

**Drug Abuse Warning Network
Sample Design and Estimation Procedures**

Technical Report

Office of Applied Studies



**DEPARTMENT OF HEALTH AND HUMAN SERVICES
Substance Abuse and Mental Health Services Administration**

OFFICE OF APPLIED STUDIES

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I. Introduction

Data on hospital emergency department visits in the United States involving the abuse of licit and illicit drugs are collected by the Substance Abuse and Mental Health Administration (SAMHSA), through its Drug Abuse Warning Network (DAWN) survey. DAWN has been a widely used indicator of drug abuse trends since the early 1970s. It was initially implemented by the Drug Enforcement Administration, and was conducted by the National Institute on Drug Abuse from 1980 until 1992, when SAMHSA assumed responsibility.

Currently, the DAWN survey consists of an ongoing probability sample of hospitals located throughout the coterminous United States. Hospitals eligible for selection into the DAWN survey must be non-Federal, short-stay, general surgical and medical hospitals with at least one 24-hour emergency department (ED).

This document describes the development of the sample design used for DAWN since 1988, including the sample selection, estimation, and variance estimation procedures currently used to produce published estimates. This report aids in interpreting DAWN data and understanding the complexities of the data estimation procedures, and the data limitations.

II. Background

The objectives of the survey are to identify drugs and other substances currently being abused and to provide demographic and other data pertaining to drug abuse for national and local drug abuse policy and planning. Drug abuse for this survey is defined as nonmedical use of a drug or substance for psychic effect, for suicide attempt or gesture, or for reasons of dependence. Participating hospitals submit monthly data to SAMHSA from which semi-annual and annual weighted estimates of the total number of emergency department visits involving drug abuse (referred to as episodes) are produced, as well as the total number of ED visits involving the abuse of specific drugs (referred to as drug mentions). These estimates are currently produced for the nation as a whole as well as for 21 specific metropolitan areas.

For the most frequently reported drugs, estimates are also broken down by demographic characteristics (age, race, sex) as well as by drug use motive, reason for ED contact, source of procurement, form in which drug was acquired, and route of administration.

Data from each hospital emergency department are collected by a reporter (usually a member of the hospital clerical staff) who reviews medical records for mentions of drug abuse. Specific methods for identifying patient drug abuse may differ from hospital to hospital, and it is believed by many that the data reflect mostly drug use which is self-reported by ED patients. In this regard, the DAWN has recently received criticism for underreporting drug abuse episodes associated with major trauma, such as motor vehicle accidents and violent assault (Brookoff, Campbell, and Shaw, 1993). Such underreporting stems from the fact that trauma patients are

often not in a position to give a history of drug abuse while being treated in the emergency department. Furthermore, medical records generated after the patient has left the ED (which may contain toxicology testing results) are generally not available to the reporter.

DAWN does not provide a direct indication of the prevalence of the use of specific drugs since only a segment of the drug user population ends up in hospital emergency rooms. It is useful in assessing health hazards associated with drug abuse and in monitoring drug abuse patterns and trends. The survey estimates are widely used by government and private research institutions alike, and play a key role in the evaluation of national policy and goals related to drug abuse. The DAWN also serves as a warning system for new illicit drugs having adverse effects on the general population.

New Sample Implementation

DAWN was originally implemented in the early 1970s, under the auspices of the Drug Enforcement Administration, as a stratified panel survey of hospitals. The sample design consisted of 100 percent sampling in 20 metropolitan areas, less than 100 percent sampling in three metropolitan areas (L.A., N.Y., and Chicago), and less than 100 percent sampling in the balance of the coterminous United States. That portion of the sample not associated with the 23 metropolitan areas, collectively referred to as the "national panel," was stratified by hospital bed size (0-99, 100-299, and 300+).

Over the years, this sample gradually deteriorated as a result of attrition and nonrandom replacement, and by 1980, when NIDA assumed responsibility for the survey, DAWN reports included only presentation of raw (unweighted) data. As a result, trend analyses for these data could be conducted only by examining panels of consistently reporting hospital emergency departments (EDs) and evaluating their raw data.

The NIDA goal was to implement a new sample which could produce representative estimates of drug episodes and mentions in hospital emergency rooms for the nation as well as for separate metropolitan areas. Under contract, Professional Management Associates, Inc. and Mathematica Policy Research, Inc. devised a sampling and estimation plan to meet the needs for precision and geographic coverage and to maintain the sample over time. A panel of experts subsequently reviewed the plan and recommended a number of changes (See Appendix A). Implementation of the new design required the recruitment of approximately 300 new hospitals. This new design also incorporated a sample maintenance plan to ensure the statistical integrity of the new sample over time.

The new design used the 1983 revised OMB metropolitan area definitions and all metropolitan areas were defined in terms of county boundaries. DEA and NIDA staff identified 21 essential metropolitan areas. The areas were selected based on their inclusion in the old sample (i.e., areas oversampled in the original design were retained to a large extent) and their levels of drug traffic and activity. The full plan consisted of oversampling for 21 metropolitan areas and

systematic sampling for the balance of the coterminous United States (again, referred to as the national panel). These 21 metropolitan areas are listed in Appendix B, along with the counties contained within each area. For the metropolitan areas, the sample is stratified by location (central city, outside central city), and within location, by the presence of an organized outpatient department and/or an alcohol/chemical dependency inpatient unit (both, one only, or neither). The national panel is stratified only by the presence of outpatient departments and/or alcohol/chemical dependency inpatient units. Within each sampling stratum, hospitals are selected by simple systematic sampling. Once a hospital is selected, all of its EDs are included. Hospitals having more than 80,000 ED visits per year are selected with certainty.

The new survey design incorporates a combined ratio estimator for all regional and national estimates. With this approach, each survey estimate is "benchmarked" by the ratio of the total number of hospital emergency department visits occurring during the period in the estimation region (obtained from the American Hospital Association) to a weighted estimate of this number obtained from the sample.

To maximize the rate of retention of the original sample units into the new sample, a Keyfitz procedure was employed when the new sample was selected. As a result, for many metropolitan areas the percentage of old reporting units in the new sample was over seventy percent.

For many metropolitan areas the new sample captures a significantly smaller percentage of total visits in the non-central city areas in comparison with the old sample. The new sample also captures a smaller percentage of the total visits for facilities belonging to the National Panel (2 percent versus 5 percent). For most of the metropolitan areas, the coverage of the new sample in the central cities is comparable to the coverage of the old sample. In terms of total visits captured, the new sample allocates a larger fraction of its sample to the central city locations. This resulted from an optimal allocation scheme for the new sample based on the estimated variance of total drug episodes in each sampling stratum.

NIDA's 1990 DAWN Annual Report was the first publication to be based wholly on weighted estimates from the new sample. Weighted estimates are now available starting with data from 1978. For the years 1978-1987, years for which the responding hospitals no longer constituted a representative sample, the data have been reweighted to produce estimates comparable to 1988 and later. [See Section XVII for more details on the methodology.]

III. Sample Universe

Participating hospitals in DAWN are selected from the population of all non-Federal, short-stay general medical and surgical hospitals having an emergency department open 24 hours per day (and having a emergency department physician available 24 hours per day), in the contiguous United States. Hospitals located in Hawaii, Alaska, and the U.S. territories are not included

within the sample universe. Veterans Administration hospitals and drug treatment facilities (being Federal hospitals) also are not within the scope of the survey.

For the purposes of the survey, a hospital entity is generally defined in terms of its corporate identity rather than its physical location. Hence, two or more hospital facilities belonging to the same corporate entity may in some cases be considered a single hospital in the population, as long as this corporate entity includes at least one or more emergency departments meeting the eligibility criteria. There are exceptions to this, particularly for large hospital conglomerates, which are sometimes considered by the survey to represent multiple distinct hospitals existing in the population. How these conglomerates are handled will be discussed in more detail in Section V.

IV. Sampling Frame

Hospitals participating in the survey have been selected from a universal list of hospitals produced by the American Hospital Association. This list is updated annually and contains detailed information about each hospital.

The current sample was selected from the 1984 AHA hospital file for the New York and Chicago metropolitan areas, and from the 1985 file for all other metropolitan areas. The one exception to this involves the selection of new sample units for sample maintenance (to account for births and attrition). Such units are selected from the most recent AHA files available.

As discussed earlier, some hospitals belonging to corporations representing large hospital conglomerates are treated as distinct hospitals and in 1985 were sampled individually, rather than as one corporate entity. Specifically, all conglomerates existing on the original sampling frame have been "split" into separate entities whenever one or more of the following conditions obtain: (1) the conglomerate has a total of 80,000 or more emergency department visits per year; (2) the conglomerate includes hospitals both inside and outside a given metropolitan area; or (3) the conglomerate includes hospitals both in the central city and in the suburbs of a particular metropolitan area. The reason for having the last criterion relates to the stratification of the sample within each metropolitan area (see Section VI). This splitting apart of large corporate entities does not apply to newly established hospitals (known as births) appearing on the frame subsequent to 1988.

Each year the sampling frame is updated to give newly eligible hospitals a chance of selection into the sample. These newly eligible units consist of existing hospitals that previously did not meet the eligibility criteria, as well as newly established hospitals (see Sections VIII and XVI).

V. Survey Precision Target Levels

The new sample has been designed with the objective of meeting various precision level requirements for the national and regional estimates, based on the concept of relative standard error (rse). The relative standard error of any estimate is defined to be the standard error of the estimate divided by the estimate itself.

The desired rse level for national estimates of total drug episodes was determined to be six percent. Estimates of total episodes for the New York, Chicago, and Los Angeles-Long Beach metropolitan areas were also desired to have this same precision level. With the exception of Baltimore, Buffalo, Denver, San Diego, and San Francisco, where 100 percent sampling was performed, the precision level for estimates of total episodes for all other cities was set to an eight percent rse. One hundred percent sampling was performed for the five metropolitan areas mentioned above because it was found that the sampling fractions required to meet the eight percent rse requirement were so large that it was decided to increase the sample slightly more to eliminate the sampling error altogether.

VI. Stratification

The DAWN sample has two levels of stratification. At the first level, the sample is stratified by metropolitan area, yielding 21 estimation cells, plus one additional cell for the national panel. The national panel cell is necessary for the production of national estimates. Such estimates are obtained by adding together the estimates from the 21 metropolitan areas as well as the estimate from the national panel for each estimation category.

Within each estimation cell, all hospitals having 80,000 or more emergency department visits per year are assigned to a certainty stratum. For the 21 metropolitan areas, the remaining non-certainty hospitals are stratified by location (central city, outside central city), and within location, by the presence of an organized outpatient department and/or an alcohol/chemical dependency inpatient unit (both, one only, or neither). The national panel is stratified only by the presence of outpatient departments and/or alcohol/chemical dependency inpatient units. Within each sampling stratum in the national panel, hospitals are selected by systematic sampling. Within each stratum in a metropolitan area, hospitals are selected by simple random sampling. The stratification scheme for the sample is summarized in Table 1 below.

Hospitals within a metropolitan area are considered to have central city locations if the city they are located in is contained within the official name of the metropolitan statistical area (MSA) given by the Office of Management and Budget (OMB) for the metropolitan area. For example, for the Los Angeles/Long Beach MSA, only hospitals having addresses within the cities of Los Angeles or Long Beach would be considered as central city hospitals. The stratification scheme outlined above resulted from a detailed analysis of the efficiency of various stratification designs performed by Dr. Eugene Ericksen in 1982, under the NIDA contract with Professional Management Associates, Inc.

TABLE 1
Stratification in 21 Metro Areas

Stratum	ED Visits	Location	OP Dept. and Alc./Chem IP
0		N/A	N/A
1	< 80,000	Central City	Both
2	< 80,000	Central City	One only
3	< 80,000	Central City	Neither
4		Suburban	Both
5		Suburban	One only
6		Suburban	Neither

Stratification in National Panel

Stratum	ED Visits	OP Dept. and Alc./Chem IP
0	80,000+	N/A
7	< 80,000	Both
8	< 80,000	One only
9	< 80,000	Neither

VII. Sample Size and Sample Allocation

Table 2 presents the sample sizes and response rates for each metropolitan area, based on the 1992 estimates.

Sample sizes for each metropolitan area were determined, based on the area's target precision levels and on the theory of optimal allocation for stratified samples. According to optimal allocation theory, the variance of the sample estimates will be minimized when the sample size, n_h , in each sampling stratum is made proportional to the quantity $W_h S_h / C_h$ where W_h is a number between 0 and 1 representing the fraction of units in the universe belonging to stratum h , S_h is the population standard deviation for the parameter to be measured, and C_h represents the square root of the cost of sampling in stratum h . According to this rule, sampling in a particular stratum should be increased whenever (1) the stratum has more units than other strata; (2) the stratum has more internal variability than other strata (in terms of what is being measured); and (3) sampling is cheaper in the stratum.

Using these optimum allocation conditions, the minimum required sample sizes (i.e., minimum cost) necessary to achieve the target levels of precision in each metropolitan area were calculated using the following cost assumptions. The stratum values of S_h and C_h were computed for all metropolitan areas combined, rather than for each metropolitan area. For the 21 metropolitan areas, it was assumed that cost per unit of collecting data in each stratum C_h was a constant multiple of the average number of ED visits per hospital in the stratum. For the national panel, it was assumed that the cost per unit was the same in all strata. This was done because it was felt that the cost model based on average ED visits was not appropriate for the national panel. For this sector, travel costs are thought to be a large component of the cost of data collection, and the overall relationship between cost and hospital size is less clear.

In addition to the above considerations, sampling rates were also subject to the following conditions. First, if fewer than four hospitals existed in the stratum population, then all hospitals in the stratum were selected into the sample. Second, if the sampling rate (i.e., the desired number of sample units divided by the number of units in the stratum population) for a particular stratum was calculated to be greater than 90 percent, then all units in the stratum were selected. Finally, if any calculations produced a sample size smaller than two, then the sample size was set to two.

TABLE 2
Sample Sizes and Response Rates for DAWN Sample
By Metropolitan Area

Metropolitan Area	Total eligible hospitals	Eligible sample hospitals	Responding sample hospitals	Response rate (%)
Atlanta	33	19	14	74
Baltimore	23	23	17	74
Boston	53	26	19	73
Buffalo	13	13	11	85
Chicago	72	43	34	79
Dallas	33	20	14	70
Denver	18	18	13	72
Detroit	53	27	22	82
LA-Long Beach	106	48	41	71
Miami-Hialeah	25	19	17	90
Minneapolis-St. Paul	31	20	15	75
New Orleans	25	17	13	77
New York	82	36	27	75
Newark	27	19	17	90
Philadelphia	70	37	33	89
Phoenix	25	19	17	89
San Diego	22	21	16	76
San Francisco	22	22	17	77
Seattle	24	18	14	78
St. Louis	42	31	26	84
Washington, DC	34	19	17	90
National panel	4,195	112	89	80
Total coterminous U.S.	5,028	637	503	79

VIII. Sample Selection and Sampling Baseweights

Initial sample units for the new sample were selected in the 21 metropolitan areas by randomly ordering the hospitals in each sampling stratum and selecting the first n hospitals into the sample. In the national panel, hospitals in each stratum were sorted geographically and then selected by systematic sampling (selecting every k th unit, where k is determined by the inverse of the probability of selection).

To minimize recruiting costs, improve response rates, and minimize the impact on long term trend estimates, an attempt was made to maximize retention of the original sample units (selected in 1973) into the new sample. This was accomplished by using a mathematical technique attributable to Keyfitz that considers prior selection probabilities when resampling from the same universe. To use this procedure, random sampling must have been performed during the selection of the original sample. As a result, only the Chicago and New York metropolitan area estimation cells, as well as the national panel, were eligible for "Keyfitzing." (Information available on the original sample in Los Angeles was not sufficient for use in the Keyfitz procedure). The technique is described below.

To perform the Keyfitz technique, hospitals in Chicago and New York were first classified as "A," "B," or "C" hospitals, according to the following definitions:

<u>Hospital Type</u>	<u>Status Description</u>
"A"	Selected in 1973
"B"	Eligible but not selected in 1973
"C"	Not eligible in 1973

Each hospital was then assigned a conditional selection probability of being selected into the new sample, given its 1973 sample status (described above). These conditional selection probabilities were calculated as a function of both P_1 , the hospital's original selection probability in 1973, and P_2 , the hospital's new selection probability, as determined by the desired sampling fraction n_h / N_h obtained from the optimal allocation calculations. Specifically, the conditional selection probabilities P_{2a} , P_{2b} , and P_{2c} were computed using the following the rules:

"A" hospitals: If $P_1 < P_2$, then $P_{2a} = 1$
 If $P_1 > P_2$, then $P_{2a} = P_2 / P_1$

"B" hospitals: If $P_1 < P_2$, then $P_{2b} = (P_2 - P_1) / (1 - P_1)$
 If $P_1 > P_2$, then $P_{2b} = 0$

"C" hospitals: $P_{2c} = P_2$

All sample units in Chicago, New York, and the national panel were selected into the new sample based on the conditional selection probabilities, P_{2a} , P_{2b} , and P_{2c} , but for purposes of estimation (discussed later), they are considered to have been selected with probability P_2 . A more detailed discussion of this procedure can be found in a NIDA working paper (Gfroerer, 1988).

Sampling baseweights for all units in the new sample were obtained by taking the reciprocal of P_2 (the overall probability of selection into the new sample). The final sampling weight for each hospital is derived each quarter by adjusting this baseweight for nonresponse occurring during the quarter, and by making a "benchmark" adjustment to the baseweight. Both of these procedures are discussed below in Section X which discusses estimation procedures.

Since the initial sample selection in 1985, newly eligible sample units have been identified each year during the processing of final annual estimates. Sampling for these newly eligibles also occurs at this time. These units are given a chance of selection by using a systematic sampling procedure that applies the same stratum selection probabilities originally used to the new sample. Hence each newly eligible sample unit is selected using the same sampling rate as was used for the other units in the stratum, and is assigned the same stratum baseweight.

IX. Annual Determination of Eligibility Criteria

Each year a new universe file of hospitals is obtained from AHA and matched by computer to the file of sample hospitals selected for DAWN. The AHA file contains the most recent information required for determining DAWN eligibility. Based on this eligibility information, a status code is assigned (or reassigned) each year to each sample unit. The hospital status code can assume the following four values:

<u>Hospital Status Code</u>	<u>Description</u>
1	Eligible respondent
2	Eligible nonrespondent
8	Ineligible
9	Closed

All sample units are defined at the hospital level, although the data is collected and submitted to SAMHSA at the level of the emergency department. A sample hospital will continue to remain eligible over time (Status Code equals 1 or 2) as long as it has at least one emergency department meeting the eligibility criteria. This rule applies even if the hospital sample unit had more than one emergency department at the time it was selected, and subsequently closed one or more of these departments.

X. Estimation

Participating hospitals in the DAWN provide data to SAMHSA each month. For each drug-related emergency department episode observed by the hospital during the month, a DAWN Emergency Department Report form is completed. This form records the date and time of the visit; the patient's age, race, and sex; the reason for taking the substance(s); the form in which the drug was acquired; the route of administration of the drug; and the reason the patient came to the ED.

The episode form contains information for as many as four different drugs (mentions), although for some variables, such as the motive for taking substance(s), it contains only one response value for the episode rather than separate response values for each individual drug mentioned in the episode. This is an important consideration because drug episodes frequently involve more than one drug, and published data may be tabulated by an episode level variable. For example, in the case of published estimates broken out by motive, most of the marijuana mentions recorded as having "suicide attempt" for motive are in all likelihood associated with an episode involving at least one other drug.

Final estimates are produced annually when all hospitals participating in DAWN have submitted their data for that year and when additional ancillary data used in estimation have become available. In recent years, the final report has included separate final estimates for the first half and the second half of the year, although quarterly estimates had been produced in earlier years. In addition to the final estimates, preliminary estimates are also produced, generally semi-annually, based on the hospitals that have responded.

There are three differences between the corresponding preliminary and final estimates. Final estimates include data from a small number of late-reporting hospitals, resulting in a slightly higher response rate. They are benchmarked to the most current AHA Annual Survey of Hospitals file for each of the 21 metropolitan areas and the national complement reflecting associated births, deaths, and organizational changes. They may include a subsample of the new births, which are initially treated by the estimation system as nonrespondents until such time as the hospitals are contacted and begin providing data.

For each metropolitan area, estimates are produced for total drug-related emergency department episodes, total emergency department drug mentions, as well as separate estimates of specific drug mentions for over 60 drugs. Similar estimates are also produced by demographic groupings (age, race, and sex) and by method of drug use and motive for drug use.

All published estimates currently are based on sampling weights which are estimated separately for each quarter. These quarterly weights are used to produce quarterly estimates. Published preliminary semi-annual estimates and published final annual estimates are produced by summing preliminary and final quarterly estimates, respectively. Estimates for the coterminous United States are obtained by summing the estimates from all metropolitan areas and from the national panel.

In addition to the quarterly estimates, which, as discussed above, form the basis of all published estimates, SAMHSA also produces monthly sampling weights each quarter, allowing for the production of monthly weighted estimates (i.e., weighted counts of total episodes and mentions occurring during a given month). Such estimates, when generated, are not published, and are generally only produced for internal research.

All estimates, as well as variance estimates, are generated from a customized computer estimation system developed specifically for DAWN. In the case of annual estimates, seven programs, executed sequentially, perform operations related to frame refinement, sample maintenance, and the calculation of sampling weights. A second set of seven programs produces tabulations and variance estimates. This entire software system is documented in a separate set of internal SAMHSA documentation.

All metropolitan area level emergency department (ED) total drug episodes and total mentions estimates are produced using a combined ratio estimate (Cochran, 1977) having the general form,

$$(1) Y_{cr} = (\hat{Y}/\hat{X})X,$$

where

- Y_{cr} = final adjusted (combined ratio) estimate of total drug episodes or mentions;
- X = total annual or semi-annual ED visits in universe obtained from AHA data;
- \hat{X} = estimate of X obtained from survey; and
- \hat{Y} = estimate of total drug episodes or mentions Y obtained from survey.

This section provides an overview of the combined ratio estimator used for estimation. A more detailed description of the components used in this estimator is provided in later sections of this document. This discussion is based in part on a discussion of the DAWN sampling weight components found in an earlier report (Hughes, 1993).

The objective of ratio estimation is to increase the precision of the desired survey estimates (i.e., estimates related to the primary variables of interest) by taking advantage of the correlation between the auxiliary variable and the primary variables. The use of the ratio X/\hat{X} , frequently referred to as a "benchmark adjustment", will produce a superior estimate (higher precision) when this correlation is high (see Cochran, 1977).

The auxiliary variable, x_i , used to "benchmark" the estimates of drug episodes and mentions, represents the total number of emergency department visits (both drug related and non drug related) occurring at a hospital, and the total, X , is the known value for the total ED visits occurring in the estimation cell (one of 21 metropolitan areas or the national panel) for the time period in question, obtained from data from the American Hospital Association (AHA). Hence, the benchmark adjustment factor is the ratio of the total emergency department visits occurring in the estimation cell to an estimate of this total obtained from the survey. At the national level, the correlation between total hospital ED visits and total hospital drug-related episodes and mentions is quite high (approximately, .7). A lag exists between the availability of ED visits from the two data sources. AHA data for the estimation year are not available until a year and a half later. As a result, the value for the known quantity X (total ED visits obtained from AHA) is based on information from the prior year. This is done to ensure the timely release of DAWN estimates. For most estimation cells, the correlation between total hospital ED visits between one year and the next is greater than .9, so the impact of using an earlier file for the benchmarking is not serious.

The estimate, \hat{Y} , which is the unadjusted weighted estimate of total episodes or mentions, is calculated by multiplying each hospital's total episodes or mentions by the hospital's final stratum sampling weight. This final stratum sampling weight is composed of the stratum baseweight and a unit nonresponse adjustment factor. A discussion of all weighting components used in the combined ratio estimator is provided in the following sections.

XI. Calculation of Survey-Weighted Estimate of Total

The calculation of the quarterly estimate, \hat{Y} , given in formula (1), above, can be expressed as follows:

$$(2) \hat{Y}_{\text{qtr,area}} = \sum_h^L \sum_i^{n_{uh}} y_{hi} \text{NRAF}_h \text{BWGT}_h,$$

where

- i = the i^{th} usable unit in stratum h ;
- h = the stratum number;
- L = the number of strata;
- y_{hi} = the total quarterly response value for the i^{th} responding hospital in stratum h (i.e., total number of episodes or mentions having a particular characteristic);
- n_{uh} = the number of usable sample units in stratum h responding for at least one month during the quarter;
- NRAF_h = the nonresponse adjustment factor for stratum h ; and
- BWGT_h = the baseweight for all usable units in stratum h .

The number, n_{uh} , is the number of usable sample hospitals in the stratum during the quarter for which estimates are being produced. In addition to the eligibility criteria discussed earlier, the sample unit must have provided data to SAMHSA for at least one month during the quarter in order to be considered a usable unit. As indicated by the subscripts for NRAF and BWGT , the calculation of these weighting components is performed at the stratum level.

XII. Calculation of the Nonresponse Adjustment Factor (NRAF)

Unit nonresponse occurs when a sampled hospital either provides no data for a particular quarter or provides data for only part of the quarter. Item nonresponse occurs when information is missing for particular data items on the Emergency Department Report form for a given drug episode (such as age). Nonresponse adjustment for emergency department estimates is performed for unit nonresponse only.

Unit nonresponse adjustment involves two types of weight adjustment. The first adjustment corrects for sampled hospitals in the sampling stratum that provide no data during the quarter. This component of the nonresponse adjustment can be expressed as the ratio of the estimated number of eligible hospitals in the stratum to the estimated number of usable hospitals (i.e., hospitals that are willing to provide data) in the stratum. The second component of the nonresponse adjustment adjusts for hospitals that respond during the quarter but do not provide data for the full quarter. For example, a hospital may provide data for only 45 days in a 91 day quarter.

Maximum allowable values for the nonresponse adjustment factor (NRAF) are defined for each sampling stratum. These values are based on the stratum sample size, the number of respondents, and the total number of hospitals existing in the stratum. When the value of the NRAF exceeds the maximum allowable value for the stratum, an alternative nonresponse adjustment procedure is considered, based on AHA visits. If the value of the alternative NRAF is less than the stratum's maximum allowable value, this alternative NRAF is used for the sampling stratum. If both the standard NRAF as well as the alternative NRAF exceed the maximum allowable value for the stratum, stratum collapsing is performed, and the NRAF is recalculated based on the newly defined collapsed stratum. These procedures are discussed in detail below.

The overall formula for the stratum level nonresponse adjustment factor is given by the expression,

$$(3) \text{NRAF}_h = \text{NRAFC}_h \text{NRAFP}_h I_{1h} + \text{NRAFA}_h I_{2h} ,$$

where

- NRAF_h = the stratum nonresponse adjustment factor;
- NRAFC_h = the unit nonresponse adjustment component;
- NRAFP_h = the partial days nonresponse adjustment component; for partial reporting in the quarter;
- I_{1h} = 0,1 indicator equal to 1 when $\text{NRAFC}_h * \text{NRAFP}_h$ is less than or equal to MAXNRAF limit;
- I_{2h} = 0,1 indicator equal to 1 if and only if $(\text{NRAFC}_h * \text{NRAFP}_h)$ exceeds limit and NRAFA_h does not exceed limit ; and
- NRAFA_h = alternative nonresponse adjustment factor based on AHA visits data.

Formula (3) expresses the fact that the nonresponse adjustment factor is calculated by either one of two procedures. If the standard procedure is used, the NRAF is computed by multiplying the unit nonresponse adjustment component by the partial (days) nonresponse adjustment component. If, however, this product exceeds the limit for the stratum's maximum allowable NRAF value (discussed below), and NRAFA does not exceed this value, then the nonresponse adjustment factor for the stratum is set to NRAFA. The calculation of the components used in equation (3) is given below.

1. Calculation of NRAFC

The nonresponse adjustment component, NRAFC, adjusts for complete nonresponse (i.e., adjusts for those sample units that provide no data at all during the quarter). The formula for NRAFC is given as follows:

$$(4) \text{ NRAFC}_h = \frac{\sum_i^{n_{eh}} \text{BWGT}_h}{\sum_i^{n_{uh}} \text{BWGT}_h},$$

where

- n_{eh} = the number of eligible hospitals sampled in stratum h ;
- n_{uh} = the number of usable hospitals sampled in stratum h responding for at least one month during quarter; and
- BWGT_h = the baseweight for a hospital in stratum h .

The formula indicates that this **NRAF** component is simply the weighted ratio of the number of eligible sample units in the stratum to the usable sample units in the stratum. As equation (4) suggests, the baseweight, BWGT_h , is the same for all units in the same sampling stratum. This follows directly from the sampling approach used.

2. Calculation of **NRAFP**

The nonresponse adjustment component **NRAFP** adjusts for partial nonresponse occurring in the sampling stratum. Partial nonresponse occurs either when (1) a hospital provides data only for a fraction of the days existing in the quarter, or (2) a hospital containing more than one emergency department provides data for only a fraction of its emergency departments. The formula for **NRAFP** is given as follows,

$$(5) \text{ NRAFP}_h = \frac{[\sum_m^3 \sum_i^{n_{uh}} \text{BWGT}_h \text{VIS}_{mi} (\text{D}_m / \text{Days}_{mi})]}{[\sum_m^3 \sum_i^{n_{uh}} \text{BWGT}_h \text{VIS}_{mi}]},$$

where

- m = the 1st, 2nd, or 3rd month in the quarter;
- n_{uh} = the number of usable sample hospitals in stratum h (i.e., the number of hospitals providing data for at least one month during the quarter);
- VIS_{mi} = the monthly ED visits for hospital i in month m ;
- D_m = the number of days in month m ; and
- DAYS_{mi} = the number of days for which hospital i reported during month m ;

In the numerator of equation (5), the monthly ED visits for each responding sample hospital in the stratum are adjusted to account for the number of days in the month represented by the visits data, and are then summed over all months in the quarter using the baseweight. In the denominator, the same visits information is summed for the stratum, but without adjusting for the number of days reporting for each hospital. This ratio then gives the partial nonresponse adjustment.

The variable **DAYS** used in equation (5) represents the average number of days for which the hospital reported data during a particular month. If the hospital only has one emergency

department, then the variable DAYS simply represents the total number of days for which the hospital reported for the month. On the other hand, for those hospitals having more than one emergency department, the variable represents the average number of days reporting, taken over all emergency departments associated with the hospital. Thus, for example, if a hospital had two emergency departments, and one department provided data for 15 days in a given month while the other provided data for 30 days, then the value of DAYS for that hospital during that month would be $45/2 = 22.5$.

3. Maximum Allowable Values for NRAF

As indicated above, maximum allowable values for the NRAF have been defined for each sampling stratum in DAWN. These values have been determined by setting limits on the variance estimator of a total, assuming simple random sampling without replacement. Large values for the NRAF can dramatically increase the sampling weights, which in turn can decrease the precision of the estimates. By setting limits on the NRAF, higher precision is achieved while adding only a minimal amount of bias.

If the variability in the number of respondents is ignored (i.e., if the number of respondents is not considered a random variable), then the variance of the estimate of the total, \hat{Y} , for a simple random sample (srs) can be expressed as,

$$(6) \text{Var}(\hat{Y})_{\text{srs}} = N^2(1 - n/N) (1/n) (n^2/n_r^2) s_r^2,$$

where N is the number of elements in the population, n is the total number of sample units (both respondents and nonrespondents), n_r is the number of respondents, and s_r^2 is the estimate of population variance obtained from the sample.

If partial nonresponse is ignored, then one notes that for this simple random sample, the NRAF will equal n/n_r . If we want to have $\text{Var}(\hat{Y}) < C$ (a constant) for all possible values of n and n_r , and if we further specify that there must be 3 respondents for every 5 eligible sample units in a stratum, then it can be shown that the limit for the NRAF in a particular sampling stratum, h , is given by,

$$(7) \text{LIMIT}_h = [n_r (5/3^2) / (1 - n/N)].$$

In addition to this restriction to the NRAF, a further restriction has been placed upon the survey requiring that the NRAF not exceed 3.5 and that it not be less than unity. Given these requirements, and noting that the quantity, $(1 - n/N)$, in equation (7) is the finite population correction factor (fpc), then the maximum allowable NRAF (MAXNRAF) for the stratum can be expressed as,

$$(8) \text{MAXNRAF}_h = \min\{ 3.5, .56 n_r / \text{fpc}_h \}, \text{ if } \text{LIMIT}_h > 1,$$

$$= 1, \text{ if } \text{LIMIT}_h < 1 .$$

The stratum's fpc in equation (8) is calculated as follows:

$$(9) \quad \text{fpc}_h = 1 - (n_{eh} / \sum_i^{n_{eh}} \text{BWGT}_h) ,$$

where n_{eh} is the number of eligible hospitals sampled in stratum h and BWGT_h is the base weight for the sample unit.

4. Alternative NRAF Calculation

As indicated by equation (3), if the product of **NRAFC** and **NRAFP** exceeds the stratum's **MAXNRAF** value, then an alternative nonresponse adjustment factor is considered, based on AHA emergency department visits information. With this approach, the total number of emergency department visits (including those that are not drug related) occurring in the stratum for the quarter is estimated, by calculating the weighted sum of the AHA visits occurring during the prior year for all eligible sample units (i.e., all original sample units that were not determined to be closed or ineligible for some other reason), and then dividing by four to arrive at a quarterly estimate. This number is then compared to the same weighted total for responding sample hospitals. The ratio of the two numbers provides the nonresponse adjustment, and is given by,

$$(10) \quad \text{NRAFA}_h =$$

$$\sum_m^3 \sum_i^{n_{eh}} (\text{BWGT}_h \text{VEMADJYR}_{hi} / 4) / \sum_m^3 \sum_i^{n_{eh}} [(\text{BWGT}_h \text{VEMADJYR}_{hi} / 4) (\text{DAYS}_{mi} / \text{D}_m)] ,$$

where

- m = the 1st, 2nd, or 3rd month in the quarter;
- n_{eh} = the number of eligible hospitals sampled in stratum h ;
- VEMADJYR_{hi} = the annual adjusted ED visits for hospital i in stratum h from AHA during prior year;
- DAYS_{mi} = the average number of days for which hospital i is reporting
- D_m = during month m ; and the number of days in month m .

The annual adjusted ED visits data from AHA, referenced in equation (10) above by the variable, **VEMADJYR**, are divided by 4 for each hospital to produce a quarterly estimate of ED visits for each hospital. Here, the assumption is made that the distribution of ED visits is uniform across all four quarters (that is, seasonality does not factor into the data). The visits data stored in **VEMADJYR** reflect an adjustment to account for hospital split conglomerates as well as hospitals that have merged since the time the sample was selected. In both of these situations, the hospital is defined differently in DAWN than it is in the AHA file, and an adjustment must be made to the AHA data to account for

these discrepancies. This adjustment procedure is discussed later in the discussion of sample maintenance Section XVI).

The alternative nonresponse adjustment factor has rarely been used in the **NRAF** calculations. For the 1992 annual weights calculations, for example, only one sampling stratum (Dallas, stratum number 5) had an **NRAF** based on this procedure. The alternative **NRAF** calculation procedure gets invoked infrequently because both the standard **NRAF** and the alternative **NRAF** tend to have similar values. As a result, when one of the two calculations is out of range (i.e., exceeds the maximum allowable value for the stratum), so is the other, and stratum collapsing must be performed (see discussion below). Once **NRAFs** all are recalculated based on the collapsed stratum definitions, both the standard as well as the alternative **NRAF** are usually in-range. Hence, the standard **NRAF** is selected.

5. Stratum Collapsing

When both the standard nonresponse adjustment ($\text{NRAFC} \cdot \text{NRAFP}$) as well as the alternative nonresponse adjustment (**NRAFA**) exceed **MAXNRAF**, then the final value for **NRAF** will necessarily also exceed **MAXNRAF** (see equation 3). When this happens stratum collapsing is performed and the final **NRAF** is recalculated based on the collapsed stratum definitions.

Stratum collapsing involves combining two or more original sampling strata into one newly defined stratum. Sample estimates are then produced based on the new stratum definitions. When a sampling stratum having a poor response rate (and, hence, a high quarterly **NRAF** value) is collapsed with another sampling stratum having a higher response rate, the **NRAF** calculated from the newly formed collapsed stratum will be lower than the **NRAF** calculated for the original problem stratum (although it may be somewhat higher than the **NRAF** calculated for the other original strata involved in the collapsing). The lower **NRAF** value will increase the precision of the estimates, although some amount of bias will be incurred in the estimates from not using the original sampling strata during estimation. This bias is assumed to be small.

When stratum collapsing is performed, an effort is made to collapse strata representing central city areas only with other central city strata, and to collapse strata representing noncentral city areas only with other noncentral city strata. Also, once a sampling stratum is collapsed with another for a given quarter, the collapsed stratum definition is used for estimates produced for subsequent quarters in the year as well. This is done to help make the stratum definitions as consistent as possible from quarter to quarter. This is an important consideration in variance estimation for annual estimates, where microdata correlations must be calculated in each stratum between pairs of quarters. In the first quarter of the following year, the collapsing patterns are then reevaluated.

As discussed earlier, when quarterly weights are being produced for a given quarter, SAMHSA also produces monthly sampling weights for each month in the quarter. These weights are not currently used for any published estimates, but are primarily used when monthly weighted estimates

are needed from DAWN for internal research. The software that produces the monthly weights is very similar to the software that produces the quarterly weights, except that the nonresponse adjustment factors are calculated for each month in the quarter, rather than calculated one time for the entire quarter.

During the production of these monthly weights, occasionally monthly stratum nonresponse response adjustment factors for one or two months in the quarter are calculated manually based upon a collapsed stratum definition, while the nonresponse adjustment factor for the remaining month(s) in the quarter is generated by computer, based on the original stratum definition. The manually calculated nonresponse adjustment factor(s) is then "hard wired" into the estimation software. Such an approach is sometimes taken when the response rates are adequate for one or more months in the quarter. When such an action is taken, the stratum definitions in the estimation software remain unchanged, and only the nonresponse adjustment factor for the "problem" month(s) is based on collapsed stratum definitions. All other variables in the program that are calculated at the stratum level continue to be based on the original stratum definitions. This approach is referred to as implicit stratum collapsing because no stratum collapsing actually occurs as far as the estimation software is concerned. Implicit collapsing helps to increase the consistency in the stratum definitions used for the monthly weights from quarter to quarter.

Stratum collapsing is a common occurrence in the calculation of DAWN sampling weights. For example, for the 1992 annual estimates 32 strata were collapsed into 14 strata. This collapsing involved, in total, ten metropolitan areas.

XIII. Calculation of the Benchmark Adjustment Factor

The quantity X/\hat{X} in equation (1) is the benchmark adjustment factor. When preliminary quarterly estimates are being produced the quantity X in the ratio's numerator represents the known total number of emergency department visits occurring in the estimation cell (metropolitan area or national panel) during the prior year (obtained from AHA), and the quantity \hat{X} in the denominator represents an estimate of this same total (for the same time period) obtained from the DAWN survey data. In the case of the final annual estimates and final quarterly estimates (published at the same time as the final annual estimates), the quantity X again represents the known number of emergency department visits occurring in the estimation cell during the prior year, but the quantity \hat{X} in the denominator represents an estimate of this total for the current year (the year for which DAWN final estimates are being produced).

Because the benchmark adjustment factor can have a value of less than one, its inclusion in the estimation process could create a situation where a sample hospital's data gets weighted by a factor less than one ($NRAF * BWGT * (X/\hat{X}) < 1$). To prevent this from happening, the quantity X/\hat{X} is set to one for any sample unit whenever the product, $NRAF * BWGT * (X/\hat{X}) < 1$.

The formula for X , the known number of ED visits in the estimation cell for the prior year given in the numerator, is calculated as follows,

$$(11) X_a = \sum_h^L \sum_i^{N_{ch}} [I_1 VEMADJYR_{hi} + I_2 VYR_{hi} (365/DAYSYR_{hi})]$$

where

- a = metropolitan area or national panel;
- N_{ch} = number of eligible hospitals in stratum h ;
- $VEMADJ_{hi}$ = the annual adjusted ED visits for hospital i in stratum h for the prior year;
- I_1 = 0,1 indicator equal to 1 when $I_2=0$;
- I_2 = 0,1 indicator equal to 1 when annual ED visits are estimated by AHA and DAWN data have been reported to SAMHSA for more than 328 days;
- VYR_{hi} = prior year annual ED visits for hospital based on data provided to DAWN; and
- $DAYSYR_{hi}$ = number days reported to DAWN in prior year.

This formula states that X is obtained by summing the AHA visits data from each hospital for the prior year when those data are not estimated, and by substituting DAWN visits data for AHA data when (1) the AHA file indicates that AHA has estimated the hospital's annual visits, and (2) the hospital has been reporting to DAWN for more than 328 days for the prior year.

The formula for \hat{X} , the estimate of total ED visits occurring in the estimation cell is given by,

$$(12) \hat{X} = \sum_q \sum_h \sum_i^{n_{uh}} BWGT_h NRAF_h VIS_{qhi}$$

where

- q = the quarter number (1st, 2nd, 3rd, or 4th);
- VIS_{qhi} = the total number of ED visits reported by hospital i in stratum h for quarter q ; and
- n_{uh} = the number of usable sample units in stratum h .

When preliminary quarterly estimates are produced, the subscript variable, q , above, represents the quarter number for the prior year. That is, the visits data for each hospital span the four quarters of the previous year.

XIV. Publication Criteria

Estimates are suppressed from publication given any of the following conditions:

1. The rse of the estimate is greater or equal to 50 percent.

When the rse is greater or equal to 50 percent, the confidence interval for the point estimate at the $\alpha = 0.05$ precision level includes the value zero. As a result, the estimate is not statistically significant (from 0) at this precision level. When this occurs, the published estimate is replaced by an elipsis (...) in the published table.

2. The estimated quantity is less than 10, or the numerator of a percentage estimate is less than 10, or the percentage is less than 0.05.

Estimates of this magnitude constitute rare events whose precision levels are difficult to quantify. This stems from the fact that (1) the validity of the normal theory approximations depends not only on the sample size, but also on the number of cases having the measured characteristic (Cochran, 1977), and that (2) accurate population variances become increasingly difficult to estimate. When such estimates are suppressed, both the percentage and the corresponding level estimates also suppressed.

XV. Variance Estimates

The variances of all estimates are estimated using standard techniques based on Taylor series linearization. Based on this approach the variance of any combined ratio level estimate for metro area a and quarterly time period q , $Y_{cra q}$ is given by,

$$(13) \quad V(Y_{cra q}) = V[(\hat{Y}_{aq}/\hat{X}_{aq})X_{aq}] \\ = \sum_h [N_h^2 (1-f_h)/n_h] [S_{yh}^2 + R_{aq}^2 S_{xh}^2 - 2R_{aq} \text{Cov}(x_{hi}, y_{hi})],$$

where

- N_h = the number of eligible units in the population for stratum h ;
- f_h = the sampling fraction in stratum h (i.e., n_h/N_h);
- n_h = the number of sample units in stratum h ;
- S_{yh}^2 = the population variance for the response variable, y in stratum h ;
- R_{aq} = the ratio $\hat{Y}_{aq}/\hat{X}_{aq}$;
- S_{xh}^2 = the population variance for the number of ED visits reported by each hospital in stratum h ;
- x_{hi} = the number of ED visits reported by hospital i in stratum h ;
- y_{hi} = the response value for hospital i in stratum h ; and
- $\text{Cov}(x_{hi}, y_{hi})$ = the covariance between x_{hi} and y_{hi} .

The expression $[N_h^2 (1-f_h)/ n_h]$ in equation (13) is estimated using the following approximation:

$$(14) \quad [N_h^2 (1-f_h)/ n_h] = \sum_i^{n_{uh}} (\text{BWGT}_{hi} * \text{NRAF}_{hi})^2 - \sum_i^{n_{uh}} \text{BWGT}_{hi} * \text{NRAF}_{hi} .$$

With this approach, estimates of the stratum hospital counts (N_h), are adjusted for out-of-business and out-of-scope hospitals since such information is incorporated into the NRAF.

Because the samples in each metropolitan area are independent of one another, an estimate of the variance for total episodes or mentions in the U.S. for a particular drug category is obtained by summing the variances of the local estimates from each of the 21 metropolitan areas as well as from the national panel:

$$(15) \quad V(Y_{crq}) = \sum_a V(Y_{craq}) .$$

For annual estimates, the quarterly estimates are aggregated, and the variance is given by:

$$(16) \quad V(Y_{cra}) = \sum_q V(Y_{cra q}) + \sum_{q_i < q_j} 2\text{cov}(Y_{cra q_i}, Y_{cra q_j}) ,$$

where

- q_i = the quarter number ranging from 1 to 4; and
- q_j = a quarter number other than q_i .

For percentage estimates (such as the percentage of total cocaine mentions associated with males), the precision of the estimate is evaluated by considering only the relative standard error of the numerator in the ratio used to calculate the percentage. This approach was adopted as a cost saving measure, after an empirical review of these estimates suggested that the relative standard error of the numerator gives a reasonable estimate of the relative standard error of the entire ratio. For published estimates of population-based rates of total drug episodes and mentions relative to total population

counts, the population counts are treated as known values and relative standard errors are not calculated.

In the case of published estimates of quarterly and annual trends, significance tests are performed to evaluate the differences between quarterly (or yearly) estimates. The variance of the difference between two estimates from two distinct time periods, t_1 and t_2 , is given by,

$$(17) \text{Var}(Y_{\text{crt1}} - Y_{\text{crt2}}) = \text{var}(Y_{\text{crt1}}) + \text{var}(Y_{\text{crt2}}) - 2 \text{cov}(Y_{\text{crt1}}, Y_{\text{crt2}}) .$$

Tables 3 and 4 provide information on the precision levels of various annual estimates for 1992. Table 3 provides error estimates for total episodes broken down by metropolitan area. Table 3 provides error estimates for the total number of ED mentions of various common drugs at the national level. Table 3 indicates that the 1992 estimate for total drug episodes in the U.S. had a relative standard error of 5.4 percent. This level of precision is consistent with the survey's target precision levels outlined in Section V. For the metropolitan area level estimates, the table indicates that over half of the total episodes estimates had relative standard errors (rse's) below ten percent. The largest relative standard error found in the table is for total episodes in Seattle (25.9 %).

The rse's for national estimates of total mentions of the more common drugs (aspirin, heroin, cocaine, marijuana, etc.) given in Table 4 tend to be somewhat higher. Of the 47 individual drug categories presented, seven had rse's under ten percent, 24 had rse's between ten and 20 percent, and 16 had rse values greater than 20 percent. SAMHSA is currently developing generalized variance formulas that will be included in future publications. These formulas will allow the reader to estimate the rse values for estimates of total drug mentions for various drug categories broken-out by various levels of detail.

Table 3. Examples of estimates, standard errors, relative standard errors, and confidence intervals for total episodes according to metropolitan area: 1992

Metropolitan area	Estimated episodes	Standard error	Relative standard error	Confidence interval (95 percent)
Total coterminous U.S.	433,493	23,409	5.4	387,612 - 479,374
Atlanta	8,767	412	4.7	7,959 - 9,575
Baltimore	12,946	1,036	8.0	10,916 - 14,976
Boston	12,744	777	6.1	11,220 - 14,268
Buffalo	1,962	73	3.7	1,820 - 2,104
Chicago	17,580	1,424	8.1	14,789 - 20,371
Dallas	4,062	443	10.9	3,194 - 4,930
Denver	3,664	348	9.5	2,982 - 4,346
Detroit	15,777	2,903	18.4	10,087 - 21,467
Los Angeles-Long Beach	19,697	1,458	7.4	16,840 - 22,554
Miami-Hialeah	4,707	169	3.6	4,375 - 5,039
Minneapolis-St. Paul	3,923	381	9.7	3,177 - 4,669
New Orleans	5,353	214	4.0	4,933 - 5,773
New York	44,759	7,161	16.0	30,723 - 58,795
Newark	8,748	1,268	14.5	6,262 - 11,234
Philadelphia	20,573	2,428	11.8	15,815 - 25,331
Phoenix	6,103	366	6.0	5,385 - 6,821
San Diego	6,088	572	9.4	4,966 - 7,210
San Francisco	10,592	328	3.1	9,948 - 11,236
Seattle	6,200	1,606	25.9	3,053 - 9,347
St. Louis	4,405	899	20.4	2,644 - 6,166
Washington, D.C.	10,687	1,218	11.4	8,299 - 13,075
National Panel	204,155	21,640	10.6	161,740 - 246,570

NOTE: These estimates are based on a representative sample of all non-Federal short-stay hospitals with 24-hour emergency rooms.

SOURCE: SAMHSA, Drug Abuse Warning Network (May 1993 data file).

Table 4. Examples of estimates, standard errors, relative standard errors, and confidence intervals for total episodes, total mentions, and mentions of selected drug groups: 1992.

Total episodes, total mentions, and drug group	Estimate	Standard error	Relative standard error	Confidence interval (95 percent)
Episodes	433,493	23,409	5.4	387,612 - 479,374
Mentions	751,731	41,345	5.5	670,694 - 832,768
Acetaminophen	31,355	2,038	6.5	27,360 - 35,350
Alcohol-in-combination	141,772	8,081	5.7	125,933 - 157,611
Alprazolam	16,498	1,551	9.4	13,458 - 19,538
Amitriptyline	10,132	1,226	12.1	7,729 - 12,535
Amitriptyline combinations	1,174	306	26.1	573 - 1,775
Amphetamine	3,713	691	18.6	2,359 - 5,067
Aspirin	18,834	1,620	8.6	15,659 - 22,009
Chloral hydrate	544	150	27.6	250 - 838
Chlordiazepoxide	2,911	582	20.0	1,770 - 4,052
Chlorpromazine	2,309	319	13.8	1,684 - 2,934
Clorazepate	1,432	262	18.3	918 - 1,946
Cocaine	119,843	8,988	7.5	102,226 - 137,460
Codeine	1,896	246	13.0	1,413 - 2,379
Codeine combinations	7,944	874	11.0	6,231 - 9,657
d-Propoxyphene	6,551	786	12.0	5,010 - 8,092
Desipramine	1,945	350	18.0	1,259 - 2,631
Diazepam	13,947	1,492	10.7	11,022 - 16,872
Diphenhydramine	7,861	1,093	13.9	5,719 - 10,003
Doxepin	3,605	447	12.4	2,729 - 4,481
Ethchlorvynol	168	67	39.9	37 - 299
Flurazepam	2,271	479	21.1	1,332 - 3,210
Glutethimide	170	75	43.9	24 - 316
Haloperidol	2,896	391	13.5	2,130 - 3,662
Heroin/Morphine	48,003	3,936	8.2	40,288 - 55,718
Hydromorphone	615	223	36.2	179 - 1,051
Imipramine	4,371	608	13.9	3,180 - 5,562
Inhalants/Solvents/Aerosols	1,235	275	22.3	695 - 1,775
Lorazepam	8,925	1,151	12.9	6,668 - 11,182
LSD	3,499	612	17.5	2,299 - 4,699
Marijuana/Hashish	23,997	2,064	8.6	19,952 - 28,042
Meperidine	1,163	327	28.1	522 - 1,804
Meprobamate	461	140	30.4	186 - 736
Methadone	2,812	354	12.6	2,118 - 3,506
Methamphetamine/Speed	6,563	1,509	23.0	3,604 - 9,522
Methaqualone	718	155	21.6	414 - 1,022
Methylphenidate	1,044	207	19.8	639 - 1,449
O.T.C. diet aids	1,272	285	22.4	714 - 1,830
O.T.C. sleep aids	7,034	907	12.9	5,256 - 8,812
Oxycodone	3,750	540	14.4	2,692 - 4,808
PCP/PCP combinations	5,282	660	12.5	3,988 - 6,576
Pentazocine	547	166	30.3	222 - 872
Pentobarbital	24	4	16.4	16 - 32
Phenobarbital	3,220	428	13.3	2,381 - 4,059
Secobarbital	228	59	25.8	113 - 343
Secobarbital/Amobarbital	16	4	22.7	9 - 23
Thioridazine	2,881	418	14.5	2,062 - 3,700
Trifluoperazine	986	258	26.2	480 - 1,492
All other drugs	223,315	13,339	6.0	197,053 - 249,577

NOTE: These estimates are based on a representative sample of all non-Federal short-stay hospitals with 24-hour emergency rooms.

SOURCE: SAMHSA, Drug Abuse Warning Network (May 1993 data file).

XVI. Sample Maintenance

To maintain the statistical integrity of the sample in the face of changes in both the universe and sample population, sample maintenance must be performed. Sample maintenance involves three activities: (1) adjusting data received from the annual AHA hospital file to account for hospital mergers; (2) giving newly established hospitals a chance of selection into the sample; (3) selecting additional existing hospitals into the sample in cases of sample attrition; and (4) identifying "critical" reporting facilities each quarter and making sure that such facilities provide their data in a timely manner.

1. Annual AHA ED Visits Data

Each selected hospital carries with it over time its original sampling weight, which gets incorporated into the estimation formulas. These formulas, as outlined above, also make use of annual AHA emergency department visits information for each sample hospital. Because the original baseweight is a function of the probability of selection at the time the sample unit was selected, it is important that all subsequent data provided from AHA for each hospital be "consistent" with the definition of the original sampling unit and its original baseweight.

As discussed in an earlier section, a sample hospital may be one facility or it may be a collection of such facilities belonging to the same corporation. Such hospital organizations frequently change their composition. For example, two hospitals in the sample, representing two separate sampling units at the time of sample selection, may merge into the same corporation and be given the same corporate business address. Once this happens, the AHA file will have only one data record for the two merged organizations, despite the fact that the two merged hospitals still represent two physically distinct facilities. Furthermore, the ED visits information for this one record will reflect combined data from the two facilities. When the two records in DAWN's sample control file, representing the two original sampling units, are matched with AHA's list of hospitals (so that AHA's annual ED visits data can be attached to each original sampling unit's record), each of the two records in the sample control file will receive annual AHA ED visits information corresponding to the combined value for the two units. To adjust for such changes as the merger described above, a scaling factor, VEMFAC, is applied to the AHA ED visits data. VEMFAC apportions the combined visits data to each original sampling unit so that each unit only gets its appropriate share of the visits. Even though two hospitals have merged on the AHA file, it should be noted that the survey data continues to be collected separately for each of the two units.

In addition to merging, the original sampled hospital can also "demerge." This happens when the original DAWN sample unit splits into two or more corporate entities at some point in time. Each of the "demerged" units is designated as a sample unit and has the hospital's original sampling weight. In such an instance, AHA's annual list of hospitals will now include two or more hospitals for this sample unit, where it had previously had only one.

An example of how a hospital merger is handled by the sample control file is given below. Assume the following two sample units are listed in the sample control file for 1991:

DAWN Sample Control File

Observation	Original AHA ID No.	1990 Recorded AHA Visits
1	110100	9,544
2	110175	10,525

If the two hospitals merge in 1991, the AHA data for these two hospitals might look as follows for 1991:

1991 AHA Hospital File

Observation	New AHA ID No.	1991 Recorded Visits
1	110003	20,441

When the two hospitals merged, they became a single observation in the AHA data file, and both received a new AHA ID number. The 1991 AHA information for this merged unit represents visits in 1991 for both of the original units.

The annual AHA data tape is accompanied by documentation listing all hospitals that have merged and demerged during that year, with their previous and new AHA ID numbers. This information is used to merge the current AHA data with the original sample control file. In the example given above the final matched file will appear as follows:

Sample Control File
After Matched to 1991 AHA File

	Original AHA ID No.	New AHA ID No.	1990 AHA Visits	1991 AHA Visits	1991 DAWN Adjusted Obs. AHA Visits
1	110100	110003	9,544	20,441	9,812
2	110175	110003	10,629	20,441	10,629

The two data records in the sample control file representing the original two sample units both have a combined 1991 AHA ED visits total of 20,441. This information has been adjusted (in last column in the table above) using proportions reflected in the 1990 AHA data. These sample units are labeled Type M units on the control file.

In addition to the mergers, the unadjusted AHA annual visits data are also adjusted for those hospitals that were "split" for the DAWN sample at the time of frame development (see Section V). These units are labeled Type S, and the AHA visits are proportionally allocated as they are for the merged hospitals.

The final category of hospital that is defined differently on the AHA files than for DAWN represents the hospital demerger (Type D unit). Once a hospital demerges into two or more corporate entities, AHA's list of hospitals will include records for each of the new entities with corresponding visits information while the DAWN will reflect the aggregated unit as it appeared in the frame at the time of the original sample selection.

By aggregating the AHA reported visits over all sample units having the same original sample identification number, the estimation software restores the AHA data to the correct level of aggregation for these units. The identifiers used to determine the identification of each DAWN sample unit are discussed later in this section.

Those sample units that have not changed in any way in terms of their corporate status (i.e., have not merged or demerged) since the time of their selection into the sample, and are not split conglomerates, are labeled as Type R (regular) units. Type R hospital units also receive a proration factor equal to unity, causing no adjustment to take place in the DAWN estimation software for the AHA reported visits data.

2. Sample Unit Identification Numbers

There are two basic types of sample unit identifiers used for the survey, the AHA ID number, and the HCFA (Health Care Financing Administration) Medicare Provider number, also supplied by AHA. Each DAWN sample unit has several identifiers based on these two variables. These identifiers are discussed below.

At the time of selection into the sample, each new sample unit receives an AHA identification number based upon current AHA information. This information gets stored into the DAWN variable AHAIDX. Because each sampling unit is defined at the hospital level, each AHAIDX number represents a unique sampled hospital.

In addition to the AHAIDX number, each selected hospital is also assigned at the time of selection one or more DAWN Provider numbers for each of its eligible emergency departments. The Provider number is created from the HCFA Medicare Provider number to identify particular

emergency departments within a hospital. Thus, each Provider number uniquely identifies an emergency department participating in or previously participating in DAWN. As is the case with the AHAIIX number, the Provider numbers associated with each DAWN emergency department do not change once they are assigned.

Over time, both AHA and HCFA may change their identification numbers for hospitals that undergo organizational change. Although these changes do not impact upon the DAWN AHAIIX number or the Provider number, this information gets recorded into additional identification variables specific for a given hospital and year. These additional variables allow the system to maintain a proper audit trail for tracking the history of any hospital in the AHA files. This is especially necessary for mergers and demergers, where data processing requires the linking of old and current AHA ID numbers.

Because data reported by participating hospitals are maintained in computer files at the emergency department level, the Provider number also serves as an important tool for linking many of these files together.

3. Selecting New and Additional Existing Hospitals into the Sample

Each year, newly eligible sample units are given a chance of being selected into the sample. The sample selection occurs by performing systematic sampling in the strata where the new frame units reside. The sampling interval used for selection is the same as that used to select the original sample units in the stratum and is equal to the value of the stratum baseweight.

In the case of sampling strata requiring additional sample units because of sample attrition, attempts are first made to recruit previously selected nonresponding hospitals.

4. Identifying Potential Critical Late Reporters

Each quarter, participating DAWN hospitals having enough drug episodes and mentions to impact significantly published estimates are identified by DAWN as Potential Critical Late Reporters. Such facilities are identified based on their weighted number of cocaine mentions from two quarters prior, the number of days reported by the facility for the current quarter, and the response rate for the stratum. This information is used to establish priorities for data collection follow-up procedures.

XVII. Sample Weights for Years 1978 through 1987

The original DAWN sample, implemented in the early 1970s, gradually deteriorated as a result of attrition and nonrandom sample replacement (Section II). By 1980, when DHHS took control of the survey, the original sample was appropriate only for presentation of raw (i.e., unweighted) data. Representative weighted estimates only became available commencing with the 1988 survey data, once the new statistical sample became fully implemented. Representative weighted estimates for years prior to 1988 have not been available until recently, when analyses were performed to develop appropriate weighting procedures for these data. The methodology used to develop these sampling weights is discussed below.

Hospitals belonging only to the original sample were not dropped from the DAWN reporting system immediately upon implementation of the new sample. Most such facilities remained in the system until 1989. This created an overlap period between 1988 and 1989 during which both "old" and "new" reporters supplied data. In particular, from the fourth quarter of 1988 to the second quarter of 1989, the new sample was virtually implemented and the old sample was also still in place. This overlap period was used to evaluate various procedures for weighting the old sample data (from 1977 to 1987); for each particular method considered, estimates were generated for the overlap period using the old sample data and then compared to weighted estimates for the same period obtained from the new statistical DAWN sample. The performance of each estimation procedure used for the old sample was then measured in terms of how well estimates derived from them agreed with the new sample estimates for this same period. For the purposes of the analysis, the newly published estimates for this period (based on the new sample) were taken to be "true" values, and the discrepancies between the old and new estimates were expressed in terms of relative bias.

For this overlap period, the performance of various weighting procedures was considered for nine drug categories: total episodes, total mentions, heroin-morphine mentions, cocaine mentions, marijuana-hashish mentions, acetaminophen mentions, aspirin mentions, diazepam mentions, and phenobarbital mentions. These drug categories were selected, in part, based upon the drugs mentioned in the objectives stated in the National Drug Control Strategy -- a 1991 White House publication which specifies targets for reductions in the total number of drug related medical emergencies, as well as emergency department mentions of cocaine, heroin, and other "dangerous drugs." In addition, other drugs were selected to ensure that some over-the-counter and prescription drugs were included in the analysis.

For each estimation procedure considered, the relative bias in each of the nine drug categories was calculated for each of DAWN's 21 metropolitan areas, as well as for the national panel. With the exception of the two categories, total episodes and total mentions, these relative biases were assigned a weight between zero and one, by taking the published estimate for the drug category for the overlap period, and dividing by the sum of the published estimates for all seven remaining drug categories. The weighted absolute relative biases were then added together within each metropolitan area to produce a total relative bias for the region. This weighting technique ensured

that large biases associated with a small number of drug mentions did not unduly influence the choice of estimator. For example, based on the published estimates, the estimated number of ED visits involving phenobarbital abuse for Newark during the overlap period is ten, while the estimated number of ED visits involving abuse is close to 3600. Clearly, other things being equal, a model which estimates the number of phenobarbital mentions to be 5 (a 50 percent relative bias) and cocaine mentions to be 3601 (less than one percent relative bias) is superior to a model that estimates the number of phenobarbital mentions to be 9 (a 10 percent relative bias) and the number of cocaine mentions to be 2500 (a 30 percent relative bias), even though the sum of the biases in the first case is larger.

The evaluation of the performance of various weighting procedures for the old sample data focused on the following weighting considerations:

1. Benchmarking

The ratio of the AHA ED visits total to the sample estimate of the same total constitutes a benchmark adjustment. When such a ratio is calculated at the level of the estimation cell (i.e., metropolitan area or national panel), as in the case of the current sample estimates, the estimator takes the form of a combined ratio estimator, as given in equation (1). Both the combined ratio estimator and the separate ratio estimator were evaluated for the old sample data, to determine how well the respective estimates agreed with estimates from the new sample for the overlap period.

2. AHA Versus DAWN ED Visits Data

Estimates of the weighted total number of ED visits used in the denominator of the benchmark adjustment can be based on the hospital data provided to DAWN each month, or on the AHA visits data associated with the hospital. For the old sample data, both approaches were considered.

3. Equal Probability Versus Unequal Probability Sampling Weights

Although the new statistical sample uses equal probability sampling in each sampling stratum, weighting approaches were evaluated for the old sample that assumed both equal probability and unequal probability sampling.

Representative national estimates of total drug episodes and total drug mentions for each year (1978-1987) were generated by first determining the best weighting model for each metropolitan area (based upon the sum of the weighted absolute relative biases across all drug categories) and using the model to produce a regional estimate. Then these estimates were added together to produce a national estimate.

Users of published DAWN data for years 1978-1987 should bear in mind that these weights are based on a methodology different from that currently used in the new sample. Because the estimates for these years are weighted estimates from a nonrandom sample, they may have some

degree of sample bias in addition to sampling error. Furthermore, changes in reporting procedures occurring during the ten-year period, as well as other factors, may impact upon the estimates. These considerations are discussed below.

The classification for Hispanics was not introduced into the DAWN data collection form until 1981. Thus, demographic estimates for this group are not available prior to this year. Drug-related episodes where the patient seeks detoxification only became reportable as of 1987. The addition of this reason for visit category had the effect of increasing the total number of reportable cases in the DAWN system. This change may have had a significant impact upon estimates for cocaine and heroin, where at least 20 percent of the mentions currently are associated with seeking detoxification.

In addition, regional estimates will tend to be less reliable than national estimates for this time period. The sample size is not adequate to support estimates for the Baltimore metropolitan area prior to 1979 or for Newark prior to 1984 (both of these areas were initially part of the National Panel until they were split apart). Certain other metropolitan areas may be problematic for the whole period (i.e., 1978 to 1987), such as San Francisco, where changes in the new sample boundary definitions for the metropolitan area may impact upon the estimates. In addition, no estimates are available for Miami prior to 1987 due to an insufficient sample. A detailed report on the 1978-87 estimation procedure and its limitations is in preparation.

Variance estimates have not as yet been produced for weighted episodes and mentions estimates for years 1978 through 1987. A detailed report on the 1978-87 estimation procedure and its limitations is in preparation.

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APPENDIX A

Recommendation of the Sampling Design for NIDA's Drug Abuse Warning Network

From the Panel of Consultants: Ira Cisin, Ph.D.; Richard Clayton, Ph.D.; Lloyd Johnston, Ph.D.; Leslie Kish, Ph.D.; Joseph Waksberg, B.S.

The five consultants listed above were convened for a one-day meeting at the Parklawn Building in Rockville on June 28, 1983, along with representatives from NIDA, DEA, and FDA. The purpose of this meeting was to consider the several sampling strategies which had been developed for a revised DAWN system, and to make recommendations on these and related issues. The panel unanimously agreed upon the following recommendations during the course of that meeting:

1. Sample Redesign. We feel that, overall, the various agencies involved would be best served if the sampling plan for this study was put back on the "drawing board" for an exploration of the various proposals set down below-specifically to determine their feasibility and likely impact on the cost and usefulness of the overall DAWN system. The panel is not critical of the sampling work developed so far, given the constraints under which the original sampling designs were developed should be relaxed or changed.
2. In the Interim. It is recommended that the existing DAWN data system be continued during this redesign and reappraisal period.
3. National Probability Sample. At the most general level there is clear agreement that a nationally representative probability sample of emergency rooms was desirable.
4. Local Area Samples. It is also agreed that some minimum number of area-specific samples is desirable, given the mix of objectives from the various agencies. The absolute minimum is probably in the range of 12 to 14 areas (cities or SMSA's), very likely including many of the largest cities in the country. Beyond that number, there is a cost/benefit tradeoff to be considered seriously, about which we offer the following suggestions:
 - a) That the quality of the data - including such things as getting a high response rate from hospitals and accurate and complete reporting from hospitals - receive a higher priority than the numbers of cases or areas to be included in the system.
 - b) That there be consideration given to consolidating some of the separately reported SMSA's (e.g., San Diego and Los Angeles, Washington and

Baltimore), after an initial examination of the degree to which their trends may have covaried in the past.

- c) That the sample be designated in three stages: (1) a design for the minimum set of urban areas, (2) a design for a nationally representative probability sample for the rest of the country, and then (3) consideration of whether to add more urban area samples considering the costs already projected from the first two steps.
 - d) That the requirements for sampling accuracy in the pre-selected metropolitan areas be made more flexible - with greater accuracy requirements for the very large cities than for the smaller cities. This yields a more efficient national sample design. (Or it can permit the inclusion of more local areas for a fixed dollar investment in local area samples.)
 - e) That, among the criteria which might be considered in selecting the specific urban areas to be oversampled, consideration should be given to population size, level of drug problem, variability in usage statistics across time, and the possibility that some cities have provided leading indicators of more general trends.
 - f) When selecting hospitals with SMSA's, stratify hospitals (as Dr. Ericksen's proposal does) and consider sampling even more of the strata than he did at a probability of selection less than 1.0.^{*} This should result in a smaller, but still adequate, number of hospitals in those key SMSA's. In addition, it leaves a pool of hospitals which can be used as replacements for ones which refuse to participate in those same SMSA's.
5. Clustered sampling. It is possible that increased efficiency in start-up and operating costs may be achieved by selecting the national probability sample using a stratified, clustered design, since having the hospitals clustered geographically may (1) reduce travel costs, (2) facilitate training and quality control, and (3) even yield increased sampling efficiency if there is great heterogeneity within areas. For these reasons, we recommend that the possibility of a clustered sample at least be explored,
6. Probability proportionate to size. If, as we suspect, the average cost per case is substantially lower in the large hospitals, drawing the sample of hospitals with the probability of being drawn set proportionate to hospital size should be seriously considered as a cost saving measure. In essence, a larger proportion of the hospitals sampled will be large hospitals and possibly fewer hospitals overall would be

* The panel agreed that when the selection probability gets close enough to 1.0, it should simply be made 1.0; however, there was some disagreement over what was "close enough."

needed. (Size presumably would be measured by the number of emergency room visits handled by the hospital in a given period of time.) We think that a procedure of stratification by size could be used within Dr. Ericksen's stratification plan.

7. Replacements. Hospitals which refuse to participate, or which drop out of the panel, should have some type of substitution to maximize the accuracy of the sample. If the hospital is part of one of the urban area samples, it should be replaced by another hospital, if possible, to maintain the number of cases as well as to correct for various distortions which might be introduced by non-replacement. If a proper substitution is not available, imputation of data from other similar hospitals in the area is possible. However, if the missing hospital is unique and "essential" to any estimate for the area (e.g., Washington General in D.C.), then it must be recognized that an adequate sample cannot be secured for the specific urban area, and consideration should be given to dropping that area as one of the selected ones. On the other hand, for purposes of the national estimates, an adequate substitution may well be available in another city in the same region (or, again, imputation can be considered.)

Emergency rooms which close should no be replaced.

8. Weighting. In the calculation of national sample estimates, compensatory weighting should be used to correct for variations in sampling probabilities for the elements (drug-related emergencies) which are known to have occurred during the sampling process.
9. Noise Reduction. Some methods for "smoothing the data" - such as the use of moving averages or of longer reporting intervals - should be considered for the local area estimates most subject to "noise" in the trend estimates.
10. Splicing. We believe that, during the period of transition from the old sample to the new one, it would be desirable to develop a) useable trend data during that period, and b) some notion of how the old data "map" onto the new data both for the overall national sample and the specific local areas retained in the plan. Therefore, we recommend keeping the original panel functioning during the transition period and, also, adding the new hospitals in representative, randomly selected, clustered subsamples. This permits the recruitment effort to be done in steps over time, yet allows national estimates to be made by both the old and new methods as soon as the first new subsample is acquired (though the new method will start out with much larger confidence intervals in the early stages than it will have later).

FIPS Code	PMSA/MSA	Counties Included
2080	Denver, CO PMSA	Adams Arapahoe Denver Douglas Jefferson
2160	Detroit, MI PMSA	Lapeer Livingston Macomb Monroe Oakland St. Clair Wayne
4480	Los Angeles-Long Beach, CA PMSA	Los Angeles
5000	Miami-Hialeah, FL PMSA	Dade
5120	Minneapolis-St. Paul, MN-WI MSA	Anoka, MN Carver, MN Chicago, MN Dakota, MN Hennepin, MN Isanti, MN Ramsey, MN Scott, MN Washington, MN Wright, MN St. Croix, WI
5560	New Orleans, LA MSA	Jefferson Parish Orleans Parish St. Bernard Parish St. Charles Parish St. John the Baptist Parish St. Tammany Parish
5600	New York, NY PMSA	Bronx Kings New York Putnam Queens Richmond Rockland Westchester
5640	Newark, NJ PMSA	Essex Morris Sussex Union

FIPS Code	PMSA/MSA	Counties Included
6160	Philadelphia, PA-NJ PMSA	Bucks, PA Chester, PA Delaware, PA Montgomery, PA Philadelphia, PA Burlington, NJ Camden, NJ Gloucester, NJ
6200	Phoenix, AZ MSA	Maricopa
7040	St. Louis, MO-IL MSA	Franklin, MO Jefferson, MO St. Charles, MO St. Louis, MO St. Louis city, MO Clinton, IL Jersey, IL Madison, IL Monroe, IL St. Clair, IL
7320	San Diego, CA MSA	San Diego
7360	San Francisco, CA PMSA	Marin San Francisco San Mateo
7600	Seattle, WA PMSA	King Snohomish
8840	Washington, DC-MD-VA MSA	District of Columbia Calvert, MD Charles, MD Frederick, MD Montgomery, MD Prince Georges, MD Arlington, VA Fairfax, VA Loudon, VA Prince William, VA Stafford, VA Alexandria city, VA Fairfax city, VA Falls Church city, VA Manassas city, VA Manassas Park city, VA

APPENDIX C

Calculation of Population-Based Rates

In addition to the estimates described in this report, rates of total drug episodes and selected mentions (cocaine, heroin/morphine, and marijuana/hashish) relative to the total population are produced for the total U.S. and the 21 DAWN metropolitan areas, broken-out by sex, and within sex, by age. Population-based rates are obtained by taking the estimates of total episodes and mentions for each demographic category, and dividing by the number of persons in the population belonging to the demographic category. Because the same patient may be involved in multiple drug-related episodes within a given quarter, these rates do not represent prevalence rates but rather incidence rates for total ED drug abuse episodes or mentions per 100,000 persons.

The population estimates used to produce these rates represent the total civilian noninstitutional population in each metropolitan area and in the coterminous U.S. (excluding Alaska and Hawaii). These estimates are generated using the following three Census Bureau data files:

1. **The Civilian Noninstitutional Population of the U.S. by Age, Race, and Sex (CNP tables).** This series provides monthly population estimates, by age, sex, race, and Hispanic origin for the total U.S.
2. **1990 Census Counts by Age, Sex, and Race (ASR File).** This series provides population estimates by State and county, broken-out by combinations of age, sex, race, and Hispanic origin.
3. **County-Level Population Estimates (CPOP file).** This series provides estimates of annual total population by county as of July 1 of each year.

The population estimates are obtained by (1) adjusting the CPOP annual county population counts to the 1990 ASR demographic counts, to produce annual county demographic counts; and then by (2) adjusting the annual county demographic counts to the CNP to produce monthly county demographic counts; and finally by (3) summing the monthly county demographic counts across all counties in the metropolitan area and across all months in the quarter (half-year or year), to produce quarterly (semiannual or annual) demographic counts for each DAWN area.

The first step in this process involves estimating the percentage of persons belonging to each demographic grouping used by DAWN (sex crossed by age) in each county. This percentage is estimated from the 1990 ASR file and is given by,

$$(25) P_{ASR_{c,k}} = ASR_{c,k} / \sum_k ASR_{c,k} ,$$

where $ASR_{c,k}$ is the population count from the ASR file for persons in county, c , having demographic characteristic k and where the sum in the denominator is over all demographic categories (age, sex combinations).

The percentages $P_{ASRC,k}$ are next used in conjunction with data from the CPOP file to estimate the total number of persons in each county having demographic characteristic k for the year in question. This estimate is given by,

$$(26) \text{ CPOP}_{c,k,y} = P_{ASRC,k} * \text{ CPOP}_{c,y},$$

where $\text{ CPOP}_{c,y}$ represents the annual population count for county c in year y from the CPOP file.

Next, $\text{ CPOP}_{c,k,y}$ is converted into a monthly estimate by scaling it by an adjustment factor, $F_{k,m}$, calculated from the CNP file, which contains population counts for the U.S. as a whole by demographic groupings. The formula for the adjustment factor is given by,

$$(27) F_{k,m} = \text{ CNP}_{k,m} / \sum_c \text{ CPOP}_{c,k,y},$$

where $\text{ CNP}_{k,m}$ is the monthly total U.S. population count for persons having demographic characteristic k . The adjustment factor, $F_{k,m}$, is then multiplied by $\text{ CPOP}_{c,k,y}$ to produce the monthly estimate for the population count in county c having characteristic, k :

$$(28) \text{ CPOP}_{c,a,k,m} = F_{k,m} * \text{ CPOP}_{c,k,y}$$

The calculation of the final monthly population estimate for each metropolitan area then given by,

$$(29) \text{ CPOP}_{a,k,m} = \sum_c \text{ CPOP}_{c,a,k,m},$$

where $\text{ CPOP}_{a,k,m}$ is the monthly population estimate for DAWN metropolitan area a , for sex by age group k , during month m , and $\text{ CPOP}_{c,a,k,m}$ is the monthly population estimate for county c , in DAWN metropolitan area a , for sex by age group k , during month m .

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