table 6. Decrease in Person and Household Population Totals from Hybrid Adjustment Approach by Threshold and Year and Population of Households and Persons Age 12 or Older**

Year	Persons				Households			
	$x=10;$ $t_k=97$ th Percentile	$x=12;$ $t_k=98$ th Percentile	$x=15;$ $t_k=99$ th Percentile	Population Total	$x=10;$ $t_k=97$ th Percentile	$x=12;$ $t_k=98$ th Percentile	$x=15;$ $t_k=99$ th Percentile	Population Total
2008	4,561	1,364	871	252,242,520	9,155	3,366	2,405	121,141,060
2009	3,961	622	501	254,105,610	8,389	1,020	819	122,327,660
2010	4,074	0	0	255,961,940	3,677	1,402	1,203	122,885,160
2011	3,640	2,568	1,205	257,542,240	11,728	2,295	537	123,038,570
2012	5,406	93	0	261,996,320	5,041	1,707	815	125,920,480
2013	6,096	2,874	1,892	264,411,700	9,244	2,273	2,004	127,622,320
2014	3,948	174	0	266,665,160	5,973	2,041	0	129,492,740
2015	5,544	1,229	0	269,526,470	7,064	1,522	0	131,962,260
2017	4,951	844	0	272,468,480	8,336	1,238	201	123,085,790
2018	7,736	3,058	2,824	275,325,390	9,678	3,042	224	124,824,660
2019	2,696	930	478	276,872,470	8,362	1,886	0	126,433,890

Reallocation of the excess weight to the respondent population guards against the potential coverage bias introduced by the hybrid adjustment. Two reallocation approaches were



evaluated as part of the remaining analyses related to victimization estimates, precision, and trends over time. Both approaches use a *ratio adjustment* to increase the weight of non-extreme cases by an amount equivalent to the decrease in weight among outlier cases. The difference between the two approaches is the set of respondents who receive the ratio adjustment:

1. Reallocate weights among all respondents (i.e., persons or households), excluding outlier cases.
2. Reallocate weights among other victims (i.e., victims of person crimes or victims of household crimes), excluding outlier cases.

Both approaches will ensure population control totals are maintained. However, a drawback of using either of these ratio adjustment approaches is the characteristics (e.g., age, race) of the outlier cases and those whose weights are being inflated are not controlled for during the adjustment. Although a model-based post-stratification adjustment could better control the redistribution of weights, such an approach was not evaluated as part of this analysis due to the added complexity it would entail. Further, analysis of the ratio adjustment approach, as discussed in the subsequent sections of this report, did not identify any issues suggesting a more complicated approach is necessary.

#### **4.2.4 Impact on Annual Victimization Estimates and Precision**

After identifying the potential thresholds for the hybrid adjustment approach and methods for reallocating weights, the next step was to examine the effect of these options on annual crime rates. To evaluate the impact of the hybrid adjustment approach on annual victimization estimates and the precision of victimization estimates, victimization rates and standard errors were calculated for major person- and household-level crime types overall (see **Table 7**) and for total violent and total property crime within subgroups defined by geographic, demographic, and socioeconomic characteristics (see **Table 8**).<sup>9</sup> Victimization rates for crimes reported to the police were also calculated for various crime types (see **Table 9**). Estimates in these tables are for the 2019 NCVS survey year. For the adjusted estimates, the hybrid adjustment was applied to

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<sup>9</sup> Standard errors were calculated using the Taylor series linearization techniques described in *User's Guide To National Crime Victimization Survey (NCVS) Direct Variance Estimation* available at [https://bjs.ojp.gov/sites/g/files/xyckuh236/files/media/document/ncvs\\_variance\\_user\\_guide\\_11.06.14.pdf](https://bjs.ojp.gov/sites/g/files/xyckuh236/files/media/document/ncvs_variance_user_guide_11.06.14.pdf). These standard errors are for comparison purposes within the context of this analysis only. For official estimates of precision, see *Criminal Victimization, 2019*.

identify and adjust the weights of outlier cases using a victimization count threshold of 10 and the 97th contribution percentile.<sup>10</sup>

For each type of crime or population subgroup, four sets of estimates are presented in the tables below. The “original” estimates are based on the NCVS public-use file without any outlier-case adjustment applied. The remaining three sets of estimates apply the hybrid adjustment but vary based on the reallocation approach: (1) no reallocation, (2) reallocation to all respondents, and (3) reallocation to other victims.

**Overall Crime Type Estimates:** The hybrid adjustment generally resulted in a 1%–5% reduction in victimization rates for overall crime types (*Table 7*) with the largest changes observed for the crime types of RSA and intimate partner violence. Standard errors also generally decreased by 2%–9% for each crime type with the largest changes occurring for estimates of intimate partner violence and burglary. The reallocation approaches evaluated had negligible effects on victimization rates and standard errors.

**Table 7. Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors, 2019**

Type of Crime	Original		No Reallocation		Ratio—All Respondents		Ratio—Victims	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE
<b>Violent crime</b>	21.00	1.081	20.71	1.045	20.71	1.045	20.73	1.046
Rape or sexual assault	1.66	0.273	1.58	0.259	1.58	0.259	1.58	0.259
Robbery	1.93	0.223	1.93	0.223	1.93	0.223	1.93	0.223
Assault	17.41	0.943	17.20	0.922	17.20	0.922	17.22	0.924
Aggravated assault	3.68	0.333	3.64	0.326	3.64	0.326	3.65	0.326
Simple assault	13.73	0.860	13.56	0.840	13.56	0.840	13.57	0.841
<b>Violent excluding simple assault</b>	7.27	0.490	7.15	0.474	7.15	0.474	7.16	0.474
Domestic violence	4.21	0.501	4.09	0.475	4.09	0.475	4.09	0.475
Intimate partner violence	2.51	0.372	2.39	0.338	2.39	0.338	2.40	0.338
Stranger violence	8.14	0.541	8.00	0.523	8.00	0.523	8.01	0.523
Violent crime involving injury	4.57	0.427	4.51	0.422	4.51	0.422	4.51	0.423

(Continued)

<sup>10</sup> Changes in annual victimization rates and precision for the other two thresholds (i.e.,  $x=12$  victimizations and 98th percentile;  $x=15$  victimizations and 99th percentile) were generally negligible due to the small number of cases identified as outliers within a given year (not shown).

**Table 7. Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors, 2019 (Continued)**

Type of Crime	Original		No Reallocation		Ratio—All Respondents		Ratio—Victims	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE
Violent crime involving a weapon	4.04	0.289	4.00	0.281	4.00	0.281	4.01	0.282
<b>Property crime</b>	101.38	2.215	99.96	2.062	99.96	2.062	100.10	2.064
Burglary/trespassing	17.23	0.800	16.87	0.751	16.87	0.751	16.89	0.752
Burglary	11.74	0.639	11.40	0.580	11.40	0.580	11.42	0.581
Trespassing	5.49	0.403	5.47	0.404	5.47	0.404	5.47	0.404
Motor-vehicle theft	3.92	0.301	3.92	0.301	3.92	0.301	3.92	0.301
Other theft	80.23	1.913	79.17	1.817	79.17	1.817	79.29	1.819

**Population Subgroup Estimates:** The effect of the hybrid adjustment on victimization rates of violent and property crime within population subgroups (*Table 8*) was a decrease of less than 4% with many estimates remaining unchanged (i.e., there were no extreme cases within a particular population subgroup). The largest changes were observed for violent crime among persons ages 18 to 24 and property crime for households outside of a metropolitan statistical area (MSA). Standard errors generally decreased by less than 8% though the standard error for property crime rates for households outside of an MSA (19%) and property crime rates for households with an income of \$50,000–\$74,999 (17%) were markedly higher. As with the overall crime rates, very little difference in rates and standard errors was observed between the different reallocation methods. Differences in the weighted distribution for the household and person characteristics analyzed were less than 0.1% (see *Table A.9* in *Appendix A*).

**Table 8. Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors by Characteristics of Persons and Households, 2019**

Type of Crime and Victim Demographic Characteristic	Original		No Reallocation		Ratio—All Respondents		Ratio—Victims	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE
<b>Violent crime</b>	21.00	1.081	20.71	1.045	20.71	1.045	20.73	1.046
<b>Sex</b>								
Male	21.16	1.456	20.99	1.441	20.99	1.441	21.01	1.443
Female	20.84	1.363	20.45	1.309	20.45	1.309	20.47	1.310
<b>Race/ethnicity</b>								
White	20.95	1.376	20.49	1.303	20.49	1.303	20.51	1.305
Black	18.65	1.970	18.65	1.970	18.65	1.970	18.68	1.972
Hispanic	21.30	2.060	21.30	2.060	21.30	2.060	21.32	2.063
Asian	7.49	2.047	7.49	2.047	7.49	2.047	7.49	2.050
Other	66.34	18.400	66.34	18.400	66.34	18.400	66.42	18.423
<b>Age</b>								
12 to 17	35.16	4.858	35.16	4.858	35.16	4.858	35.20	4.864
18 to 24	37.23	3.934	35.78	3.679	35.78	3.679	35.82	3.684
25 to 34	25.04	2.896	25.04	2.896	25.04	2.896	25.08	2.900
35 to 49	19.47	1.409	19.47	1.409	19.47	1.409	19.50	1.410
50 to 64	18.94	1.836	18.36	1.724	18.36	1.724	18.38	1.726
65 or older	5.95	0.829	5.95	0.829	5.95	0.829	5.96	0.830
<b>MSA Status</b>								
Central city of MSA	25.99	1.846	25.62	1.785	25.62	1.785	25.65	1.787
In MSA but not central city	16.48	1.352	16.25	1.317	16.25	1.317	16.27	1.319
Outside MSA	26.33	5.326	26.00	5.270	26.00	5.270	26.03	5.277
<b>Household Income</b>								
Less than \$25,000	37.76	4.352	37.76	4.352	37.76	4.352	37.81	4.357
\$25,000–\$49,999	19.72	1.739	19.72	1.739	19.72	1.739	19.74	1.741
\$50,000–\$74,999	18.44	2.091	17.99	1.996	17.99	1.996	18.01	1.998
\$75,000 or more	15.78	1.346	15.26	1.244	15.26	1.244	15.28	1.245
<b>Property crime</b>	101.38	2.215	99.96	2.062	99.96	2.062	100.10	2.064
<b>MSA Status</b>								
Central city of MSA	144.43	4.354	141.95	4.190	141.95	4.190	142.15	4.196
In MSA but not central city	74.92	1.994	74.72	1.949	74.72	1.949	74.83	1.952
Outside MSA	92.07	10.162	88.75	8.251	88.75	8.251	88.88	8.262
<b>Household Income</b>								
Less than \$25,000	132.27	6.066	130.42	5.693	130.42	5.693	130.60	5.700
\$25,000–\$49,999	100.21	4.052	99.45	3.876	99.45	3.876	99.59	3.881
\$50,000–\$74,999	93.29	3.853	90.51	3.193	90.51	3.193	90.64	3.198
\$75,000 or more	88.88	2.681	87.90	2.618	87.90	2.618	88.03	2.621

**Crimes Reported to Police:** The impact of the hybrid adjustment on victimization rates for crimes reported to the police (*Table 9*) was less than 3% for all crime types except intimate partner violence (4%). Standard errors of victimization rates decreased by 10% or less for all crime types except for the household crime of other theft (11%). As with the overall and population subgroup estimates, differences between the reallocation methods were insignificant.

**Table 9. Impact of Hybrid Adjustment Approach and Reallocation Methods on Victimization Rates and Standard Errors for Crimes Reported to Police, 2019**

Type of Crime	Original		No Reallocation		Ratio—All Respondents		Ratio—Victims	
	Rate	SE	Rate	SE	Rate	SE	Rate	SE
<b>Violent crime</b>	8.58	0.584	8.43	0.557	8.43	0.557	8.44	0.557
Rape/sexual assault	0.56	0.196	0.56	0.196	0.56	0.196	0.56	0.197
Robbery	0.90	0.112	0.90	0.112	0.90	0.112	0.90	0.112
Assault	7.12	0.512	6.97	0.481	6.97	0.481	6.98	0.482
Aggravated assault	1.92	0.166	1.91	0.165	1.91	0.165	1.92	0.166
Simple assault	5.20	0.465	5.05	0.431	5.05	0.431	5.06	0.432
<b>Violent—excluding simple assault</b>	3.38	0.281	3.38	0.281	3.38	0.281	3.38	0.281
Domestic violence	2.20	0.329	2.14	0.322	2.14	0.322	2.14	0.322
Intimate partner violence	1.47	0.314	1.41	0.304	1.41	0.304	1.41	0.304
Stranger violence	3.25	0.298	3.16	0.272	3.16	0.272	3.17	0.272
Violent crime involving injury	2.26	0.263	2.26	0.263	2.26	0.263	2.26	0.264
Violent crime involving a weapon	2.12	0.183	2.11	0.183	2.11	0.183	2.12	0.183
<b>Property crime</b>	33.00	1.119	32.40	1.007	32.40	1.007	32.44	1.008
Burglary/trespassing	8.35	0.496	8.22	0.473	8.22	0.473	8.23	0.474
Burglary	6.03	0.442	5.92	0.416	5.92	0.416	5.93	0.416
Trespassing	2.32	0.196	2.30	0.197	2.30	0.197	2.30	0.197
Motor-vehicle theft	3.12	0.277	3.12	0.277	3.12	0.277	3.12	0.277
Other theft	21.53	0.882	21.07	0.786	21.07	0.786	21.10	0.787

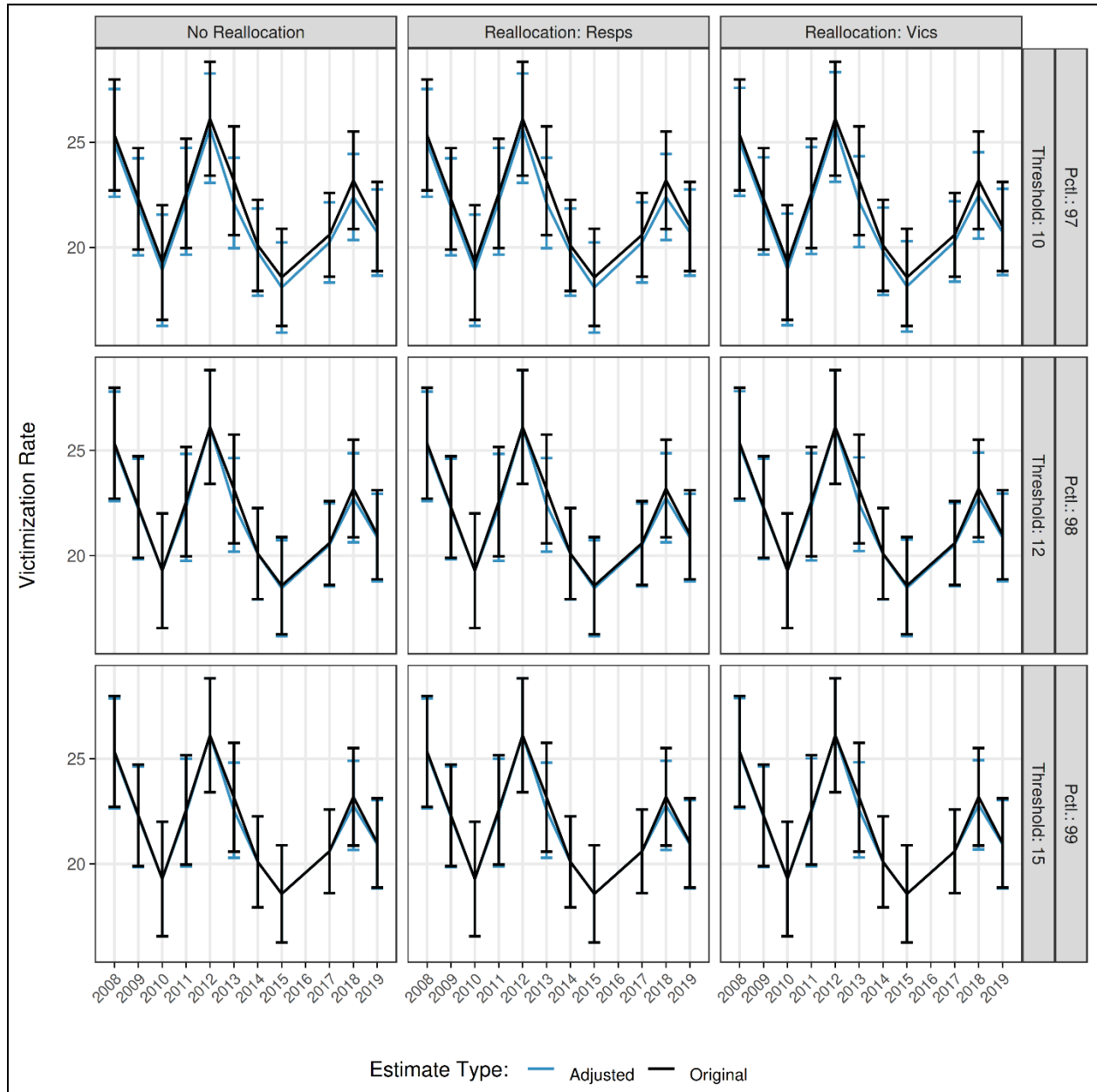
#### 4.2.5 Impact on Trends in Victimization Estimates Over Time

One of the many strengths of the NCVS is the ability to evaluate trends in criminal victimization over time. To ensure the hybrid adjustment would not disrupt these trends or lead to different conclusions about patterns in criminal victimization over time, adjusted estimates were compared to the unadjusted estimates from 2008–2019. For this analysis, adjusted estimates were created for the three sets of thresholds (e.g.,  $x=10$  victimizations and 97th contribution percentile) crossed with the different reallocation methods and compared to the unadjusted

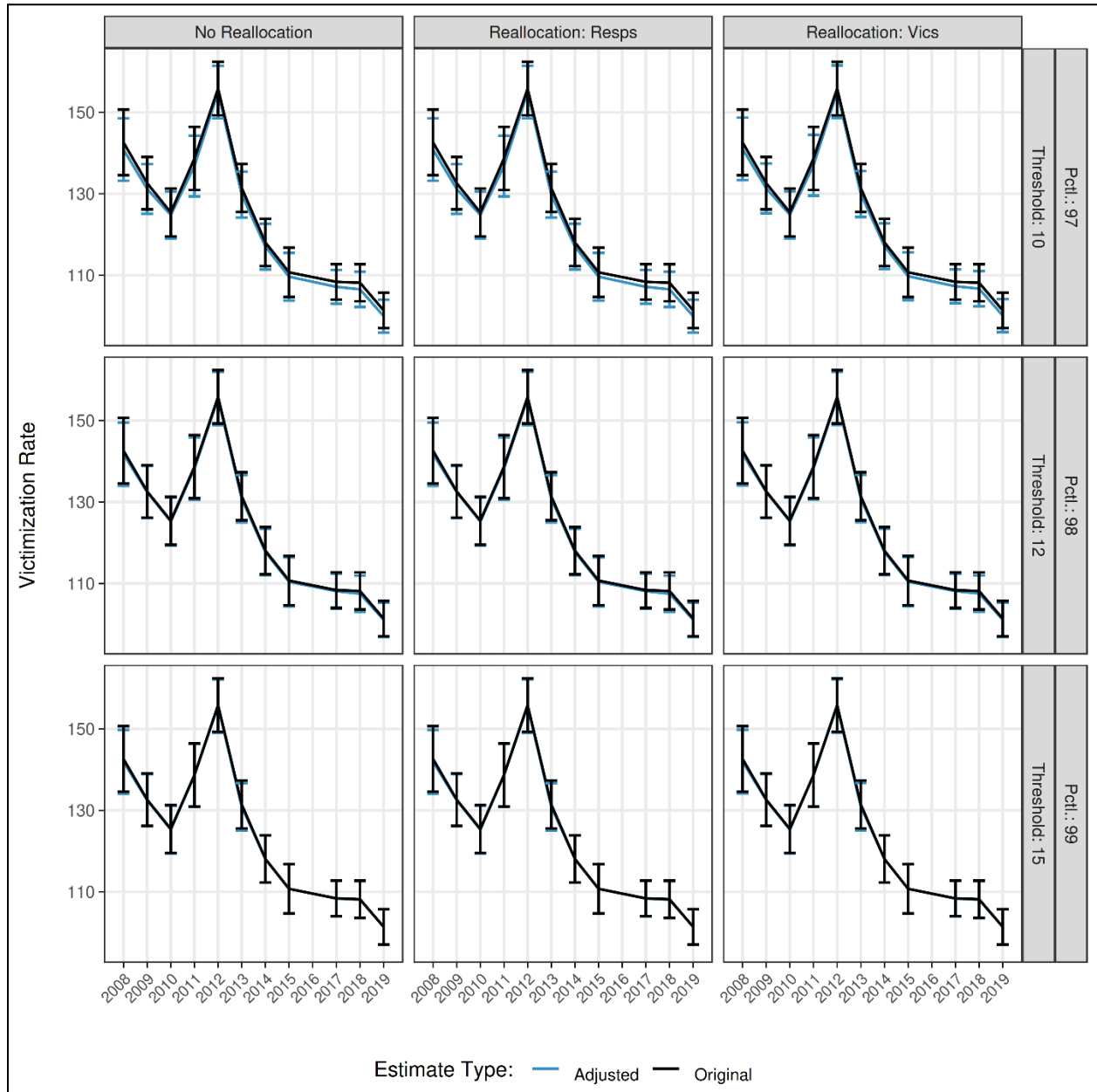
estimates for each year. Trends for total violent crime and total property crime appear in *Figure 6* and *Figure 7*, respectively.

For both total violent and total property crime, the largest change in rates was observed when the lowest thresholds (i.e.,  $x=10$  victimizations and 97th contribution percentile) were used for the hybrid adjustment regardless of the reallocation approach. However, the direction and rate of change in the adjusted estimates were generally consistent with the changes observed in the unadjusted estimates over time. For the other two sets of hybrid adjustment thresholds (e.g.,  $x=12$  victimizations and 98th contribution percentile), the adjusted annual estimates were almost identical to the unadjusted estimates resulting in a nearly imperceptible change to trends over time. Regardless of the thresholds or reallocation approach used, the hybrid adjustment for extreme cases does not disrupt historical trends in criminal victimization over time.

**Figure 6. Impact of Hybrid Adjustment Approach and Reallocation Methods on Trends in Violent Crime Victimization Rates, 2008–2019**



**Figure 7. Impact of Hybrid Adjustment Approach and Reallocation Methods on Trends in Property Crime Victimization Rates, 2008–2019**





## SECTION 5. SUMMARY AND RECOMMENDATIONS

The primary goals of this evaluation were to (1) examine if extreme cases exist in the NCVS data and identify the factors contributing to this extremity, (2) develop methods to limit the impact of extreme cases on NCVS estimates and estimate precision, and (3) evaluate the effect of these mitigation strategies on annual estimates, precision, and trends in victimization estimates over time. Examination of the annual NCVS data from 2008–2019 revealed some respondents do have unique experiences with criminal victimization as demonstrated by their reports of high victimization counts during a single interview. When these respondents with high victimization counts also represent a large number of persons in the population, they can have a disproportionate effect on annual NCVS estimates and negatively affect precision. Ensuring these atypical cases have a population representation (i.e., person or household weight) commensurate with the uniqueness of their experiences is justified.

This reasoning motivated the development of the hybrid adjustment approach that considers both the individual extremity of the case, based on the number of victimizations reported during a single interview, and their contribution to annual estimates. Using this framework, three sets of thresholds for the victimization count and contribution percentile were evaluated to determine the impact on annual victimization estimates, precision of annual estimates, and trends in victimization estimates over time. Two approaches for reallocating the weights (i.e., reallocation to other respondents, reallocation to other victims) using a simple ratio adjustment were also evaluated as was an approach where weights were not reallocated after the adjustment.

Within a given year, the hybrid approach typically classifies fewer than 10 persons and fewer than 15 households as outliers. Applying the hybrid adjustment typically leads to minor reductions in annual rates of victimization, slight improvement in precision, and no discernable impact on trends in victimization estimates over time for the period analyzed (i.e., 2008–2019). The impact of the different reallocation approaches was thus negligible due to the small number of cases adjusted each year.

Based on these findings, RTI recommends incorporating the hybrid adjustment approach into the NCVS weighting procedures using the following thresholds and reallocation methods:

- Victimization count threshold ( $x$ ): 10
- Contribution threshold ( $t_k$ ): 97th percentile
- Reallocation approach: All respondents (excluding outlier cases)

Although these thresholds result in more cases being adjusted than the other thresholds evaluated, the difference in the impact on annual estimates was relatively small and the tighter limits will reduce the likelihood of an extreme case going undetected. The victimization count threshold of 10 also aligns with the approach used for counting high-frequency repeat victimizations (i.e., series crimes) in the NCVS. Reallocating the weights to all respondents, as opposed to only other victims, helps to prevent cases on the boundary of extremity from exceeding the contribution threshold after the hybrid adjustment and reallocation, thus eliminating the need for an iterative process.

## **APPENDIX A: SUPPLEMENTAL TABLES**

**Table A.1 Interview-level Contribution Percentiles for Person-level Crime Types by Year**

Year	Violent Crime			RSA			Robbery			Aggravated Assault			Simple Assault		
	97th	98th	99th	97th	98th	99th	97th	98th	99th	97th	98th	99th	97th	98th	99th
2008	24,067	33,063	39,697	33,248	33,248	36,088	9,924	31,922	32,418	8,384	14,958	32,738	24,481	33,016	40,509
2009	24,561	32,615	37,412	51,427	57,915	57,915	13,667	20,599	25,637	18,047	20,888	36,702	24,561	32,391	36,769
2010	20,231	28,191	38,359	43,740	43,740	43,747	6,283	21,666	27,534	9,920	21,239	28,572	22,576	27,853	39,947
2011	19,996	26,755	35,060	13,792	13,792	26,807	12,757	14,836	20,804	11,636	20,671	23,668	26,581	31,613	42,613
2012	21,818	30,541	37,051	32,363	38,218	38,761	8,390	11,961	21,147	7,298	18,786	32,382	23,601	30,525	35,699
2013	25,476	31,867	40,135	28,850	28,850	33,608	26,613	32,252	36,976	14,561	20,531	31,372	22,915	32,436	39,992
2014	20,514	29,381	33,777	21,661	21,661	30,272	8,652	18,623	33,633	24,494	32,148	34,726	20,384	28,904	33,777
2015	19,866	26,972	34,329	34,081	35,683	37,343	13,317	16,836	21,588	10,571	17,981	22,284	18,744	30,033	37,572
2017	12,587	16,108	22,150	11,073	22,152	22,314	9,520	9,943	16,828	9,689	12,999	19,213	12,646	16,050	19,812
2018	14,636	18,155	22,842	15,889	18,337	18,897	9,946	12,462	17,784	9,504	13,282	16,367	14,585	18,499	24,432
2019	12,004	16,015	25,542	16,818	22,321	32,772	8,377	13,013	17,442	7,437	10,523	13,882	12,259	16,369	26,670

**Table A.2 Interview-level Contribution Percentiles for Household-level Crime Types by Year**

Year	Property Crime			Burglary			Motor Vehicle Theft			Other Theft		
	97th	98th	99th	97th	98th	99th	97th	98th	99th	97th	98th	99th
2008	9,878	11,797	15,780	10,917	13,197	17,360	5,197	5,625	7,107	9,097	10,276	14,850
2009	8,997	10,509	14,488	8,488	10,555	16,109	4,869	5,774	7,267	8,645	9,692	12,539
2010	7,984	9,504	13,030	8,172	11,060	15,830	5,066	6,036	6,188	7,110	8,295	11,184
2011	10,780	12,932	17,139	11,028	12,969	16,505	5,934	6,065	6,186	10,038	12,268	15,039
2012	8,091	9,679	13,973	7,173	9,679	15,239	5,508	5,852	7,195	7,740	9,137	12,724
2013	8,207	9,486	13,348	7,007	8,643	12,521	5,108	5,814	6,174	7,780	9,016	13,165
2014	8,408	9,822	14,851	7,025	8,078	10,899	5,675	6,882	8,947	7,824	9,158	13,894
2015	8,547	10,406	13,086	7,302	9,098	11,782	5,530	6,059	9,312	7,886	9,608	12,828
2017	5,671	6,645	8,492	4,923	5,893	9,646	3,877	4,135	5,140	5,372	6,202	8,001
2018	5,954	6,990	9,729	5,942	6,752	8,944	4,048	4,184	5,684	5,474	6,415	8,931
2019	5,891	7,063	9,827	5,576	6,305	8,722	4,393	5,224	7,469	5,474	6,768	9,102

**Table A.3 Sum of Person Weights and Series-adjusted Weighted Victimizations for Person-level Outlier Cases before and after Hybrid Adjustment by Year:  $\alpha=10$ ,  $t_k=97$ th Percentile**

Year	Number of Outlier Cases	Before Hybrid Adjustment						After Hybrid Adjustment					
		Person Weight	VIOLENT	RSA	ROB	AAST	SAST	Person Weight	VIOLENT	RSA	ROB	AAST	SAST
2008	5	10,948	215,594	55,539	35,939	3,105	121,011	6,387	120,337	30,905	17,230	2,188	70,014
2009	4	8,546	195,168	0	61,805	47,712	85,651	4,585	98,242	0	24,933	26,421	46,888
2010	4	7,131	165,240	43,740	0	39,188	82,312	3,056	70,612	20,231	0	11,759	38,622
2011	4	6,811	177,027	0	0	26,206	150,820	3,171	79,986	0	0	9,472	70,514
2012	8	13,624	291,995	76,979	77,795	44,070	93,151	8,218	174,547	39,670	50,579	23,802	60,496
2013	8	14,204	481,010	2,292	55,282	83,591	339,845	8,108	201,249	2,123	13,487	55,350	130,288
2014	4	7,927	167,625	4,531	4,204	51,406	107,484	3,979	82,055	1,709	1,865	29,916	48,565
2015	4	8,891	208,410	37,343	0	17,352	153,715	3,347	78,343	16,555	0	6,518	55,270
2017	8	10,100	196,529	23,527	2,231	60,398	110,372	5,149	97,797	12,205	1,144	22,793	61,654
2018	9	13,663	350,452	36,613	21,856	33,619	258,364	5,928	131,521	29,161	12,197	15,856	74,307
2019	4	4,180	123,118	34,620	0	18,044	70,454	1,484	43,450	12,004	0	7,437	24,008

ROB=robbery; AAST=aggravated assault; SAST=simple assault.

**Table A.4 Sum of Person Weights and Series-adjusted Weighted Victimizations for Person-level Outlier Cases before and after Hybrid Adjustment by Year:  $\alpha=12$ ,  $t_k=98$ th Percentile**

Year	Number of Outlier Cases	Before Hybrid Adjustment						After Hybrid Adjustment					
		Person Weight	VIOLENT	RSA	ROB	AAST	SAST	Person Weight	VIOLENT	RSA	ROB	AAST	SAST
2008	2	3,812	103,006	19,451	32,418	0	51,137	2,448	66,078	12,398	20,664	0	33,016
2009	1	1,522	54,792	0	0	0	54,792	900	32,391	0	0	0	32,391
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	4	6,811	177,027	0	0	26,206	150,820	4,243	107,021	0	0	12,674	94,347
2012	2	3,455	62,792	0	20,360	0	42,432	3,362	61,066	0	20,360	0	40,705
2013	4	6,236	327,200	0	55,282	46,042	225,875	3,363	127,470	0	16,871	34,713	75,886
2014	1	1,978	32,217	0	0	12,081	20,136	1,804	29,381	0	0	11,018	18,363
2015	1	2,267	58,931	0	0	9,066	49,865	1,037	26,972	0	0	4,150	22,822
2017	2	1,925	55,741	1,213	0	26,480	28,048	1,081	32,217	976	0	14,086	17,154
2018	2	3,966	158,646	0	0	0	158,646	908	36,309	0	0	0	36,309
2019	2	1,731	69,240	34,620	0	0	34,620	801	32,029	16,015	0	0	16,015

ROB=robbery; AAST=aggravated assault; SAST=simple assault.

**Table A.5 Sum of Person Weights and Series-adjusted Weighted Victimizations for Person-level Outlier Cases before and after Hybrid Adjustment by Year:  $x=15$ ,  $t_k=99$ th Percentile**

Year	Number of Outlier Cases	Before Hybrid Adjustment						After Hybrid Adjustment					
		Person Weight	VIOLENT	RSA	ROB	AAST	SAST	Person Weight	VIOLENT	RSA	ROB	AAST	SAST
2008	2	3,812	103,006	19,451	32,418	0	51,137	2,941	79,394	14,886	24,810	0	39,697
2009	1	1,522	54,792	0	0	0	54,792	1,021	36,769	0	0	0	36,769
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	2	3,900	103,673	0	0	26,206	77,467	2,695	70,120	0	0	16,607	53,512
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	3	4,694	284,009	0	55,282	15,192	213,535	2,802	120,406	0	21,248	15,051	84,107
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	2	3,966	158,646	0	0	0	158,646	1,142	45,684	0	0	0	45,684
2019	1	1,116	44,642	22,321	0	0	22,321	639	25,542	12,771	0	0	12,771

ROB=robbery; AAST=aggravated assault; SAST=simple assault.

**Table A.6 Sum of Household Weights and Series-adjusted Weighted Victimizations for Household-level Outlier Cases before and after Hybrid Adjustment by Year:  $x=10$ ,  $t_k=97$ th Percentile**

Year	Number of Outlier Cases	Before Hybrid Adjustment					After Hybrid Adjustment				
		Household Weight	PROPERTY	BURG	MVTFT	TFT	Household Weight	PROPERTY	BURG	MVTFT	TFT
2008	8	13,202	289,839	65,889	6,417	217,533	4,047	76,684	16,598	1,796	58,290
2009	5	10,714	220,282	122,311	0	97,972	2,325	44,477	16,235	0	28,242
2010	3	4,824	100,910	45,510	0	55,400	1,147	23,951	10,433	0	13,518
2011	10	17,737	337,260	157,532	0	179,729	6,009	104,833	43,189	0	61,645
2012	6	7,675	155,107	68,264	0	86,843	2,634	46,203	14,345	0	31,858
2013	9	13,121	282,119	62,079	4,625	215,416	3,877	72,154	22,506	1,492	48,157
2014	5	7,832	173,210	46,612	0	126,598	1,858	38,906	7,789	0	31,117
2015	8	11,038	207,383	51,833	3,543	152,007	3,975	65,149	17,627	1,424	46,097
2017	13	12,495	223,178	68,175	0	155,003	4,159	71,484	23,980	0	47,504
2018	14	13,830	284,345	105,074	0	179,270	4,152	79,984	27,307	0	52,676
2019	8	10,478	225,953	58,535	1,124	166,294	2,116	45,248	12,669	491	32,088

BURG=burglary; MVFTFT=motor vehicle theft; TFT=other household theft.

**Table A.7 Sum of Household Weights and Series-adjusted Weighted Victimizations for Household-level Outlier Cases before and after Hybrid Adjustment by Year:  $x=12$ ,  $t_k=98$ th Percentile**

	Number of Outlier Cases	Before Hybrid Adjustment					After Hybrid Adjustment				
		Household Weight	PROPERTY	BURG	MVTFT	TFT	Household Weight	PROPERTY	BURG	MVTFT	TFT
2008	3	4,753	140,180	64,007	0	76,172	1,386	33,870	18,749	0	15,121
2009	1	1,551	30,697	18,057	0	12,640	531	10,509	6,182	0	4,327
2010	1	1,939	34,327	21,454	0	12,873	537	9,504	5,940	0	3,564
2011	2	3,314	84,709	80,486	0	4,223	1,019	25,865	24,870	0	995
2012	2	2,348	73,077	68,264	0	4,813	641	19,359	18,283	0	1,075
2013	2	2,859	98,073	0	0	98,073	586	18,032	0	0	18,032
2014	2	3,045	61,049	0	0	61,049	1,004	18,316	0	0	18,316
2015	1	1,922	49,972	11,532	0	38,440	400	10,406	2,401	0	8,005
2017	2	1,676	47,073	24,801	0	22,271	438	12,847	5,112	0	7,735
2018	5	4,468	118,617	74,430	0	44,186	1,426	34,137	18,492	0	15,645
2019	2	2,593	50,449	20,084	0	30,365	708	13,073	6,305	0	6,768

BURG=burglary; MVTFt=motor vehicle theft; TFT=other household theft.

**Table A.8 Sum of Household Weights and Series-adjusted Weighted Victimizations for Household-level Outlier Cases before and after Hybrid Adjustment by Year:  $x=15$ ,  $t_k=99$ th Percentile**

	Number of Outlier Cases	Before Hybrid Adjustment					After Hybrid Adjustment				
		Household Weight	PROPERTY	BURG	MVTFT	TFT	Household Weight	PROPERTY	BURG	MVTFT	TFT
2008	2	3,269	117,179	47,578	0	69,601	864	30,630	13,808	0	16,822
2009	1	1,551	30,697	18,057	0	12,640	732	14,488	8,523	0	5,966
2010	1	1,939	34,327	21,454	0	12,873	736	13,030	8,144	0	4,886
2011	1	1,202	29,811	29,811	0	0	666	16,505	16,505	0	0
2012	1	1,203	43,317	38,504	0	4,813	388	13,973	12,420	0	1,553
2013	2	2,859	98,073	0	0	98,073	856	26,331	0	0	26,331
2014	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0
2017	1	436	14,831	0	0	14,831	235	8,001	0	0	8,001
2018	1	369	22,855	22,855	0	0	144	8,944	8,944	0	0
2019	0	0	0	0	0	0	0	0	0	0	0

BURG=burglary; MVTFt=motor vehicle theft; TFT=other household theft.

**Table A.9 Impact of Hybrid Adjustment Approach and Reallocation Methods on the Weighted Distribution of Characteristics of Persons and Households,  $x=10$ ,  $t_k=97$ th Percentile, 2019**

Characteristic	Original	No Reallocation	Ratio—All Respondents	Ratio—Victims
<b>Persons</b>				
<b>Sex</b>				
Male	48.648	48.648	48.648	48.648
Female	51.352	51.352	51.352	51.352
<b>Race/ethnicity</b>				
White	61.914	61.914	61.914	61.914
Black	12.062	12.062	12.062	12.062
Hispanic	17.297	17.297	17.297	17.297
Asian	6.285	6.285	6.285	6.285
Other	2.441	2.441	2.441	2.441
<b>Age</b>				
12 to 17	9.008	9.008	9.008	9.008
18 to 24	10.708	10.707	10.707	10.707
25 to 34	16.358	16.358	16.358	16.358
35 to 49	22.206	22.207	22.207	22.207
50 to 64	22.626	22.625	22.625	22.625
65 or older	19.095	19.095	19.095	19.095
<b>MSA Status</b>				
Central city of MSA	33.390	33.390	33.390	33.390
In MSA but not central city	52.987	52.987	52.987	52.987
Outside MSA	13.623	13.623	13.623	13.623
<b>Household Income</b>				
Less than \$25,000	17.053	17.053	17.053	17.053
\$25,000–\$49,999	24.776	24.776	24.776	24.776
\$50,000–\$74,999	18.551	18.551	18.551	18.551
\$75,000 or more	39.620	39.620	39.620	39.620

(Continued)



**Table A.9 Impact of Hybrid Adjustment Approach and Reallocation Methods on the Weighted Distribution of Characteristics of Persons and Households,  $x=10$ ,  $t_k=97$ th Percentile, 2019 (Continued)**

Characteristic	Original	No Reallocation	Ratio—All Respondents	Ratio—Victims
<b>Households</b>				
<b>MSA Status</b>				
Central city of MSA	34.622	34.620	34.620	34.621
In MSA but not central city	51.410	51.413	51.413	51.412
Outside MSA	13.968	13.967	13.967	13.967
<b>Household Income</b>				
Less than \$25,000	20.226	20.226	20.226	20.226
\$25,000–\$49,999	25.856	25.857	25.857	25.857
\$50,000–\$74,999	18.057	18.056	18.056	18.056
\$75,000 or more	35.860	35.861	35.861	35.861