

QUANTIFICATION OF MIGRATION

Estimating Underenumeration among Unauthorized Mexican Migrants to the United States: Applications of Mortality Analyses

Jennifer Van Hook & Frank D. Bean

Because residual techniques generate estimates of the *enumerated* portion of the unauthorized Mexican population, they underestimate the true size of the unauthorized population at any point in time by an amount equal to the size of the unenumerated portion of the population. In order to develop estimates of the total size and growth of the unauthorized Mexican population, it is thus important that methods be developed for assessing the size and growth of the *unenumerated* portion of the population. A number of researchers have made and continue to make assumptions about the underenumeration rate for the unauthorized migrant population that are not substantially empirically based. For instance, some have argued that the undercount rate for unauthorized migrants must be at least as high as the highest rate among native-born groups. On the basis of this logic, some analysts argue that undercoverage must be as high as 20 percent, the rate exhibited by native-born African-American males (e.g., Passel, Siegel, and

Robinson, 1982). Others have argued that the undercount rate in the 1990 Census may be at least as high as it was in the 1980 Census (Woodrow, 1991). However, if the unauthorized migrant population were more settled and less concentrated in agricultural occupations in 1990 than in 1980, then the undercount rate in 1990 might be lower than it was in 1980.

Evidence about the size of the unenumerated portion of the unauthorized population for the census years 1980 and 1990 has been obtained by employing one of two different approaches. The first involves direct attempts to estimate first the undercount rate through comparisons of U.S. Census results with external data about small or localized populations, such as school enrollment records, in-depth survey results, and the findings from ethnographic field research. Estimates of the rate of undercount are then applied to the estimates of the size of the unauthorized population enumerated in the Census in order to approximate the size of the entire unauthorized population. The second approach entails first making independent assessments of the entire unauthorized migrant population or national origin groups within the population based on data sources and methods that are thought to be less sensitive to undercount, and then comparing these estimates with the enumerated population in order to estimate the rate of undercount. The results of both of these approaches are reviewed below, first with respect to the 1980 Census enumeration and then the 1990 Census enumeration.

Direct examinations of the level of undercount indicate that between 20 and 50 percent of the stock of unauthorized residents appeared to be missing from the 1980 Census enumeration. One study compared Los Angeles public school enrollments with estimates of families with school-aged children in the 1980 Census (Muller and Espenshade, 1985) (see Table 1). The results indicated that nearly all families in Los Angeles were enumerated, including families of unauthorized migrants. These results are consistent with the observation that the census is better at enumerating settled populations such as unauthorized migrant families than single migrants. The results of the study also suggested that the undercount rate of the entire unauthorized population was probably no greater than 50 percent. This view was substantiated by the results of a survey of Mexican adults living in Los Angeles County (Heer and Passel, 1985, 1987). Foreign-born respondents were asked whether they were legal residents and if so, to show the interviewer their "Green Card" or equivalent evidence of legal status. Foreign-born respondents who indicated they were undocumented or failed to show evidence of legal status were enumerated as unauthorized migrants. Comparisons of the results of the survey with the number of unauthorized Mexican migrants enumerated in the 1980 Census (Passel, 1985) suggested that the undercount rate among Mexican unauthorized migrants was probably no greater than about 44 percent (Passel, 1985; Passel and Robinson, 1988) (See Table 2).

Table 1
Studies with Implications for Underenumeration

Author(s), Date of Publication or Release	Estimation Date	Type or Description	Method	Estimate
Bean, King, and Passel (1983)	1980	Mexican unauthorized migrants	Sex-ratio, age distribution assumptions Data: Mexican Census	1.5 - 3.8 million (no more than 4 million)
Keely (1983)	1980	Undercount rate in 1980 Census for the unauthorized population	Expert opinion	33% - 50% undercount
Heer and Passel (1985)	1980	Adult Mexican unauthorized migrants in Los Angeles County, Males: 18-44; Females: 18-39	Survey on legal status in Los Angeles	44% undercount
Muller and Espenshade (1985)	1980	Families in Los Angeles	Compared Los Angeles school enrollment data with Census estimates in Los Angeles	1980 Census enumerated most families in Los Angeles
Passel (1985a)	1980	Mexican unauthorized migrants	Revision of Bean, et. al. (1983)	1.9 million
Bean, King, and Passel (1986)	1980	Mexican unauthorized migrants	Revision of Bean, et. al. (1983)	1.5 - 2.8 million
Passel (1986)	1980	Undercount rate in 1980 Census for the unauthorized population	Expert opinion	no more than 50% undercount
Heer and Passel (1987)	1980	See Heer and Passel (1985)		

Table 1 (Continued)

Author(s), Date of Publication or Release	Estimation Date	Type or Description	Method	Estimate
Passel and Robinson (1988)	1980	Total unauthorized migrant population	Revision of Bean, et. al. (1983)	Total: 2.5 to 3.5 million Mexican: 1.9 million
Borjas, Freeman, and Lang (1991)	1980	Total Mexican unauthorized migrant population	Analysis of deaths to Mexican-born persons	1.9 million
Woodrow (1991)	1990	Total unauthorized migrant population	Projection from 1980 Estimate to 1990	3.3 million (point estimate)
GAO (1993)	1990	Total Mexican unauthorized migrant population	Projection of 1980 Mexican Census population to 1990	2.7 million
GAO (1993)	1990	Undercount rate in 1980 Census for the unauthorized population	Review of ethnographic studies	25% undercount, most estimates fell between 5% and 28%

Table 2
Direct and Indirect Estimates of the Undercount for the Unauthorized
Migrant Population in 1980 and 1990 U.S. Censuses

	Estimated Unauthorized Pop'n (in millions)		Undercount Percentage	
	Total	Mexican-born	Total	Mexican-born
1980 Census				
<i>Direct Estimates of Undercount</i>				
Heer and Passel (1985, 1987); Passel (1985); Passel and Robinson (1988)	3.4-3.7 ^a	2.0 ^a	40-45%	44%
<i>Indirect Estimates of Undercount</i>				
Bean, et. al. (1983)	na	1.5-3.8	na	25-70% ^b
Revisions of Bean, et. al. (1983)				
Passel (1985)	na	1.9	na	40% ^b
Bean, et. al. (1986)	na	1.5-2.8	na	25-60% ^b
Passel and Robinson (1991)	2.5-3.5	1.9	18-42%	40% ^b
Borjas, Freeman and Lang (1991)	na	1.9	na	40% ^b
1990 Census				
<i>Direct Estimates of Undercount</i>				
GAO (1993)	3.2 ^a	2.6 ^a	25%	25%
<i>Indirect Estimates of Undercount</i>				
GAO (1993)	3.4	2.7	29% ^b	30% ^b
Woodrow (1991)	3.3		27% ^b	
Warren (1995)	1.0	2.6	-92% ^b	8% ^b

na: estimate not available.

^aImplied population based on estimate of undercount (see note below).

^bImplied undercount rate based on estimate of population (see note below).

Note: The implied population and undercount rates are based on the assumption that 2.1 million unauthorized migrants (1.1 million unauthorized Mexicans) were enumerated in the 1980 Census, and that 2.4 million (1.9 million Mexicans) were enumerated in the 1990 Census.

Indirect evidence of undercoverage suggests a narrower range of undercount for the unauthorized population, falling roughly between 30 and 40 percent. As noted above, Bean, King, and Passel (1983) attempted to estimate the number of Mexicans who had emigrated to the United States by analyzing the age and sex composition of the population enumerated in the 1980 Mexican Census. Due to uncertainties about the patterns of undercount in the Mexican Census and the age-sex composition of the emigrant population, Bean, et al. (1983) concluded

that the number of unauthorized Mexicans living in the United States could be as low as 1.5 and as high as 3.8 million. Comparing this range with the number enumerated in the 1980 U.S. Census—1.131 million (Warren and Passel, 1987)—the Bean, et al. (1983) estimate implies an undercount between 25 and 70 percent. However, residual estimates of the Mexican unauthorized population enabled researchers to narrow the range of assumptions used in this analysis (Bean, King, and Passel, 1986; Passel, 1985; Passel and Robinson, 1988). The results of these revisions indicated that there were probably as few as 1.5 to 1.9 million unauthorized Mexican migrants in 1980. Assuming that Mexicans comprise about 60 percent of the unauthorized population, this suggests that between 2.5 and 3.2 million unauthorized migrants were living in the U.S. in 1980. A comparison of these estimates with the approximation of the enumerated unauthorized population suggests an undercount rate of 25 to 40 percent among Mexicans and 18 to 36 percent among all unauthorized migrants.

Using a different approach, Borjas, Freeman, and Lang (1991) analyzed vital statistics data to determine the number of unauthorized immigrants missed in the 1980 Census. The method they used is similar to that used by Robinson (1980), except that it yields more precise results because it employs data on the number of deaths to Mexican-born persons residing in the United States (such data became available in 1984 when vital statistics began to record place of birth on death certificates). The methodology used by Borjas, Freeman, and Lang rests on the assumption that (1) all deaths to unauthorized and legally resident Mexican-born persons that take place in the United States are recorded in the U.S. vital statistics and (2), that the Mexican-born population experiences age specific death rates that are quite similar to those experienced by the U.S. native-born population. If these assumptions hold, then the total Mexican-born population living in the United States may be approximated by dividing the number of deaths to Mexican-born persons by the death rate. By comparing this estimate with the number of Mexican-born persons enumerated in the 1980 Census, the number of unenumerated Mexican-born persons can then be estimated. Borjas, Freeman, and Lang's results indicate that the number of unenumerated unauthorized Mexicans in 1990 was about 800,000. They add this to Warren and Passel's estimate to yield a total of 1.9 million unauthorized migrants from Mexico, which implies a 40 percent undercount rate. The results of this method tend to be highly sensitive to the underlying assumptions. Nevertheless, if the effects of its limitations could be minimized, the method has potential because it is empirically based, it can provide national level results, and it can be used to obtain annual estimates of the unauthorized population by age, sex, and country-of-origin, as we demonstrate below in an application to the 1990 Census enumeration of unauthorized Mexican-born male and female migrants.

To summarize, the results of undercount studies as well as comparisons of external estimates with estimates of the enumerated unauthorized population suggest that at least 60 percent of unauthorized residents were enumerated in the 1980 Census. This implies that there were at most about 3.4 million unauthorized migrants and 1.9 million unauthorized Mexican migrants living in the United States in 1980.

In the case of the 1990 Census enumeration, both direct and indirect evidence suggest that the undercount rate for the unauthorized migrant population was lower than it was in 1980. The direct evidence comes from a series of ethnographic studies conducted by researchers working with the Census Bureau. The main purpose for conducting these studies was to gain qualitative information about the causes of undercount, although the results of the research can also be used to shed light on undercoverage rates among various populations. The ethnographic evaluations were conducted in 29 different neighborhoods across the United States and Puerto Rico, each of which contained about 100 households. These 29 neighborhoods were selected because they were thought to contain large concentrations of difficult-to-enumerate populations. Experienced ethnographers made an effort to become familiar with the households and household members who lived within the sample area by accessing informal networks and gaining information about the actual residences of people. Their assessments of the numbers of residents were compared with the official Census counts for the sample areas. The results of the comparisons showed that, among those living in areas containing large concentrations of unauthorized migrants,¹ the undercount rate was *at most* 25 to 30 percent. One area, Long Island, had an undercount rate as high as 72 percent, but this result was not typical. The other areas showed undercount rates as low as or lower than 28 percent, and five areas had undercount rates less than 18 percent (U.S. GAO, 1993; de la Puente, 1993).

Indirect evidence of the undercoverage of the unauthorized population in 1990 comes from only a few studies. Although Warren (1995) produces estimates of the entire unauthorized population in 1990, his estimates appear too low and cannot be relied upon. For instance, he puts the total Mexican-born unauthorized population at 1.0 million, which is 92 percent *lower* than the residual estimate for 1990 (U.S. GAO, 1993). Woodrow (1991) makes a “point estimate” of the unauthorized population in 1990 of about 3.3 million. Woodrow (1991) constructs this estimate by projecting forward the estimated 1980 unauthorized population to 1990, adjusting for net growth during the 1980s and legalizations due to the amnesty provisions of IRCA.

Another study showing indirect evidence of the undercount rate in 1990 was conducted by U.S. GAO (1993) in consultation with Corona Vasquez (1991). By comparing the Mexican population enumerated in the Mexican Census in 1980

with those enumerated in the 1990 Mexican Census, Corona Vasquez (1991) estimated that 1.5 to 3 million Mexicans emigrated during the decade. By adjusting this estimate for differential undercount and legal migration to the United States, GAO (1993) concluded that about that about 2.7 million unauthorized Mexicans were present in the United States in 1990. Assuming that Mexicans comprise about 80 percent of the total unauthorized migrant population (based on the 1989 CPS residual estimates), GAO puts the total unauthorized migrant population at 3.4 million. Like the results obtained from the ethnographic studies, the Woodrow (1991) and GAO (1993) estimates imply an undercount rate of about 30 percent. This level of undercoverage implies an unauthorized population of about 3.4 million (2.7 million Mexican unauthorized migrants) in 1990.

In what follows, we apply the “death registration” method used by Borjas, Freeman, and Lang (1991) to obtain another estimate of the total unauthorized Mexican population and the underenumeration rate for 1990. One of the drawbacks of the death registration method is that it is sensitive to its underlying assumptions. Nevertheless, if the data used to produce the final estimates were more carefully selected so that confidence in the underlying assumptions was greater, then the method could be used to obtain annual estimates of the total size of the unenumerated unauthorized population by country of origin. In the section below, we describe the method in greater detail and evaluate its underlying assumptions. Then, using a range of plausible initial assumptions, we estimate likely ranges for the undercount rate for the 1990 unauthorized Mexican migrant population.

Methodology

On the assumption that all deaths to Mexican-born persons living in the United States are recorded as such in the U.S. vital statistics and that an appropriate and supportable assumption about the death rate experienced by the Mexican-born population can be made, then the number of Mexican-born persons living in the United States by age and sex (L_x) can be estimated by dividing the number of deaths to Mexican-born persons living in the United States (d_x) by the death rate experienced by the population (m_x):

$$L_x = d_x / m_x$$

where x indexes age and sex groupings (Borjas et al., 1991). The population estimate L_x is an estimate of the person-years lived during the year and only approximates the population at the time of the census enumeration. By subtracting the number of Mexican-born persons enumerated in the census (C_x) from the estimated population (L_x), we can then estimate the size of the unenumerated portion of the Mexican-born population (U_x):

$$U_x = L_x - C_x$$

If most legally resident Mexican-born persons are enumerated in the Census, then it can be assumed that most of the unenumerated population, U_x , consists of unauthorized persons. Thus, the total unauthorized population, T , can be estimated as the sum of the unenumerated population, U (that is, U_x summed across all x 's), and the estimated enumerated unauthorized population, I ; and the undercount rate can be estimated as U/T .

Underlying Assumptions

Number of Deaths (d_x)

First, the quality of the estimates depend on the extent to which deaths to Mexican-born persons that take place in the United States are recorded in U.S. vital statistics, and further, that the U.S. vital statistics correctly identify place of birth. It is reasonable to assume that the vast majority of deaths to foreign-born persons are recorded in U.S. death records. As others have argued, it would be very difficult, and there would be little motivation, to "hide" the death of a foreign-born person living in the United States (Borjas et al., 1991). Even among infants whose mothers had illegally crossed the border to give birth, very few infant deaths would go unrecorded because the vast majority of births to unauthorized migrants take place in hospitals (Forbes and Frisbie, 1991).

However, even if all deaths to foreign-born persons are recorded in the U.S. vital statistics, place of birth of some foreign-born persons may be misrecorded as U.S.-born on their death certificates. Unfortunately, little is known about the quality of data about place of birth on death certificates. However, some evidence suggests that Hispanic ethnicity is inaccurately recorded on about 20 percent of infant (Hahn, Mulinare and Teutsch, 1992) and seven percent of adult death certificates (Sorlie and Johnson, 1992). Place of birth is likely to be more accurately recorded than ethnicity because place of birth is easier to define, is not complicated by mixed parentage, and does not depend on perceptions of self-identity (for a discussion on the difficulties in measuring race/ethnicity in death data, see Hahn and Stroup, 1994). Borjas, Freeman and Lang (1991: 81) similarly argue that the error associated with misreporting place of birth is likely to be small: "While there may be some tendency for friends and relatives of unauthorized aliens to disguise country of origin, the head of Registration of Methods of the Public Health Service informed us that in his opinion these records are no less accurate for unauthorized aliens than for other groups, leading us to discount this potential source of error."

In making estimates of the unenumerated Mexican-born population, we assume the error associated with inaccurate reporting of place of birth to be no

greater than five percent. Hence, we employ two alternative sets of estimates of the number of deaths of Mexican-born persons. The first, labeled “D1” in Table 3, is the number of deaths to Mexican-born U.S. residents recorded in the U.S. vital statistics. The second, labeled “D2,” is the recorded number of deaths inflated by five percent.

Mortality Schedule (m_x)

The validity of the estimate also depends on the extent to which the age- and sex-specific death rates used in making the estimate (m_x) conform to the actual mortality schedule experienced by the Mexican-born population. Unfortunately, there is a great deal of uncertainty about the mortality schedule of this population because of uncertainty in estimates of the population at risk of dying. Borjas, Freeman and Lang (1991) assume that the Mexican-born population experience the same or higher age-specific death rates as the entire U.S. population, and therefore use its mortality schedule for making their estimates. However, evidence exists that there are significant differences between the mortality schedules of the total U.S. (dominated by non-Hispanic whites) and Hispanic origin populations. Estimates made in the United States and Healthy People 2000 Review (U.S. Department of Health and Human Services, 1992) indicate that Hispanic males aged 15 to 44 have age-specific death rates that range from 15 to 24 percent higher than non-Hispanic whites, and Hispanic females and Hispanic males older than 44 have rates that range from 9 to 32 percent lower. These estimates are unlikely to be strongly biased due to uncertainty in the size of the population at risk of dying because they closely correspond with other estimates that are not affected by this type of error. In an analysis of data obtained from the National Longitudinal Mortality study, in which approximately 115,000 men and women age 15 to 24 were interviewed and then followed up five years later, Singh and Yu (1996) found that Hispanic men and women age 15 to 24 experience mortality levels that are nearly identical to (about 96 percent of) those reported by the United States and Healthy People 2000 Review.

One potential source of error in the estimates made in the United States and Healthy People 2000 Review is that the number of deaths to persons of Hispanic origin could be underestimated due to inaccurate recording of ethnicity on death certificates. As discussed above, this error has been found to be as large as seven percent. We use three different mortality schedules in making alternative estimates of the number of unenumerated Mexican-born persons living in the United States in 1990. The first mortality schedule, labeled “M1” in Table 3, is that experienced by the white population. The second, labeled “M2,” is the mortality schedule of Hispanics as it is reported in the United States and Healthy People 2000 Review.

Table 3
Underlying Assumptions Used in Estimates of the
Mexican-born Unenumerated Population, 1990

	Age	Deaths to Mex. Born		Death Rate, 1990			Enumerated Mex. Born	
		(D1) Observed	(D2) Adj. +5%	(M1) White	(M2) Hispanic	(M3) Hisp. +7%	(C1) Observed	(C2) Adjusted
Males	0-4	77	81	.0021	.0021	.0022	52,447.	89,336
	5-9	40	42	.0002	.0002	.0003	78,906	165,818
	10-14	43	45	.0003	.0003	.0003	105,632	163,248
	15-19	417	438	.0011	.0013	.0014	216,179	254,156
	20-24	949	996	.0015	.0017	.0018	396,386	400,525
	25-34	1,539	1,616	.0018	.0022	.0023	720,819	720,819
	35-44	954	1002	.0027	.0033	.0036	405,138	416,813
	45-54	803	843	.0056	.0044	.0047	200,583	207,819
	55-64	911	957	.0146	.0114	.0122	99,858	99,858
	65-74	1,275	1,339	.0345	.0242	.0258	55,017	112,505
	75-84	1,917	2,013	.0800	.0557	.0596	28,657	28,657
85+	1,537	1,6134	.1922	.1306	.1397	9,892	9,892	
SUM	10,462	10,985				2,369,514	2,669,446	
Females	0-4	93	98	.0016	.0017	.0018	49,941	59,301
	5-9	38	40	.0002	.0002	.0002	76,655	138,957
	10-14	22	23	.0002	.0002	.0002	98,073	127,960
	15-19	66	69	.0005	.0004	.0004	165,074	178,244
	20-24	107	112	.0005	.0004	.0004	254,153	254,153
	25-34	234	246	.0006	.0006	.0006	518,797	518,797
	35-44	293	308	.0012	.0011	.0012	344,507	369,850
	45-54	419	440	.0032	.0023	.0024	192,755	211,313
	55-64	674	708	.0082	.0059	.0063	109,420	127,744
	65-74	1,122	1,178	.0195	.0146	.0156	63,470	144,398
	75-84	1,951	2,049	.0494	.0352	.0376	40,698	52,452
85+	2,098	2,203	.1554	.1082	.1158	14,957	15,623	
SUM	7,117	7,473				1,928,500	2,198,792	

Note: Deaths include deaths to Mexican-born U.S. residents only

Finally, the third mortality schedule, labeled "B3," is the Hispanic schedule in which each of the age- and sex-specific death rates are inflated by seven percent in order to account for possible underreporting of Hispanic deaths.

Enumerated Mexican-born Population (C_x)

The estimates of the unenumerated population also depend on the extent to which Mexican-born persons who are enumerated in the 1990 U.S. Census correctly identify their place of birth. Warren and Passel (1987) calculate that

215,000 Mexican-born people misreported themselves as U.S. born in the 1980 Census. Woodrow (1991) estimates that by November, 1989, about 636,000 Mexican-born persons inaccurately reported as U.S. born in the CPS. To obtain this figure, Woodrow (1991) first estimated the total U.S.-born Mexican-origin population as 8,493,000 persons (a figure reached by projecting forward the estimate from 1980), and then she subtracted this figure from the number enumerated in the 1989 CPS.

In making our estimates, we employ two approximations of the total enumerated Mexican-born population. The first, labeled “C1” in Table 3, is the Mexican-born population as it is observed in the 1990 Census. The second, “C2,” is the observed population adjusted upward for inaccurate reporting of place of birth. The “C2” population was arrived at by adding to the observed Mexican-born population an estimate of the number of people who reported themselves as U.S. born but who are actually Mexican born. The number of misreporters, in turn, was estimated as the difference between an independent estimate of the Mexican U.S.-born population (Woodrow’s (1991) estimate projected forward from November, 1989 to April, 1990) and that observed in the U.S. Census.

Unenumerated Mexican-born Population (U)

Another assumption made by Borjas, Freeman, and Lang (1991) is that their estimate of the unenumerated Mexican-born population, U, consists entirely of unauthorized migrants. However, the legal Mexican-born population is likely to have age- and sex-specific underenumeration rates that are at least as high as those among non-Hispanic whites. Therefore, the unenumerated portion of the population would consist of both legal and unauthorized Mexican-born persons. Accordingly, we subtract from our estimate of U (i.e., the sum of U_x) the approximate number of unenumerated *legal* Mexican-born persons.

We approximate the unenumerated legal population in the following way. Several researchers have put the 1990 enumerated unauthorized population at about 2.4 million (Woodrow, 1991; GAO, 1993; Clark, et al., 1994). We approximate the Mexican component of the 1990 unauthorized population as proportional to the relative sizes of the Mexican-born and total unauthorized population enumerated in the 1989 CPS, such that the Mexican-born unauthorized population in 1990 is estimated at 1.908 million. The remaining enumerated Mexican-born population (including those who misreported as U.S.-born), numbering 2.960 million, is classified as legally resident. We then allocate the legal and unauthorized Mexican-born populations into age- and sex-categories by assuming that the unauthorized population has the same age and sex composition as Mexican-born, non-citizen, post 1982 arrivals. Finally, we apply the age- and sex-specific

undercount rates of the white population (Robinson et al., 1993) to our approximation of the legal population. As a result of this procedure, we estimate that about 34,160 legal Mexican-born males (2.1 percent) and 5,249 females (0.4 percent) are missing from the 1990 Census. Accordingly, we subtract 34,160 from our estimates of the unenumerated male population, and 5,249 from the unenumerated female population.

Correspondence Between Person-years (L_x) and the Number Eligible to be Enumerated

In estimating the number of unenumerated Mexican unauthorized migrants, the death registration method compares an estimate of the person-years lived in the United States by Mexican-born persons (L_x) with the number of such persons enumerated in the census (C_x). This procedure relies on the assumption that L_x closely approximates the number of Mexican-born persons who were eligible to be enumerated in the census (that is, they were living in the United States on April 1, 1990). For this assumption to hold, all Mexican-born persons living in the United States on April 1, 1990 who subsequently die in 1990, must have died in the United States. If a significant number were to leave the United States after April 1, then their deaths would not be recorded in the U.S. vital statistics, and the estimates of L_x and U_x would be too low. U_x could even be negative if more people were counted in the census than were estimated based on the number of deaths. We expect that this would be most evident among older people because they are more likely to return to Mexico mid-year because of an illness or retirement. To minimize this type of error, we exclude estimates of U_x for the age-sex groups in which the estimate of U_x is negative from the sum total of the unenumerated population estimates. That is, when summing across all U_x 's, only the positively valued estimates are included in the sum.

In addition, for the above assumption to hold, all deaths that take place in the United States to Mexican-born persons must be due to those who were living in the United States on April 1. If a significant number were to migrate to the United States after April 1 and subsequently die, then L_x and U_x would be overestimated. We expect that this would occur more often among those who work seasonally in the United States, such as working-aged men. Unlike the first type of error described above, which can be detected in part by negatively-signed estimates of U_x , this type of error is difficult to identify. Hence, we do not attempt to adjust our estimates to take into account this kind of discrepancy. Rather, we simply note that this type of phenomenon is likely to lead to overestimates of the number of unenumerated Mexican-born persons living in the United States at the time of the U.S. Census.

1990 Estimates

We produce a series of estimates of the number of unenumerated unauthorized Mexican-born persons living in the United States in 1990. An estimate is made for each combination of the assumptions regarding the numbers of deaths, different mortality schedules, and sizes of the enumerated Mexican-born population. Since we employ two alternative estimates of the number of deaths, three alternative mortality schedules, and two alternative enumerated populations, we make a total of twelve estimates ($2 \times 2 \times 3 = 12$).

Table 4 illustrates how one such estimate is constructed. In this example, the unadjusted number of deaths to Mexican-born persons (D_1), the mortality schedule experienced by white men and women (M_1), and the unadjusted enumerated Mexican-born population (C_1) are used to construct the approximation. The first and second columns show the number of deaths (d_x) and the age- and sex-specific death rates (m_x), respectively. Dividing the number of deaths by the death rate, we obtain the third column, an estimate of the total Mexican-born population in 1990. The fourth column displays the enumerated Mexican-born population (C_x), and the final column shows the difference between the total and enumerated population estimates, that is, the unenumerated Mexican-born population (U_x). As expected, the estimates of U_x tend to be negative at the older ages, particularly among males. Summing across the positive values, we obtain an approximation of 686,952 unenumerated males and 173,068 unenumerated females. When we subtract the estimated number of unenumerated legal migrants from these figures, we obtain estimates of approximately 653,000 unenumerated unauthorized males and 168,000 unenumerated unauthorized females. If we assume an enumerated unauthorized migrant population of 1.9 million (1.1 million males, 0.8 million females), then these estimates imply an underenumeration rate of about 37 percent among males, 17 percent among females, and 30 percent among both sexes combined.

Table 5 presents estimates of the unenumerated unauthorized Mexican-born population, the total unauthorized population, and the implied undercount rate for each of the twelve combinations of underlying assumptions. The estimates of the total unauthorized Mexican migrant population range 2.1 to 2.9 million, with the interquartile range spanning 2.2 to 2.6 million. The undercount rates corresponding with the interquartile range of estimates ranges from only 14 to 26 percent. Even the highest estimate of 2.9 million unauthorized migrants implies an undercount rate of only 34 percent. The estimates of the underenumeration rate are higher for males, among whom as many as 40 percent may not have been enumerated. Finally, we note that of the three underlying assumptions, those pertaining to the mortality schedule and the enumerated population tend to exert the greatest influence on the estimates.

Table 4
Example of an Estimate of the Unenumerated
Mexican-born Population, 1990
(Using Underlying Assumptions D1, M1, and C1)

	Age	Deaths (D1)	Death Rate (M1)	Total Pop'n (Person-Years) (L) = D1/M1	Enumerated Population (C1)	Unenum. Population (U) = L - C1
Males	0-4	77	.0021	36,858	52,447	-15,589
	5-9	40	.0002	169,062	78,906	90,156
	10-14	43	.0003	148,541	105,632	42,909
	15-19	417	.0011	363,310	216,179	147,131
	20-24	949	.0015	649,864	396,386	253,478
	25-34	1,539	.0018	874,096	720,819	153,278
	35-44	954	.0027	351,932	405,138	-53,206
	45-54	803	.0056	143,729	200,583	-56,854
	55-64	911	.0146	62,512	99,858	-37,346
	65-74	1,275	.0345	37,005	55,017	-18,012
	75-84	1,917	.0800	23,952	28,657	-4,705
	85+	1,537	.1922	7,999	9,892	-1,893
SUM (of Positive Values)				2,868,861	2,369,514	686,952
Females	0-4	93	.0016	57,642	49,941	7,701
	5-9	38	.0002	221,636	76,655	144,981
	10-14	22	.0002	118,459	98,073	20,386
	15-19	66	.0005	145,726	165,074	-19,348
	20-24	107	.0005	230,551	254,153	-23,602
	25-34	234	.0006	380,792	518,797	-138,005
	35-44	293	.0012	245,964	344,507	-98,543
	45-54	419	.0032	132,979	192,755	-59,776
	55-64	674	.0082	82,647	109,420	-26,773
	65-74	1,122	.0195	57,580	63,470	-5,890
	75-84	1,951	.0494	39,527	40,698	-1,171
	85+	2,098	.1554	13,504	14,957	-1,453
SUM (of Positive Values)				1,727,006	1,928,500	173,068

Table 5
Various Estimates of the Unenumerated Unauthorized Mexican-born Population and Percentage Undercount

<i>Assumptions About:</i>		Unenumerated Unauthorized		Total Unauthorized Population		Percentage Undercount				
		Population Est. (in 1,000s)		Estimate (in 1,000s)		Males	Females	Total		
D. Number of Deaths	M. Mortality Schedule	Males	Females	Total	Males	Females	Total			
1. D1, M1, C1		653	168	821	1,752	977	2,728	37.3	17.2	30.1
2. D1, M1, C2		481	77	558	1,580	886	2,466	30.4	8.7	22.6
3. D1, M2, C1		371	227	598	1,470	1,036	2,506	25.2	21.9	23.9
4. D1, M2, C2		199	101	300	1,298	909	2,208	15.3	11.1	13.6
5. D1, M3, C1		290	158	447	1,389	967	2,355	20.9	16.3	19.0
6. D1, M3, C2		136	64	200	1,235	873	2,108	11.0	7.3	9.5
7. D2, M1, C1		719	180	899	1,818	988	2,806	39.5	18.2	32.0
8. D2, M1, C2		543	84	627	1,642	893	2,534	33.1	9.4	24.7
9. D2, M2, C1		416	260	677	1,515	1,069	2,584	27.5	24.3	26.2
10. D2, M2, C2		240	120	361	1,339	929	2,268	17.9	12.9	15.9
11. D2, M3, C1		324	186	510	1,423	994	2,418	22.8	18.7	21.1
12. D2, M3, C2		162	79	241	1,261	888	2,149	12.8	8.9	11.2
Minimum		136	64	200	1,235	873	2,108	11.0	7.3	9.5
Maximum		719	260	979	1,818	1,069	2,887	39.5	24.3	33.9
25th Percentile		230	83	313	1,329	892	2,221	17.3	9.3	14.1
50th Percentile (Median)		348	139	487	1,447	948	2,394	24.0	14.6	20.3
75th Percentile		496	181	677	1,595	990	2,585	31.1	18.3	26.2

See Table 3 on page 561 for various estimates of the number of deaths, mortality schedules, and the enumerated population.

In conclusion, the death registration method produces estimates of the underenumeration rate that correspond with other evidence about undercount. Namely, the underenumeration rate for unauthorized Mexican migrants in 1990 appears not to be as high as it was in 1980, most likely is no greater than 35 percent and may even be as low as 15 to 25 percent. In addition, the results corroborate other evidence that the female unauthorized migrant population is better represented in the U.S. Census enumeration than the corresponding male population. Nevertheless, the results also show that the death registration method produces estimates that are highly sensitive to their underlying assumptions. Although the method has a great deal of potential for use in the future, the quality of the estimates could be greatly improved if better information about the mortality rates experienced by the foreign-born population and the enumerated population were available.

Note

1. These were nine areas located in Long Island, rural Marion County, Oregon, Houston, Bronx, San Diego, San Francisco, Miami, rural Santa Barbara County, and New Orleans.

References

- Bean, Frank D., Allan G. King, and Jeffrey S. Passel. 1986. Estimates of the Size of the Illegal Migrant Population of Mexican Origin in the United States: An Assessment, Review and Proposal, pp. 13-36 in H.L. Browning and R. de la Garza (eds.), *Mexican Immigrants and Mexican Americans: An Evolving Relation*, Austin: University of Texas Press.
- . 1983. The Number of Illegal Migrants of Mexican Origin in the United States: Sex Ratio-Based Estimates for 1980, *Demography*, 20, 1 (February): 99-109.
- Borjas, George J., Richard B. Freeman, and Kevin Lang. 1991. Undocumented Mexican-Born Workers in the United States: How Many, How Permanent? Pp. 77-100 in J. M. Aboud and R. B. Freeman (eds.), *Immigration, Trade, and the Labor Market*, National Bureau of Economic Research, Chicago: The University of Chicago Press.
- Corona Vasquez, Rodolfo. 1991. Confiabilidad de los Resultados Preliminares del IX Censo General de Poblacion y Vivienda de 1990, *Estudios Demograficos y Urbanos* 16, El Colegio de Mexico, 6:1 (Jan.-Apr. 1991), 33-68.
- Forbes, Douglas and W. Parker Frisbie. 1991. Spanish Surname and Anglo Infant Mortality: Differentials Over a Half-Century. *Demography* 28(4): 639-660.
- Hahn, Robert A. and Donna F. Stroup. 1994. Race and Ethnicity in Public Health Surveillance: Criteria for the Scientific Use of Social Categories. *Public Health Reports* 109(1): 7-15.

- Hahn, Robert A., Joseph Mulinare and Steve M. Teutsch. 1992. Inconsistencies in Coding of Race and Ethnicity Between Birth and Death in U.S. Infants. *Journal of the American Medical Association* 267(2): 259-263.
- Heer, David M. and Jeffrey S. Passel. 1987. Comparison of Two Different Methods for computing the Number of Undocumented Mexican Adults in Los Angeles County, *International Migration Review*, 21: 1446-1473.
- . 1985. Comparison of Two Different Methods for Computing the Number of Undocumented Mexican Adults in the Los Angeles PMSA, Paper presented at the annual meeting of the Population Association of America, Boston, Massachusetts.
- Keely, Charles B. 1983. Affidavit submitted for plaintiffs in Cuomo, et al., v. Baldrige, et al., U.S. District Court, Southern District of New York, 80 Div. 4550(JES).
- Muller, Thomas, and Thomas J. Espenshade. 1985. *The Fourth Wave: California's Newest Immigrants*, Washington, D.C.: The Urban Institute Press.
- Passel, Jeffrey S. 1986. Undocumented Immigration, *The Annals*, 487 (September): 181-200.
- . 1985. Undocumented Immigrants: How Many? Paper presented at the Annual Meeting of the American Sociological Association, Las Vegas, Nevada.
- Passel, Jeffrey S. and J. Gregory Robinson. 1988. Methodology for Developing Estimates of Coverage in the 1980 Census Based on Demographic Analysis: Net Undocumented Immigration, Preliminary Evaluation Results Memorandum No. 114, Revised September. Washington, D.C.: United States Department of Commerce, Bureau of the Census.
- Passel, Jeffrey S., Jacob S. Siegel and J. G. Robinson. 1982. Coverage of the National Population by Age, Sex, and Race in the 1980 Census: Preliminary Estimates by Demographic Analysis, *Current Population Reports*, P-23, No. 115. Washington, D.C.: U.S. Government Printing Office.
- Puente, Manuel de la. 1993. Why are People Missed or Erroneously Included by the Census: A Summary of Findings From Ethnographic Coverage Reports, *Proceedings of the Research Conference on Undercounted Ethnic Populations*, May 5-7, Richmond, Virginia, U.S. Bureau of the Census.
- Robinson, J. Gregory. 1980. Estimating the Approximate Size of the Illegal Alien Population in the United States by the Comparative Trend Analysis of Age-Specific Death Rates, *Demography*, 17: 2 (May): 159-176.
- Robinson, J. Gregory, Bashir Ahme, Prithwis Das Gupta and Karen A. Woodrow. 1993. Estimation of Population Coverage in the 1990 United States Census Based on Demographic Analysis, *Journal of the American Statistical Association*, 88:423 (September): 1061-1071.
- Singh, Gopal K. and Stella M. Yu. 1996. Trends and Differentials in Adolescent and Young Adult Mortality in the United States, 1950 through 1993. *American Journal of Public Health* 86(4): 560-564.
- Sorlie, P. D. and Rogot E. Johnson. 1992. Validity of Demographic Characteristics on the Death Certificate. *Epidemiology* 3: 181-184.
- U.S. Department of Health and Human Services. 1992. *Health 1992: United States and*

- Healthy People 2000 Review*. Washington, D.C.: Public Health Service.
- U.S. General Accounting Office. 1993. *Illegal Aliens: Despite Data Limitations, Current Methods Provide Better Population Estimates, Report to the Chairman, Information, Justice, Transportation and Agriculture Subcommittee, Committee on Government Operations, House of Representatives*, GAO/PEMD-93-25, Washington, D.C.: U.S. Government Printing Office.
- Warren, Robert. 1995. *Estimates of the Undocumented Immigrant Population Residing in the United States by Country of Origin and State of Residence: October 1992*, Washington, D.C.: U.S. Department of Justice, Immigration and Naturalization Service, April (Draft).
- Warren, Robert and Jeffrey S. Passel. 1987. *A Count of the Uncountable: Estimates of Undocumented Aliens Counted in the 1980 United States Census*, *Demography*, 24: 3 (August): 375-394.
- Woodrow, Karen A. 1991. *Preliminary Estimates of Undocumented Residents in 1990: Demographic Analysis Evaluation Project D2, Draft, Preliminary Research and Evaluation Memorandum No. 75*, May 22.

