Usability of the American Community Survey Estimates of the Group Quarters Population for Substate Geographies[1]

Michael Beaghen, Sharon Stern
U.S. Census Bureau, 4600 Silver Hill Road, Washington, DC 20233

Abstract
The American Community Survey (ACS) provides estimates of detailed characteristics of persons both in housing units (HU) and group quarters (GQ). However, the GQ sample frame, sample design and estimation methodology differ from those of the HU. Importantly, the sample and estimation methodology for the GQ population are designed to be optimal for state-level estimates, whereas those of the HU population are designed for smaller geographies. These differences present challenges for the usability of estimates of GQ and total population at substate geographic levels, particularly for one-year estimates. For example, for some substate geographies there may be anomalies in the estimates of poverty. This paper describes these challenges and reviews proposed and implemented methodological changes to enhance the usability of GQ and total population estimates for smaller geographies.

Key Words: sample design, estimation, ACS, GQ

1. Introduction

The American Community Survey (ACS) provides estimates of detailed characteristics for the total population of the United States. Unlike many surveys, these estimates include people living both in housing units (HU) and group quarters (GQ). A HU may be a house, an apartment, a mobile home, a group of rooms or a single room that is occupied (or, if vacant, intended for occupancy) as separate living quarters. Separate living quarters are those in which the occupants live separately from any other individuals in the building and which have direct access from outside the building or through a common hall. A GQ is a place where people live or stay that is normally owned or managed by an entity or organization providing housing and/or services for the residents. These services may include custodial or medical care as well as other types of assistance, and residency is commonly restricted to those receiving these services. GQs include such places as college residence halls, residential treatment centers, skilled nursing facilities, group homes, military barracks, correctional facilities, and workers' dormitories. For a complete description of the types of GQs included in the 2007 ACS see U.S. Census Bureau (2009a).

[1] Any views expressed on statistical, methodological, technical, or operational issues are those of the authors and not necessarily those of the U.S. Census Bureau.

The nature of the GQ population and of the ACS sampling and estimation methodologies have lead to several unique issues for the usability of estimates of substate geographies for the GQ population and for estimates of the total resident population (the total resident population is the combined population in HUs and GQs). In particular, the ACS GQ sampling and weighting methodologies are designed to produce estimates at the state level, while estimates of the GQ population are used at the substate level. As a consequence, the variances of substate estimates are higher than desired and there are limitations for the usability of estimates of GQ and total population at substate geographic levels, particularly for one-year estimates. This paper describes some of these underlying methodological issues, explains the limitations in the usability of the estimates of GQ population in themselves or as a contribution to total resident population estimates, and reviews proposed methodological changes to enhance the usability of GQ and total population estimates for smaller geographies.

The Census Bureau releases ACS estimates of total GQ population for counties and estimates of characteristics of the GQ population for larger geographies including the larger states. While estimates of the GQ population are of interest in their own right, they are also included in ACS estimates of population and characteristics for the total resident population at the lowest levels of geography released. Consequently, any anomalies in the estimates of GQ population may be reflected in the estimates of the total resident population.

Some of the unique issues associated with estimates of the GQ population include the following.

- There is greater clustering of people in GQs than in HUs. HUs are relatively small with a mean household size of 2.61 persons (2007 ACS). In contrast, GQ units are typically much larger and can range in size up to thousands of people. Furthermore, there is a high intracluster correlation for the GQ population; that is, people within a given GQ facility tend to have similar characteristics. For example, people who live in college dorms tend to be between 18 and 22 years old, and people in a given correctional facility tend to be all the same sex.
- The sample of GQ residents selected is typically a cluster of 10 people from a GQ facility and thus about four times larger than the average cluster of people selected in a housing unit.
- The sampling and estimation methodologies for the GQ population are designed to produce optimal state-level estimates, whereas those of the total resident population are designed for substate geographies. In particular, the GQ population estimates are controlled at the state level, whereas the ACS estimates of the total resident population are controlled at the level of county-based weighting areas.
- GQ units are more sparsely distributed across geography than HUs.
- The characteristics of the GQ population differ from the HU population in some predictable ways. Hence, the GQ population has an observable, and disproportionate, impact on total resident population estimates of certain characteristics such as income, poverty, and disability status.
- The GQ sampling frame faces greater challenges in its construction than the HU sampling frame. The Delivery Sequence File (DSF) updates the MAF for housing units. However, there is almost no mechanism to update the GQ sampling frame.

Section 2 of this paper provides background information with an emphasis on methodologies pertaining to producing estimates of the GQ population. Section 3 describes the challenges that estimates of GQ population present data users. Specifically, Section 3.1 examines the differences between the Census Bureau's Population Estimates Program (PEP) and ACS estimates of GQ population by county, and Section 3.2 investigates the effects of GQ estimation on the reliability of poverty estimates. Section 4 examines the quality of the GQ sampling frame over time. Section 5 concludes the paper and gives recommendations for data users and suggestions for future research.

2. Background

This section provides a general overview of the ACS and related programs with particular attention to elements such as GQ sampling and weighting which may impact the quality of estimates of the GQ population for substate areas.

2.1 The American Community Survey

The ACS is a critical piece of the Census Bureau's reengineered decennial census. The ACS takes a series of monthly samples to produce annual estimates of detailed demographic, social, economic, and household characteristics comparable to those previously produced once a decade by the decennial census long-form sample. Starting in 2010 the ACS will produce these estimates based on five years of collected sample for the same small areas, census tracts, and block groups for which the decennial census long-form sample formerly produced estimates. The Census Bureau also produces three-year and one-year ACS data products for larger geographic areas. Like the decennial census, the ACS estimates include people living in both HUs and GQ facilities (U.S. Census Bureau, 2009b).

The ACS sample of HU addresses and people in HUs was implemented at its full size of three million addresses starting in 2005. In 2006 the ACS released its first one-year estimates of the household population only based on the 2005 data. In 2006 people in GQs were added to the ACS sample and in 2007 the Census Bureau released the first ACS one-year estimates of the total resident population and of the GQ population for the 2006 period. The Census Bureau releases ACS one-year estimates for geographies that meet the threshold population size of 65,000. In 2008 the ACS released its first three-year estimates for the period 2005-2007 and likewise will release three-year estimates each year for geographies that meet the threshold population size of 20,000. The 2008 ACS release included the first three-year estimates of the GQ population (for the 2005-2007 period, though they were based only on sample collected in 2006 and 2007). Starting in 2010 the ACS will release its first five-year estimates based on data collected from 2005 through 2009 and will release new five-year estimates each year (for the 2005-2009 period the GQ estimates will be based only on sample collected from 2006 to 2009). The five-year estimates will include estimates for tracts and block groups. For details on ACS data releases see U.S. Census Bureau, 2008a.

2.2 Official Population Estimates

The Census Bureau's Population Estimates Program (PEP) publishes total resident population estimates and demographic components of change (births, deaths, and migration) each year (U.S. Census Bureau, 2009c). The program also publishes the estimates by demographic characteristics (age, sex, race, and Hispanic origin) and total HUs for the nation, states and counties. Further, it publishes population counts of GQ residents for each state by major types of GQ facilities and total population only for each county. The reference date for these estimates is July 1. PEP estimates of population are derived by combining administrative records data with data from the previous census (U.S Census Bureau, 2009d). The official population estimates are critical to the ACS because ACS estimates of HUs and people are controlled to the PEP estimates (see Section 2.6).

2.3 The ACS Housing Unit and Group Quarters Sampling Frames

The ACS sampling frame for HUs comprises all valid, residential HU addresses in all counties and county equivalents in the 50 states and the District of Columbia. These are obtained from the Master Address File (MAF), a database maintained by the U.S. Census Bureau containing a listing of residential and commercial addresses in the U.S. The MAF is updated twice each year in July and January with the Delivery Sequence Files provided by the U.S. Postal Service. The MAF is also updated with the results from various Census Bureau field operations including ACS field interviewing (U.S. Census Bureau, 2009e).

The ACS GQ sampling frame was initially created from the Special Place/Group Quarters facility files, which were obtained from decennial census operations and merged with the MAF. This frame includes GQs added from operations such as the GQ Incomplete Information Operation (IIO) at the Census Bureau's National Processing Center in Jeffersonville, Indiana, and the Count Question Resolution (CQR) Program, in addition to GQs closed on census day. The frame is also updated annually with the results of the ACS fieldwork in addition to research conducted by the Census Bureau (Bates, 2008). The GQ sampling frame includes an expected population for each GQ, which is essential to the current GQ sample design and is also used in the GQ weighting.

2.4 ACS Sampling

The ACS interviews both people residing in HUs and people residing in GQs. The ACS HU sample includes about three million HU addresses each year. While the HU sampling rates vary by geography, they are, overall, roughly comparable or lower than the sampling rates for people in GQs. For the main HU sampling, selected addresses are allocated systematically in a predetermined sort order to all twelve months of the sample year. In an additional phase of sampling called supplemental sampling, a sample of addresses new to the frame from the January Delivery Sequence Files is systematically assigned to the months of April through December of the sample year for data collection.

In contrast to the HU address sample, the ultimate sampling unit for the GQ sample is the GQ resident, not the GQ facility itself. The GQ frame is divided into two sampling strata within each state, a small GQ stratum and a large GQ stratum, each with different sampling methods. The small strata consist of GQs with expected populations of 15 or fewer people and GQs closed on census day 2000. The expected sizes come from the sampling frame, which were obtained primarily from the 2000 Census. Small stratum GQs are sampled systematically within each state, sorted by small versus closed on census day, new GQ facility versus previously existing, GQ type, and geographical order (county, tract, block, street name, and GQ identifier). The sampling rate is usually 1-in-40 (from 2006 through 2007 the sampling rate was fixed at 1-in-40, but starting with the 2008 ACS some states have higher sampling rates). Small stratum GQs are selected into sample in such a manner that a given facility can be in sample at most once in a five-year period (the same is true of the selection of HUs). If there are 15 or fewer people found in a small stratum GQ, then everyone in the GQ is in sample. If there are 16 or more people found in a small stratum GQ, then ten people are systematically selected from the GQ. There were approximately 105,000 small stratum GQ facilities, 77,000 large stratum GQ facilities, and 3,000 facilities with an unknown population count on the 2007 GQ sampling frame (U.S. Census Bureau, 2009e).

The large strata include GQs with expected populations of 16 or more people. The primary sampling unit for large stratum GQ facilities is a group of ten people, not the facility itself. For each large stratum GQ one or more systematic samples of groups of ten people are taken to achieve a sampling rate which is usually 1-in-40 (from 2006 through 2007 the sampling rate was fixed at 1-in-40, but starting with the 2008 ACS some states have higher sampling rates). All large GQ facilities in a state are sorted by GQ type and geographical order in the large GQ frame. To illustrate the sampling method, assume we have a state with a sampling rate of 1-in-40. If a GQ in the large stratum has an expected population of less than 400, zero or one group of ten is selected, with higher expected sizes more likely to have a group selected; if it has an expected size of 400 exactly one group of ten people is selected; if it has an expected population from 401 to 799 one or two groups of ten is selected with GQs having higher expected sizes more likely to have two groups selected; with 800 exactly two groups are selected, etc. For additional information about the sampling methods described see U.S. Census Bureau, 2008b or 2009e. A consequence of the GQ sample design is that the typical size of the cluster of people selected in sample from a GQ facility is about 10.

2.5 Overview of ACS Group Quarters Person Weighting

There are three stages of weighting for GQ sample people. The first stage calculates for all sample people initial weights which reflect the probability of selection. The initial weights also reflect adjustments due to differences in observed and expected GQ populations as well as a weight trimming procedure. The second stage adjusts the weights to account for non-interviewed people. The third stage adjusts these weights in a controlling or post-stratification procedure, so that the state-level sums of the weights equal independent population controls (see Section 2.6). It then rounds all of the weights to integers. These rounded weights are the final weights used in tabulating estimates. For additional information about the sampling and weighting methods described, see U.S. Census Bureau, 2008b or 2009e.

2.6 Controls

The ACS controls its estimates to the PEP estimates. Controlling estimates reduces bias due to undercoverage or overcoverage of GQs and HUs, and of people within HUs and GQs, relative to the PEP estimates. It also reduces the variance of the HU, household, and person estimates. The process of controlling applies three sets of constraints to ACS estimates. (1) The GQ person weights are controlled to independent GQ population estimates obtained from the PEP at the state level by seven major GQ types (correctional institutions, juvenile facilities, nursing homes, other long-term care facilities, college dormitories, military facilities, and other noninstitutional facilities). (2) ACS estimates of HU counts are constrained to equal PEP estimates at the weighting area level. A weighting area is usually a county but can be two or more counties when a smaller county is grouped with others. (3) Estimates of total resident population are constrained to equal PEP estimates of totals by demographic groups defined by sex, age, race and Hispanic origin at the weighting area level. Note that this third set of constraints implies that the

ACS estimates of population in HUs are not directly controlled to PEP estimates. Rather, the controls for total persons in HUs are obtained by subtracting out ACS estimates of GQ population from the PEP estimates of total resident population.

Using population controls in the weighting of survey estimates is a standard Census Bureau procedure. Census Bureau experts deemed estimates of total population by demographic breakdowns at the county level sufficiently reliable to use as controls, and subsequent research has supported this recommendation (Asiala, et al, 2008).

2.7 ACS Group Quarters Population Data Products

An extensive set of data products is available for detailed characteristics of the total resident population for all geographic areas that meet the respective one-, three-, or five-year population thresholds (for a description of the available data products, see U.S. Census Bureau, 2008a). However, only limited products are available for the GQ population itself. ACS estimates for counties include the size of the GQ population without characteristics. ACS estimates for larger states provide some characteristics of the GQ population, though these are not broken down by type of GQ. ACS estimates for regions and divisions provide some characteristics of the GQ population broken down by institutional versus noninstitutional GQ. Lastly, ACS estimates for the nation provide some characteristics of the GQ population broken down by some major types of GQ.

3. Group Quarters Usability Issues

In this section we discuss several specific issues relevant to users of ACS estimates of GQ, household, and total resident populations. As will be seen, the estimates of GQ population present greater challenges for using estimates of total resident population than for estimates of GQ population themselves. This is because, with the exception of total county GQ resident population, the ACS produces estimates of GQ population at the state level or higher, a level at which the estimates are of a high level of reliability. On the other hand, the GQ population estimates are a part of the estimates of total residence, estimates which are produced for substate geographies such as counties, tracts, or block groups. At these lower levels of geography the estimates of GQ population are less reliable.

3.1 Differences Between ACS and Official Population Estimates of Group Quarters Population at the County Level

Each year the Census Bureau releases one-year ACS estimates of total GQ population for counties with total resident populations of 65,000 or more. However, the ACS estimates of county GQ population totals, unlike those of the total resident population, are not controlled to equal the PEP estimates. Rather, the Census Bureau controls estimates of GQ population at the state level by major GQ type. This results in ACS county-level GQ population estimates that differ from the PEP estimates, and may also result in over-statements of year-to-year changes in county-level estimates of total GQ population. Both of these phenomena can be disturbing to data users. Furthermore, because the GQ sampling is conducted at the state level, some counties can have disproportionately small or large numbers of GQ people in sample for a given year, contributing to high sampling variability for county-level estimates. Thus the ACS versus PEP differences and the ACS year-to-year fluctuations of county estimates of GQ population may be large. Of particular concern to data users are counties with GQ population which have no GQ sample interviews.

Table 1 summarizes the differences between the PEP and ACS estimates for GQ people over the 790 counties for which the ACS one-year estimates were published in 2007. The median absolute value of the difference is 876 and the mean absolute value of the difference is 1,471.

TABLE 1: Summary of Differences between the 2007 ACS GQ Estimates and the Official (PEP) Population Estimates

	Mean	Standard Deviation	Minimum	First Quartile	Median	Second Quartile	Maximum
Absolute Difference	1,471	1,748	0	380	876	1,892	19,483
Percent Absolute Difference	30.1	37.1	0	8.3	18.8	40.1	438

The size of the differences between the ACS and PEP county estimates of the GQ population are large enough to suggest that this is more than just a problem of perception, and that the ACS estimates of GQs may have unexpectedly high sampling variability. Consider two of the counties with the largest differences. First, Webb County, Texas, (total population of 193,117 according to Census 2000) had a PEP estimate of 3,489 people in GQs in 2007, whereas the ACS estimated only 828, a difference of 2,661 people, or –76.3 percent. Next, Harford County, Maryland, (total population of 218,590 according to Census 2000) had 1,716 people living in GQs in 2007 according to the PEP, but had 6,138 people according the 2007 ACS - a difference of 4,422 people or 257.7 percent.

The differences seen between the ACS and PEP estimates of GQ population might be attributed to ACS estimates being more up-to-date than PEP ones. However, the surprisingly large year-to-year changes in ACS county estimates suggest the differences can indeed be attributed, at least in good part, to sampling variability in the ACS estimates. The median difference between the 2007 and 2008 ACS estimates over the 790 counties is 1,090 (the average number of people residing in GQs per county in 2007 was only 7,903 for these 790 counties). For an example of relatively extreme year-to-year fluctuation in the ACS estimates, consider the estimates of GQ population for Harford County, Maryland, for 2006, 2007, and 2008, which are 2,897, 6,138, and 1,463. Another relatively extreme example is Benton County, Oregon, which had 6,129 and 2,709 according to the 2006 and 2007 ACS, though the PEP estimated the GQ population of 4,280 for these years.

Ultimately, the difference between ACS and PEP estimates of total GQ population for counties may not be a great concern in itself as data users can turn to the PEP. However, it is suggestive of the limitations of ACS estimates of GQ population at the county level.

3.2 One-Year Estimates of Poverty

Though the actual number of people residing in GQs is small, their effect on total resident population estimates can be large for characteristics that are strongly related with GQ residence. Such characteristics include disability status, income, or variables derived from income such as poverty. For example, in 2007 the poverty rate for the GQ poverty universe was 64.5%, while the poverty rate for the total resident population was 13.0%. County-level estimates of poverty present examples of how limitations in the GQ population estimates can adversely affect total resident estimates. In particular, these examples reveal the effects of the clustering of GQ people and the sample design. In the following examples the number of estimated people in GQs is seen to vary greatly from year to year.

First it is necessary to define the poverty universe, the population for which the Census Bureau calculates poverty (U.S. Census Bureau, 2009f). The poverty universe includes all people in HUs and people 15 years and older in the following types of GQs: emergency and transitional shelters, group homes, residential treatment centers, and workers group living facilities. On the other hand, people in military facilities, correctional facilities, college dorms, juvenile facilities, nursing homes and other long term care facilities are not included in the poverty universe and thus are not included in ACS poverty statistics. There were 1.27 million people in the GQ poverty universe (2006 ACS), which made up only 0.43% of the total poverty universe.

The poverty rate may be particularly sensitive to what happens in GQ sampling because for a given geography it is estimated only for a subset of GQ facilities. This definition of the poverty universe presents an additional complication for the representativeness of poverty estimates at the substate level. Neither the sample design nor the weighting methodology accommodates the specialized poverty universe for substate estimates. Some counties have poverty rates that may be spuriously high or low in certain years because they had disproportionately large or small numbers of poverty universe GQs in sample in those years. Many of these affected counties have relatively small populations, though even large counties may show the effects of this phenomenon. The rest of this section provides two specific examples where the clustering of GQ sample people influences the poverty estimates.

The first example is Elmore County, Alabama. The 2006 ACS estimate of the poverty rate was 14.0 percent, 2.2 percentage points higher than the rate if measured using the HU sample only (see Table 2). This difference results from the estimated 1,976 people in the poverty universe portion of the GQ population (all based on sample from a single GQ facility), 90 percent of whom were in poverty. In contrast, in 2007, Elmore County had none of these types of GQs in its sample. Its estimate of the poverty universe in 2007 had only people living in HUs, hence the poverty rate looks like it fell dramatically from 14.0 percent in 2006 to 10.4 percent in 2007. (This drop is not statistically significant; however, we are arguing that the change is spurious, due to the clustering of GQs in the sample, that is, sampling variability, so we wouldn’t expect it to be statistically significant). In fact, if comparing the poverty rate in HUs in 2006 (11.8 percent) to the 2007 poverty rate, the difference would appear less dramatic (also not a statistically significant difference).

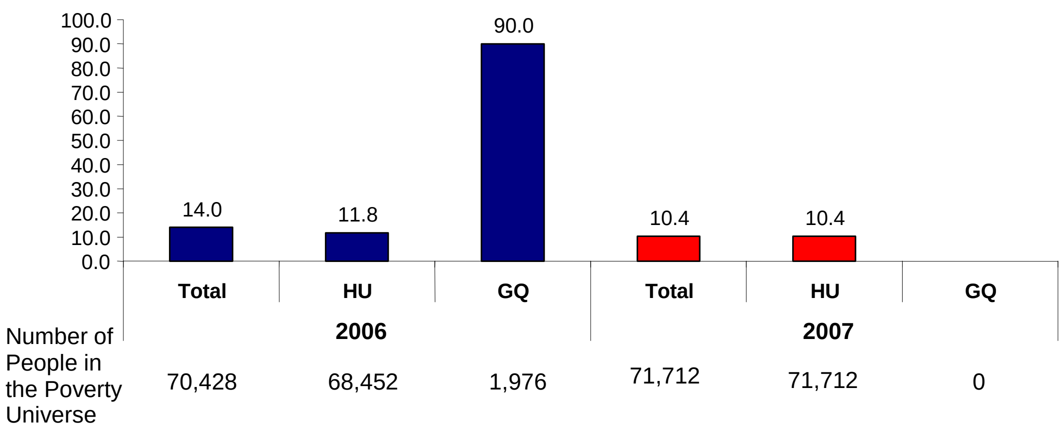
Tables 2 and 3 include columns for the percentage of people in poverty who are in GQs. In Elmore County in 2006, 18 percent of people in poverty were in GQs; in 2007 it was 0 percent. The results in Table 2 are displayed graphically in Figure 1.

TABLE 2: Elmore County, AL, Number and Percentage of People in Poverty by HU or GQ (Margins of error are in parenthesis)

		HU		GQ	
	Total	Number	Percentage	Number	Percentage
2006					
Poverty Universe	70,428	68,452	97.2	1,976	2.8
	(313)	(569)	(0.8)	(553)	(0.8)
Number in Poverty	9,881	8,103	82.0	1,778	18.0
	(2,273)	(2,212)	(5.9)	(529)	(5.9)
Percentage in Poverty	14.0	11.8	N.A.[1]	90.0	N.A.
	(3.2)	(3.2)		(13.7)	
2007					
Poverty Universe	71,712	71,712	100.0	0	0.0
	(502)	(502)	(0.0)	(0.0)	(0.0)
Number in Poverty	7,456	7,456	100.0	0	0.0
	(2,556)	(2,556)	(0.0)	(0.0)	(0.0)
Percentage in Poverty	10.4	10.4	N.A.	0	N.A.
	(3.6)	(3.6)		N.A.	

Source: The source for the 'Totals' column is the U.S. Census Bureau, American Factfinder Table S1701. The data in the rest of the table are previously unpublished.
[1] N.A. indicates 'not applicable'.

Figure 1. Percentage of People in Poverty by Residence in Elmore Co., AL: 2006 & 2007



Baltimore County, Maryland, is a noteworthy example because the effects of GQ estimates on the total poverty estimates are seen in a large county with over 700,000 people. In 2006, Baltimore County had an estimated 6,112 people in the GQ-poverty universe (see Table 3). As a result, the published 2006 Baltimore County poverty rate, 8.4 percent, was 0.6 percentage points higher than the household-only poverty rate of 7.8 percent.

In 2007, the GQ portion of the poverty universe in Baltimore County was 1,472 people, only 24 percent the size of the 2006 universe. Table 3 shows that the change in the percentage of people in poverty who lived in GQs went from 8.0 percent in 2006 to 1.5 percent in 2007[2]. In 2007, the difference between the total county poverty rate and the household-only poverty rate was only 0.1 percentage points. Thus the decrease in poverty from 2006 to 2007 from 8.4 to 7.8 percent is a result of which GQ residents fell into

TABLE 3: Baltimore County, MD, Number and Percentage of People in Poverty by HU or GQ (Margins of error are in parenthesis)

	Total	HU		GQ	
		Number	Percentage of Total	Number	Percentage of Total
2006					
Poverty Universe	768,666	762,554	99.2	6,112	0.8
	(1,943)	(2,078)	(0.8)	(581)	(0.8)
Number in Poverty	64,589	59,425	92.0	5,164	8.0
	(7,074)	(7,038)	(1.4)	(708)	(1.4)
Percentage in Poverty	8.4	7.8	N.A.[1]	84.5	N.A.
	(0.9)	(0.9)		(7.6)	
2007					
Poverty Universe	768,730	767,258	99.8	1,472	0.2
	(918)	(935)	(0.0)	(180)	(0.0)
Number in Poverty	60,042	59,151	98.5	891	1.5
	(8,042)	(8,042)	(3.7)	(190)	(3.7)
Percentage in Poverty	7.8	7.7	N.A.	60.5	N.A.
	(1.0)	(1.0)		(10.7)	

Source: The source for the 'Totals' column is the U.S. Census Bureau, American Factfinder Table S1701. The data in the rest of the table are previously unpublished.
[1] N.A. indicates 'not applicable'.

[2] The change between 2006 and 2007 in the percentage of people in poverty who lived in GQs is not statistically significant.

sample, and not necessarily a reflection of any real change in the poverty rate in Baltimore County. Again, the difference is not statistically significant, but since we are asserting that this difference is largely or entirely spurious, the lack of significance is not surprising.

3.3 Anomalous Person Per Household Estimates

Limitations in the ACS estimates of the GQ population can lead to anomalies in the estimates of total household population and, as a result, also in the ACS estimates of persons per household (PPH). This is due to the way the Census Bureau controls the ACS population totals at the weighting area level. As described earlier in Section 2.6, to obtain the controls for total persons in HUs, the ACS estimates of the GQ population for the weighting area are subtracted out from the PEP estimates of total resident population. To the extent that a GQ population estimate is anomalous, the household population estimate may also be anomalous, and consequently the PPH.

A way to indirectly assess this potential problem with the ACS estimates of the PPH would be to investigate the persons per HU as estimated by the ACS and compare it to the persons per HU estimated by the PEP. The PEP provides estimates of population in HUs and of the number of HUs, but not the number of occupied HUs, so a direct comparison of PPH is not possible. However, divergence between the ACS and PEP estimated persons per HU would be strongly suggestive of problems with the ACS estimates of persons per household.

4. Group Quarters Sampling Frame

This section examines some aspects of the quality of the ACS GQ sampling frame in the years 2006, 2007, and 2008. The ACS GQ sampling frame provides a listing of GQs eligible for selection in sample and an expected population count for each GQ. The expected population is based on the MAF and other sources and can differ from the person count obtained by the ACS field representative during the ACS interview, which is referred to as the observed count. Because of the ACS sample design, accurate expected counts are essential to sampling efficiency. To the extent that the expected population does not reflect the observed population the ACS sampling scheme is less efficient. For example, if the expected population of a given in-sample GQ facility was 20, but it was determined at the time of interview that the population was 200, then the weights of the interviewed people would be ten times larger than if the observed count were 20; they may be 400 instead of a desired 40.

An important way that the ACS improves the GQ sampling frame is to update the expected population for GQs based on previous years’ ACS field interviewing. This process is particularly valuable for the larger GQs which are in sample with high probability or certainty in a given year. However, since 2006 was the first year of implementation of the GQ sample, the frame for this year would not have benefited from this process of updating information. Thus the sampling frame was expected to be weakest for the large GQs in 2006. As the ACS matures we expect the expected populations for the large stratum GQs to be closer to the observed populations.

In Table 4 we see the improvement of the GQ frame for the largest GQs, those with expected populations of 400 or more. These GQ facilities were selected with certainty to be in the ACS sample, though only a sample of their residents was selected. We see improvement in the frame from 2006 to 2007 and again from 2007 to 2008 as the difference between the observed population and the expected population diminished over time. The mean percent differences went from –5.8 percent in 2006 to –2.9 percent in 2007, and then to –1.7 percent in 2008. Looking at the mean absolute value of the percent difference, one sees a similar pattern as it decreased from 25.9 percent, to 20.1 percent, to 14.0 percent from 2006 to 2008.

TABLE 4: Frequencies for 2006, 2007, and 2008 Large Group Quarters (Expected Population at least 400) and Small Stratum Group Quarters

	Large GQs			Small Stratum GQs		
	2006	2007	2008	2006	2007	2008
Number of Interviewed GQs	1,783	1,750	1,575	1,596	1,627	1,651
Mean Expected Population	856	856	839	6.7	6.5	6.4
Mean difference between Observed and Expected Population	-49.4	-24.8	-14.4	4.7	6.0	10.6
Mean percent difference between Observed and Expected Population	-5.8%	-2.9%	-1.7%	69.8%	92.4%	166.2%
Mean absolute difference in Observed and Expected Population	222	172	118	6.9	8.1	12.6
Mean percent absolute difference between Observed and Expected Population	25.9%	20.1%	14.0%	102.4%	123.4%	198.1%

Source: Independent calculations from 2006, 2007, and 2008 ACS GQ weighting files

Another observation worth noting about large GQs is that their observed GQ population was consistently lower than their expected GQ population. For example, in 2006 the mean percent difference between the Observed and Expected Population was –5.8 percent. Further research would be worthwhile to determine why this is happening.

In contrast to the large stratum GQs, the small stratum GQs (those with expected populations of 15 or fewer) were not updated by ACS interviews over the three-year period from 2006 to 2008. As discussed earlier, facilities in small GQ strata are selected in a manner that precludes their being selected in sample more than once in any five-year period. Since their expected populations are based largely on the 2000 decennial census, we would expect that they would become less accurate as one moves away from 2000. In fact, we see this decrease in quality in the mean differences between the expected population and observed populations, which increased from 4.7, to 6.0, to 10.6 over 2006, 2007, and 2008 (see Table 4). Another measure showing a decrease in quality over time was the mean percent absolute difference, which increased from 102.4%, to 123.4%, to 198.1% from 2006 to 2008.

A topic for future research is to determine how much these observed differences for both the large and small stratum GQS between the expected and observed populations may increase the sampling variability. For the large stratum GQs with expected populations of less than 400 there we saw no clear patterns, probably because they are a mix of updated and non-updated GQs. Tables for their differences between expected and observed population are not presented because of space limitations. There were only a small number of GQs closed on census day in the ACS samples, at most 30 in any year, and no inferences on them could be made.

5. Discussion and Future Research

Higher variances of estimates for the GQ population pose unique challenges for the ACS data users, especially for one-year estimates at the substate level. These challenges are relevant not just to the estimates of the GQ population themselves, but also to estimates of characteristics of the total resident population, as GQ population estimates contribute to the estimates of total resident population. This is most evident in estimates of characteristics that correlate with GQ residency such as poverty, income, and disability status. We also expect that the higher variances for estimates of GQ population would be evident in the substate estimates of persons per household, a topic for future research.

Data users should be aware that any issues with reliability attributable to GQ estimates are more of a limitation for one-year estimates than for multiyear estimates. With five-year estimates, the data for larger substate geographic areas will be more reliable. Consequently, data users interested in estimates of substate areas with a significant GQ population should consider the multiyear data for estimates, particularly if the interest is in characteristics correlated with GQ residence. One-year poverty estimates for substate areas such as counties are a particular concern with respect to reliability. Ultimately, data users desiring a measure of year-to-year change of poverty or income for a substate area may need to consider using estimates of the household population as an alternative to estimates of the total population. Those same data users may then use the five-year estimates when the total population is critical.

The greatest challenge to obtaining reliable estimates of GQ people for substate areas may be presented by the clustering of people in GQs. Because of this clustering the current GQ sample design and sampling rate of GQ persons of approximately 1-in-40 yield estimates that are less reliable than expected and desired for substate areas. Compounding the challenge for usability of GQ population estimates is the fact that the ACS GQ weighting is not designed to produce substate estimates; in particular, the controlling to reduce the variance of estimates is implemented at the state level. The recent revelation that the variances of GQ population estimates are higher than previously thought (Keathley, 2009) lends weight to the case that measures should be investigated to reduce the variances of the GQ population estimates.

The insights gained in this research suggest several avenues for improving the reliability of the ACS GQ estimates. The first place to look for improvements is the sample design. To start, one could investigate how much larger the variances of estimates are for GQ residents than for people in households and how much of that difference is attributable to the clustering effect. Put another way, one could look at how much larger the sample design effect is for GQ residents than for HU residents. This would give an indication as to just how much there is to gain in reducing the cluster size of the GQ residents selected into sample. Also, one could investigate the increase in sampling variability induced by differences between the expected GQ population on the frame and the observed population.

Currently, there are several methods being researched to reduce the size of the cluster of people selected in GQs. One is to reduce the size of the groups of people selected in GQs in the large GQ stratum from 10 to a smaller number, e.g., 5. Another is to reduce the cutoff of expected population size for classification in the small stratum from 15 to a smaller number such as 10 or 7. However, both approaches imply greater field interviewing costs as more GQ facilities would be visited. An approach that is specific to reducing the variance of the estimates of poverty rate would be to include in the sort order for systematic sampling whether the type of GQ is in the poverty universe. This step would effectively stratify the sample of GQ residents by the poverty-universe/nonpoverty-universe distinction and could thus reduce the year-to-year fluctuations in the number of GQ people in the poverty universe.

In addition to improving the sample design, there are potential modifications to the weighting that might improve the reliability of estimates at the substate level. One is to smooth the one-year and three-year estimates of GQ population over five years by using the latest five-year GQ estimate as a component in the total population estimates. That is, combine five-year GQ estimates with one-year and three-year household population estimates. This measure would certainly reduce the GQ component of the variance in one- and three-year estimates. However, it would present difficulties in interpretation, such as interpreting year-to-year change. A second modification is to control the GQ estimates of total population to equal PEP estimates at the county level. Such a procedure is perceived to be technically feasible and would address the inconsistency of ACS and PEP estimates. Perhaps more importantly, it may reduce some of the variation in the GQ component of the total population estimates. However, a limitation of this approach is that the PEP estimates are not broken down by type of GQ at the county level, and the distribution of characteristics can vary greatly by type of GQ. It is not clear how such a method would affect the quality of the estimates and thus their usefulness for county-level work.

Ultimately, consideration should be given to the impact that higher variances of the GQ estimates will have at the tract and county level for the five-year ACS estimates that are to be first released in 2010. Since the controls of total residence population by demographic group are implemented for county-based weighting areas, demographic estimates for counties are robust to GQ variance. However, demographic estimates of total residence could be less reliable for tracts or block groups with GQ facilities for which there is a high correlation with certain types of demographics. For example, college dorms are almost exclusively for people aged between 18 and 22 and thus age distributions may have unusually high variances.

Acknowledgements

The authors would like to acknowledge the careful review and comments of our reviewers, Donald Keathley and Mark Asiala.

References

Asiala, M., Beaghen, M., and Abright, K. (2008). "Evaluating Alternative Population Controls for ACS Estimates". *2008 Joint Statistical Meetings: Proceedings of the Survey Research Methods Section.* American Statistical Association.

Bates, L. (2008). "Creating the Group Quarters Universe for the American Community Survey for Sample Year 2009". *DSSD American Community Survey Memorandum Series Chapter Universe Creation #ACS09-UC-2.*

Keathley, D. (2009). "Improvements to the Estimation of Group Quarters Variance". *(U.S. Census Bureau Memorandum).*

U.S. Census Bureau (2008a). "A Compass for Understanding and Using American Community Survey Data: What General Data Users Need to Know". http://www.census.gov/acs/www/Downloads/ACSGeneralHandbook.pdf

U.S. Census Bureau (2008b). 2007 American Community Survey "Accuracy of the Data". http://www.census.gov/acs/www/Downloads/ACS/accuracy2007.pdf

U.S. Census Bureau (2009a). "How to Use the Data: ACS Group Quarters". http://www.census.gov/acs/www/UseData/GQ/def.htm

U.S. Census Bureau (2009b). The American Community Survey website. http://www.census.gov/acs/www/

U.S. Census Bureau (2009c). "Population Estimates: Overview". http://www.census.gov/popest/overview.html

U.S. Census Bureau (2009d). "Population Estimates: Overview". http://www.census.gov/popest/topics/methodology/

U.S. Census Bureau (2009e). "Design and Methodology: American Community Survey". Issued April 2009. http://www.census.gov/acs/www/Downloads/dm1.pdf

U.S. Census Bureau (2009f). "Poverty: definitions". http://www.census.gov/hhes/www/poverty/definitions.html