Infant Mortality and the Hispanic Paradox: A Meta-analysis

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Abstract

This paper presents results from a meta-analysis of infant mortality to shed light on the debate of the Hispanic Paradox. From Jstor, PubMed, MEDLINE, the Chicano computer database, and reference lists from prior studies, we located studies by searching for the key words: infant mortality; Hispanic paradox; epidemiological paradox; race & nativity; health & nativity; health & immigrants. We identified 33 published papers that analyzed infant mortality of at least one race/ethnic group of Hispanic descent or origin between 1975 and 2005. Each study analyzed infant mortality in one of two ways: by comparing U.S. race and ethnic groups, or by comparing the foreign born to U.S. native born. All studies had to include infant mortality rates by race/ethnicity or report infant mortality rates that could be calculated by race. Results from the meta-analysis of studies that compare Hispanics to Whites reveal a risk ratio of 1.07 (95% confidence interval, 1.03-1.12). Similar meta-analysis risk ratios emerged using infant mortality ratios of blacks to Hispanics (RR = 2.07; 95% CI 1.96- 2.19) and blacks to Whites (RR= 2.26; 95% CI 2.18 – 2.35). Overall, these findings suggest that blacks are more than twice as likely as Hispanics and whites to experience infant mortality, and that among Hispanics, the risk of infant death is lower than expected given their greater socioeconomic disadvantage.

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Introduction

As the size of the Latino population in the United States has grown, so has research exploring health outcomes among Latino and adults. Prior studies have documented the better-than-expected health of some Hispanic groups compared to others, despite poor socioeconomic circumstances (Markides and Coreil 1986; Singh and Yu 1996; Singh and Siahpush 2002). For example, evidence suggests that Hispanics have better birth outcomes than other ethnic groups, who are wealthier, more educated and better medically served (see Guendelman et al. 1990; Guendelman 1995; Guendelman et al. 1999). The relative health benefits of Hispanics, particularly Mexicans, have been attributed to their foreign birth (Singh and Siahpush 2002; Hummer et al. 1999; Collins and Shay 1994; Guendelman and Abrams 1995) and to shorter durations in the United States compared to other groups (Singh and Siahpush 2002).

Three explanations for the paradoxical findings exist. The first is the selective process of migration, where in-migrants are more likely to be healthier than nonmigrants, and return migrants are more likely to be in poor health than those who stay in the United States (Landale, Oropesa, and Gorman 2000; Palloni and Morenoff 2001; Palloni and Arias 2004). The second explanation emphasizes culturally protective behaviors that often decline over time. For example, immigrants benefit from their more healthy behaviors (e.g., less smoking), less stress, and strong family ties (Landale et al. 1999; Rumbaut and Weeks 1996). However, with more time spent in the United States, the protection incurred by immigrant status appears to decline and health worsens (Cho and Hummer 2001; Landale, Oropesa, and Gorman 2000; Rumbaut and Weeks 1996). A

final explanation for the paradox is due to error in data collection, specifically inconsistencies in counts of persons of Hispanic origin (Smith and Bradshaw 2005; Saenz 2007).

To date, many studies have documented race and ethnic disparities in infant mortality, and the paradoxical health outcomes of Hispanic infants and adults, using a variety of data sources and statistical techniques. In the present study, we conduct a meta-analysis of infant mortality rates by race and ethnicity presented in this diverse set of prior studies. To our knowledge, this is the first formal meta-analysis on the Hispanic paradox and infant mortality rates. We compute infant mortality rate ratios for Hispanics, blacks and whites, and focus on three salient comparisons that offer insights about the health paradox: Hispanics vs. whites, blacks vs. Hispanics, and blacks vs. whites.

Overview

The Hispanic population is a fast growing segment of the U.S. population, rising from 6.4% of the total population in 1980, to 9% in 1990, to 12.5% in 2000 (Gibson and Jung 2002; U.S. Bureau of the Census 2003). Despite their disadvantage in socioecomomic status relative to whites, Hispanics tend to have similar or more favorable health outcomes, such as all-cause mortality (Sorlie et al. 1993), low birth weight (Williams, Binkin and Clingman 1986; Verrier 1993) and infant mortality (Selby et al.1984; Frisbie 1994). This phenomenon has been termed the 'Hispanic Paradox' or the 'Epidemiologic Paradox' in prior studies.

Infant mortality is defined as death of an infant within the first year of life, and is often used as an indicator of economic status. Thus, the more socioeconomically disadvantaged a group, the higher the expected risk of infant mortality (Buchanan and

Weiss 1995). Traditional socioeconomic risk factors that contribute to infant mortality include low levels of education, young maternal age, marital status, and quality and use of prenatal care (Cramer 1988; Frisbie, Forbes and Hummer 1998). For example, Hispanics women are 1.5 to 3 times more likely than whites and blacks to not have completed high school, especially Mexican Americans and Puerto Ricans (Singh and Yu 1996). Hispanics are also much more likely than whites and blacks to postpone prenatal care until the third trimester or have no prenatal care at all. Rates of teenage and unwed Hispanic mothers are also about 1.5 to 2 times higher than whites, though typically lower than blacks (Leslie et al. 2003). In 2002, the Census Bureau reported that Hispanic workers earn less than non-Hispanic white workers; only 26.3% of Hispanics but 53.8% of non-Hispanic whites earned $35,000 or more. Hispanics are much more likely than non-Hispanic whites to live in poverty, 21.4% vs. 7.8% in 2002, respectively (Ramirez, and de la Cruz 2003). In contrast, however, researchers have repeatedly found infant mortality rates of Hispanics to be half the rate of blacks and very similar to whites (Kerr, Ying, and Spears 1995).

Socioeconomic experience and infant mortality rates vary among Hispanic subgroups, such as Mexicans, Cubans and Puerto Ricans (Singh and Yu 1996; Mathews, Menacker, and MacDorman 2003). Puerto Ricans tend to have socioeconomic profiles similar to blacks (Becerra et al. 1991), while Cubans and non-Hispanic whites do not differ from each other (Frisbie and Song 2003). Puerto Ricans face the highest risks of infant mortality, while Mexicans and Cubans have lower risks more similar to those of whites (Hummer, Eberstein and Nam 1992; Cervantes, Keith, and Wyshak 1999). Nativity has also been shown to be associated with infant mortality rates. Foreign born

mothers of all races have lower infant mortality rates than mothers born in the United States (Hummer et al. 1999).

Contemporary studies on infant mortality often rely on data that link birth and death certificates. However, before 1980, most states did not request Hispanic origin of parents on birth and death certificates, and studies identified Hispanic persons as those with Spanish surnames using the Buechley method (1961). Data sources gradually began to include questions about Hispanic origin. By 1981, 22 states were self-reporting Hispanic origin on birth certificates, and by 1988, 30 states and the District of Columbia were reporting Hispanic origin on their birth certificates. All 50 states were reporting by 1993 (NCHS 2004).

Data and Methods

A meta-analysis involves identifying articles on a particular topic through a reproducible search, such as one using Medline. Once a large number of studies have been identified, eligibility criteria are created to generate a uniform group of comparable studies. After narrowing down the number of studies using these criteria, relevant data are then extracted from each study and an analysis of these data is performed.

Selection Criteria. We developed our sampling frame of studies in two ways. First, to identify an initial list of studies, we searched *Jstor, PubMed, Medline, and Chicano* databases using the key words: infant mortality; Hispanic paradox; epidemiological paradox; race and nativity; health and nativity; health and immigrants. To these studies we added others found in their reference lists, yielding a total of 130 studies. We then narrowed down the 130 studies using the four selection criteria described below.

1) Studies must analyze infant mortality rates by race/ethnicity or by nativity status (foreign born vs. native born), or have rates that are calculable by race or nativity.

2) Studies must include infant mortality data on at least one Latino group and at one other comparison group, e.g. race (white, black, other), nativity status (e.g. foreign born), or Hispanic subgroup (e.g. Mexican, Cuban).

3) Studies must be published in 1970 or later and data collected no earlier than 1970.

4) Studies must be conducted in United States or on the island of Puerto Rico.

After applying the study selection criteria, 39 studies remained. We then excluded four studies that relied on data already included in the meta-analysis (Mathews, Menacker, and MacDorman 2003; Kerr, Verrier, Ying and Spears 1995; Frisbie 1994; Muhuri, MacDorman and Ezzati-Rice 2004), another study because it analyzed only one Hispanic group and did not include a comparison group (Kanaiaupuni and Donato 1999), and a final study because it defined Hispanicity based on whether persons resided in a US city with no other assessment of ethnicity (Buchanan and Weiss 1995). The final list includes 33 studies, which supply data for our meta-analysis.

Variable Definition. All studies defined infant death as death that occurs between 0 to 365 days of life. If infant mortality rates were not given, we calculated them from reported counts in the papers. We used the following Hispanic subgroups: Mexicans, Central/South Americans, Cubans, and Puerto Ricans, and defined foreign born infants as those born to mothers in Puerto Rico or outside of the United States.

For each study, we extracted infant mortality rates and sample sizes by maternal race or ethnicity. The process of data extraction was repeated three times to check for and eliminate coding and other errors. If reported in the study, we also extracted data on risk factors for infant mortality. This information includes the percentage of mothers less than 20 years old; marital status; prenatal care (none, inadequate, late); and education (12 years or less; yes/no). When available, risk factors were also obtained directly from the table counts in the papers.

Methods**.** We calculate the risk ratio from infant mortality rates for three racial pairs: Hispanics and whites, blacks and Hispanics, and blacks and whites. The main results of the meta-analysis are given by the meta-analytic risk ratios, which we calculated using both fixed effects and random effects models. Due to large variability in risk ratios between studies (see below), we present results from the random-effects models. The random effects method assumes that the true infant mortality rate that is estimated has a normal distribution. In addition, a between-study variance term is introduced in the weights and used for the pooled estimation of the overall infant mortality rate. We also generated 95 percent confidence intervals for the risk ratios using the DerSimonian and Laird method (DerSimonian and Laird 1986), and we used lowess curves to estimate the general trend lines of the infant mortality rates over time. The latter is a robust localized smoothing technique estimated with the statistical software S-plus. All other parts of the analysis were estimated with the computer program STATA.

Results

Table 1 describes the 33 studies selected for this meta-analysis. Most studies cover populations that either span the nation or focus on Texas and California, states that

include a large percentage of the U.S. Hispanic population. Three of the four localized city and county studies were performed in cities within Texas. Sixteen studies examined infant mortality at the state level. Five of 16 statewide studies were in Texas, and four were conducted in California. Thirteen studies assessed infant mortality at the national level. Correspondingly, the data sources derive from county and state birth and death records, and national matched birth and death data sets. Moreover, the data used by each study covered the years between 1970 and 2002.

Table 1 about here

Because study period and the number of live births vary by study, and because we wanted to insure a contemporary view of infant mortality, we limited studies to those from 1970 to 2002 (see discussion above on selection criteria). The sample sizes of these post-1969 studies ranged from 12,814 to over 23 million. The smallest sample was 12,814 collected by Finch (2003) who used survey data from the National Mother and Infant Health Survey (NMIHS). Large sample sizes are important because they yield a more accurate estimation of the true infant mortality rates and the risk ratios between race and ethnic groups. Furthermore, studies that presented infant mortality rates by year or groups of years were listed more than once. For example, MacDorman et al. (2005) listed infant mortality rates individually by year from 1999 through 2002, and therefore the meta-analysis uses four individual comparisons of infant mortality by year.

Figure 1 presents infant mortality rates by study period and maternal race/ethnicity. The studies are ordered from left to right according to study period. The solid lines represent lowess fitted curves that represent a moving average trend over time. Together the three lines suggest a decline in infant mortality rates for the three race/ethnic

groups. Infant mortality was as high as 38.8 per 1000 for blacks in 1970, and by 2002, it dropped to 13.9 per 1000. In contrast, among Whites and Hispanics, rates started at approximately 18-20 infant deaths per 1000 births, and leveled off at 5.6 per 1000 in 2002. Therefore, although all groups have declining rates, Hispanics and whites have comparable infant mortality, and blacks maintain higher rates than both groups across all studies. In fact, the absolute difference between blacks and whites/Hispanics widens slightly across the study periods. Moreover, from study to study, variability in infant mortality rates is higher for blacks than for whites and Hispanics. Simple standard deviations of the infant mortality rates collected from these studies are 3.4 for whites and 3.7 for Hispanics, but 6.1 for blacks. This suggests more inconsistency in study-to-study infant mortality rates for blacks than for whites or Hispanics.

Figure 1 about here

Table 2 describes the socioeconomic status of the three race and ethnic groups. These data derive from a subset of the studies listed in Table 1; all studies in the subset reported the same indicators of socioeconomic status. One example is low levels of educational attainment; it is a common risk factor associated with infant mortality. Although a variety of definitions were used to measure education in these studies, the most common indicator of education was less than a high school diploma. From the four studies that operationalized education in this way, over one-quarter of blacks and Hispanics did not finish high school compared to 13% of whites. Some studies also reported this information by Latino national origin. From these, we can see that Puerto Ricans had the highest rates of less than high school completion (43 percent), whereas

rates of high school non-completion among Mexicans, Cubans, and Central/South Americans ranged from 35 to 22 percent.

Table 2 about here

Initiation and quality of prenatal care is another indicator that relates to infant mortality. Of the five studies that reported the percentage of mothers that gave birth with no prenatal care, whites were the most likely, and Puerto Ricans least likely, to have prenatal care. Mexicans and Blacks fell in between: approximately 3.5 percent reported no prenatal care relative to one percent of whites and nine percent of Puerto Ricans. Two studies reported the percentage of women who initiated some prenatal care in the third trimester or had no prenatal care. Again, Hispanics were mostly likely followed by blacks and then whites.

Finally, some studies used a combination of variables to determine adequacy of prenatal care. For example, Hessol (2005) used the Adequacy of Prenatal Care Utilization Index to adjust for the time of enrollment in care, the number of prenatal visits, infant gender, birth weight, and gestational age. Of all the groups in Table 2, Mexicans, Puerto Ricans, and South and Central Americans have the highest rates of inadequate care. Among all Latinos, whites and blacks, blacks had the highest rate of inadequate care (27 percent, compared to 12 percent for Latinos, and ten percent for whites.

Of all the risk factors in Table 2, maternal age and marital status were the most commonly reported. Approximately 18 percent of Hispanic mothers are 18 years or younger, compared to 11 percent of blacks and 10 percent of whites. A crossover emerges when we consider the percent of these groups with maternal ages of 19 years or

less. Here blacks are more likely than Hispanics to have given birth when 19 years old or younger (25 vs. 22 percent, respectively). Note that maternal age among Hispanics varies widely by national origin. Among Mexican mothers, 42 percent were less than 20 years old at the time of their child's birth, and among Puerto Ricans, 26 percent were less than 20 years old. Finally, the last row of Table 2 shows that many women are not married when they have their children. Blacks had the highest percentage of unmarried mothers (64 percent), followed by all Hispanics (30 percent). Whites had the lowest rate of unmarried mothers (18 percent).

Individual study risk ratios as well as the meta-analytic risk ratios between Hispanics and Whites, Blacks and Hispanics and Blacks and Whites are presented in Figures 2A-C. The larger squares indicate larger sample sizes, and these studies received more weight in the meta-analysis risk ratios. Figure 2A is the relative ratio of Hispanics to whites, where whites are the reference group (denominator). The seven squares to the left of the center line document five studies that showed the risk of infant mortality lower for Hispanics than whites. However, only the MacDorman (2005) study, using data for the year 2002, was statistically significantly different from one. The majority of studies reveal white-Hispanic rate ratios that were effectively one, implying no difference between Hispanics and whites. As shown in Table 3, the meta-analysis risk ratio for this comparison is 1.07 with a 95% confidence interval of 1.03 and 1.11 and it is statistically significant at the .05 level.

Figure 2A and Table 3 about here

Although significant, however, we interpret the ratio as one because the size of the Hispanic-white difference is so small. Furthermore, we performed a test of

heterogeneity on the relative risks from each study and found it was significant, suggesting that there is unaccounted variability not related to statistical sampling. This finding implies that random effects models are more appropriate than fixed effects models.

Figure 2B presents the risk ratios of blacks and Hispanics, using Hispanics in the denominator. In all studies, the risk of infant mortality was higher for blacks than for Hispanics and risk ratios were significant and greater than one. However, the pattern is different and more variable from that found in Figure 2A, and the direction of the squares moving from left to right suggest risk ratios increased steadily over time. As shown in Table 3, the meta-analysis risk ratio was 2.06, with a 95% confidence interval of 1.95 and 2.18 and significant at $p<.0001$.

Figure 2B about here

In the final figure (2C), we display the risk ratios of blacks to whites. Once again all were significant and greater than one, illustrating that infant mortality is more likely among black infants than whites. Table 3 supports this interpretation with an overall meta-analysis risk ratio of 2.25 and 95% confidence interval of 2.17 and 2.33. Furthermore, the risks of black infant death rose relative to whites over time.

Figure 2C about here.

To sum, our results provide strong support for the Hispanic paradox in infant mortality. Despite reduction in infant mortality among all three groups, Latinos have rates that are comparable to whites while blacks face infant mortality risks that are much higher than the other two groups. Moreover, the trend toward rising risk ratios for blacks compared to Hispanics or blacks suggest that, despite the declines depicted in Figure 2,

blacks have experienced less reduction in infant mortality than whites and Latinos. On the other hand, rates for Latinos and whites are not only similar but declining at a similar rate.

Discussion

Now the leading topic in studies on Hispanic health in the United States, the Hispanic paradox describes better-than-expected health outcomes for Hispanics compared to whites and blacks. Results from our meta-analysis of 33 prior studies on infant mortality reveal clear signs of a Hispanic health paradox. Despite poor socioeconomic status, Latinos have comparable rates of infant mortality to whites. On this point, prior studies are consistent. The meta-analysis also shows that blacks have significantly higher rates of infant death, and have experienced less reduction in those rates over time, relative to Hispanics and whites. These findings too are consistent and robust. Therefore, despite stepped-up public health interventions during the last two decades, African Americans still face unusually high risks of infant mortality.

What underlies these findings must now become part of the national health agenda. The paradoxical findings of Hispanics contradict the long-standing relationship between lower socioeconomic status and poor health. So how is it possible that Latino infants do not face higher mortality risks? Three explanations are possible. The first is related to immigration and argues that it selects the healthiest to cross international borders, and once in the United States, it selects the healthiest to remain and the least healthy to emigrate and return to their origins. The second explanation is cultural and contextual, suggesting that diet, life-style, strong social networks and support, and neighborhood conditions explain these paradoxical health outcomes. The third

explanation argues the paradox is an artifact of data sets that have miscounted the Hispanic/Latino population, and in particular, infant deaths. Research has begun to address these explanations, although to date most test one explanation rather than examine the extent to which all three may contribute to the Hispanic paradox. Future research must also disentangle explanations for different health outcomes because what may explain a paradoxical outcome for one measure of health, such as infant mortality, is likely to differ from explanations of other paradoxical health outcomes, such as adult mortality.

Explanations for the very high mortality risks of African Americans remain illusive. Is it lower socioeconomic status that explains why such high rates of infant death remain and why reduction in these risks has not occurred as rapidly as it has for whites and Latinos? This seems unlikely given findings from Verrier et al. (1994), who suggest that even high risk Hispanics with no prenatal care faced considerably lower infant mortality risks than comparable blacks. Moreover, although discrimination is certain to be part of the process, exactly how does it operate to raise the risks of infant death? And what role does discrimination play in affecting the risks that Latinos face? These are important questions that future research must address.

One final explanation of the substantial variability in black infant mortality rates relative to Hispanics and whites may be related to the type of the black population that appears in the data sets used in the 33 studies we analyze. Among the non-national infant mortality studies in our sample, most were in southern states, including Georgia, Alabama, or cities with large urban black populations, such as Chicago. In contrast, the majority of infant mortality studies that focus on Hispanics were more geographically concentrated in the

west, especially in Texas and California. These latter studies are likely to include blacks who are substantively and demographically quite different from those in traditionally southern states.

In this study, we performed a meta-analysis of prior studies that identified race and ethnic differences in infant mortality. This has, we argue, yielded a more objective review of past studies than a narrative literature review. Our integrative review offers strong evidence of an epidemiologic Health paradox among Latinos and of very poor outcomes for African Americans.

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Table 1: Selected Studies for meta-analysis of infant mortality and the Hispanic Paradox

Study	Source, Publication Year	Study Population	Data Source	Study Period	No. of Cases
1	Hedderson and Daudistel, 1982 (2)	El Paso, Texas	El Paso County Birth/Death	1970-1971,1976-1978	18,544
2	Teller and Clyburn, 1974	Texas	State Birth/Death	1970-1972	----
3	Rogers, 1984	New Mexico	State Birth/Death	1974-1977	84,951
4	Selby et al., 1984	Houston, Texas	Harris County Birth/Death	1974-1975	68,584
5	Cramer, 1987	California	State Birth/Death	1978	289,232
6	Cramer, 1988	California	State Birth/Death	1978-1982	651,951
7	Powell-Griner and Streck, 1982	Texas	State Birth/Death	1979	254,263
8	Levin and Markides, 1985	Corpus Christi, Texas	Nueces County Birth/Death	1979-1983	22,891
9	Powell-Griner, 1988	Texas	State Birth/Death	1980	257,385
10	Rogers, 1989	New Mexico	State Birth/Death	1980-1983	105,974
11	Hummer, 1992	Florida	State Birth/Death	1980-1982	39,474
12	Williams et al., 1986	California	State Birth/Death	1981	414,538
13	Becerra et al., 1991	United States	NCHS[1]	1983-1984	7,286,735
14	Engel et al., 1995	United States	NCHS[1]	1983-1986	133,818
15	Verrier et al., 1994	Texas	State Birth/Death	1984-1986	877,738
16	Frisbie et al., 1996	United States	NCHS[1]	1987	1,885,670
17	Singh and Yu, 1996	United States	National Birth/Death	1985-1987	5,535,232
18	Racine, 1998 (2)	New York	State Birth/Death	1988-1989,1992-1993	501,324
19	Finch, 2003	United States	NMIHS[2]	1988	12,814
20	Frisbie, Forbes, and Hummer 1998	United States	National Birth/Death	1989-1991	9,344,331
21	Reichman and Kenny, 1998	New Jersey	State Birth/Death	1989-1990	198,881
22	Muhuri et al., 2004 (2)	United States	NCHS[1]	1989-1991,1995-1997	23,355,912
23	Hummer et al., 1999	United States	NCHS[1]	1989-1991	10,061,787
24	Kerr, Ying, Spears, 1995	Texas	State Birth/Death	1989-1991	941,474
25	CDC, 2003	United States	National Birth/Death	1989-1991, 1998-2000	----
26	Collins et al., 2001	Illinois	State Birth/Death	1992-1995	51,412
27	Leslie et al., 2003	North Carolina	State Birth/Death	1993-1997	498,902
28	Cervantes et al., 1999	Chicago, Illinois	Chicago, Illinois Birth/Death	1994	52,033
29	Hessol and Fuentes-Afflick, 2005	California	State Birth/Death	1995-1997	1,277,393
30	Frisbie and Song, 2003	United States	NCHS[1]	1995-1997	8,892,500
31	Alexander et al., 2003	United States	NCHS[1]	1995-1997	10,357,500
32	Salihu et al., 2003	United States	National Birth/Death	1997	3,004,616
33	MacDorman et al., 2005 (4)	United States	NCHS[1]	1999-2002	15,004,603

Number in parenthesis indicates the number of comparison taken from each study. Separate comparisons indicate IMRs rates listed individually by year.
[1] NCHS, National Center for Health Statistics
[2] NMHIS, National Mother and Infant Health Survey

Table 2: Weighted Average Risk Factors of Infant Mortality by Race/Ethnicity[1,2]

		N	Mexican	PR	Cuban	Cent/South American	All Hispanic	White	Black
Education[3]	Definition								
	< 9 years	3	30.4%	7.6%	2.9%	23.6%	28.0%	2.0%	1.4%
	9-11 years	3	29.1%	32.7%	12.6%	18.9%	29.0%	11.9%	18.7%
	< 12 yr	4	34.5%	42.4%	22.3%	27.8%	30.1%	12.9%	27.4%
Prenatal Care									
	No Prenatal	5	3.7%	9.3%	4.4%	2.8%	1.1%	1.0%	3.5%
	3rd Trimester or none	2	NR[4]	NR	NR	NR	8.4%	4.5%	7.3%
	Inadequate Care	5	27.1%	24.9%	10.1%	23.0%	12.4%	9.7%	26.9%
Maternal Age									
	% <19	3	24.0%	25.9%	18.2%	26.2%	18.0%	10.0%	11.4%
	% <20	3	42.2%	26.4%	19.1%	25.3%	21.6%	9.6%	24.5%
Marital Status									
	% unmarried	11	34.6%	56.6%	22.2%	44.8%	29.5%	17.5%	64.4%

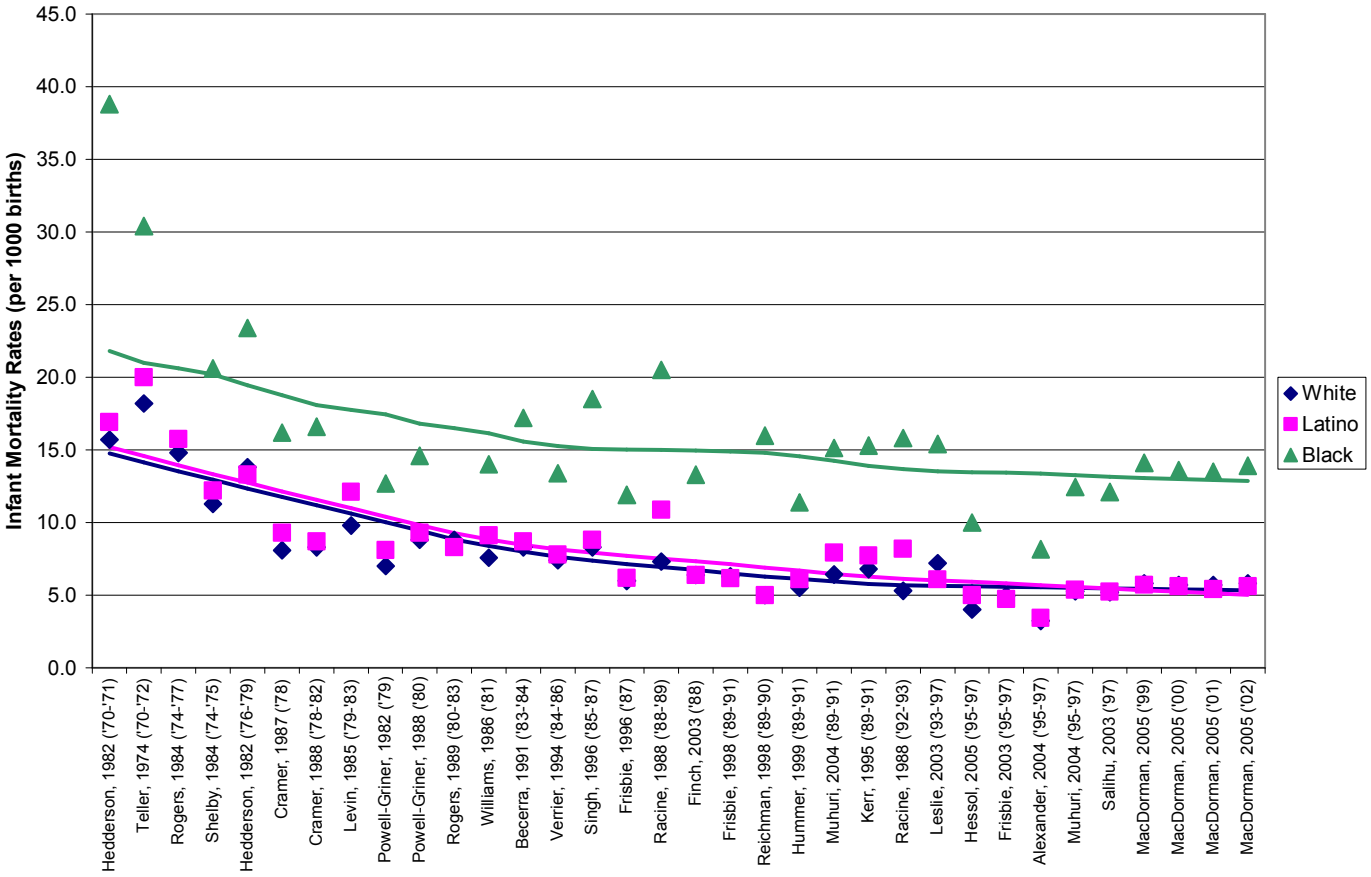
[1]Weighted averages were calculated using the proportion of total sample size as the weight for each individual category.
[2]Risk factors percentages were taken from US born racial/ethnic groups if a distinction was made by nativity status
[3]Cervantes et al. (1999) was excluded in the category of education since this study did not report education levels similar to any other study.
[4] NR, Not Reported

Table 3: Meta-Analysis Risk Ratios[1]

Group Comparisons	No. of Comparisons	Risk Ratio (95% CI)	P-value
Hispanics to Whites	22	1.07 (1.03 – 1.11)	< 0.0001
Blacks to Hispanics	19	2.06 (1.95 – 2.18)	< 0.0001
Blacks to Whites	24	2.25 (2.17 – 2.33)	< 0.0001

[1]Risk ratios are based on random effects model

Figure 1: IMR by Maternal Ethnicity and Year of Study Period[1,2,3]



[1] Publication year follows the authors name; year of study period follows in parenthesis.
[2] Studies that report IMRs for multiple years appear as individual study year (e.g. MacDorman)
[3] The solid curves represent trends estimated by lowess curves fitted; see Methods

Figure 2A: Risk Ratios of Hispanics to Whites by Maternal Ethnicity and Study Period

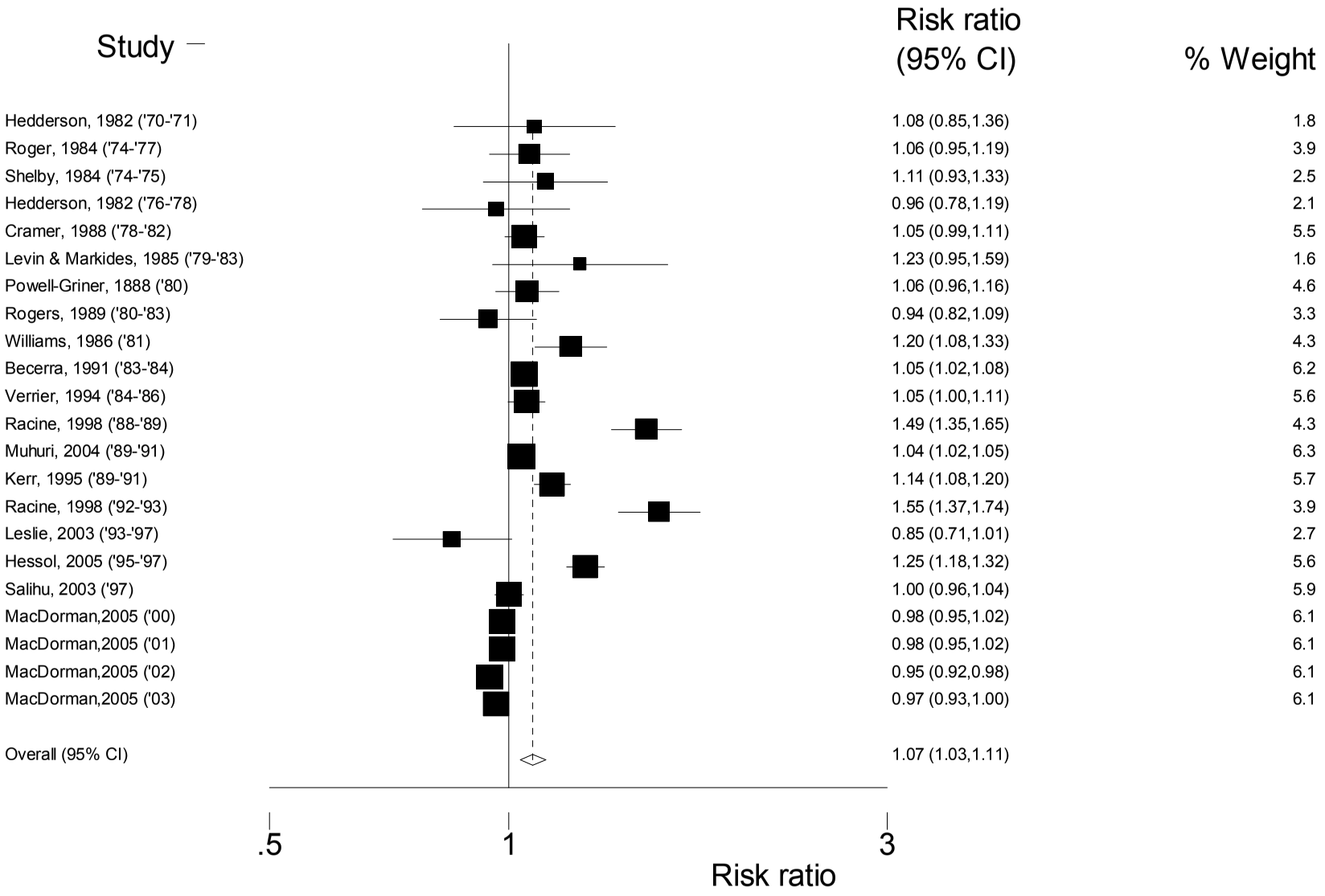


Figure 2B: Risk Ratios of Blacks to Hispanics by Maternal Ethnicity and Study Period

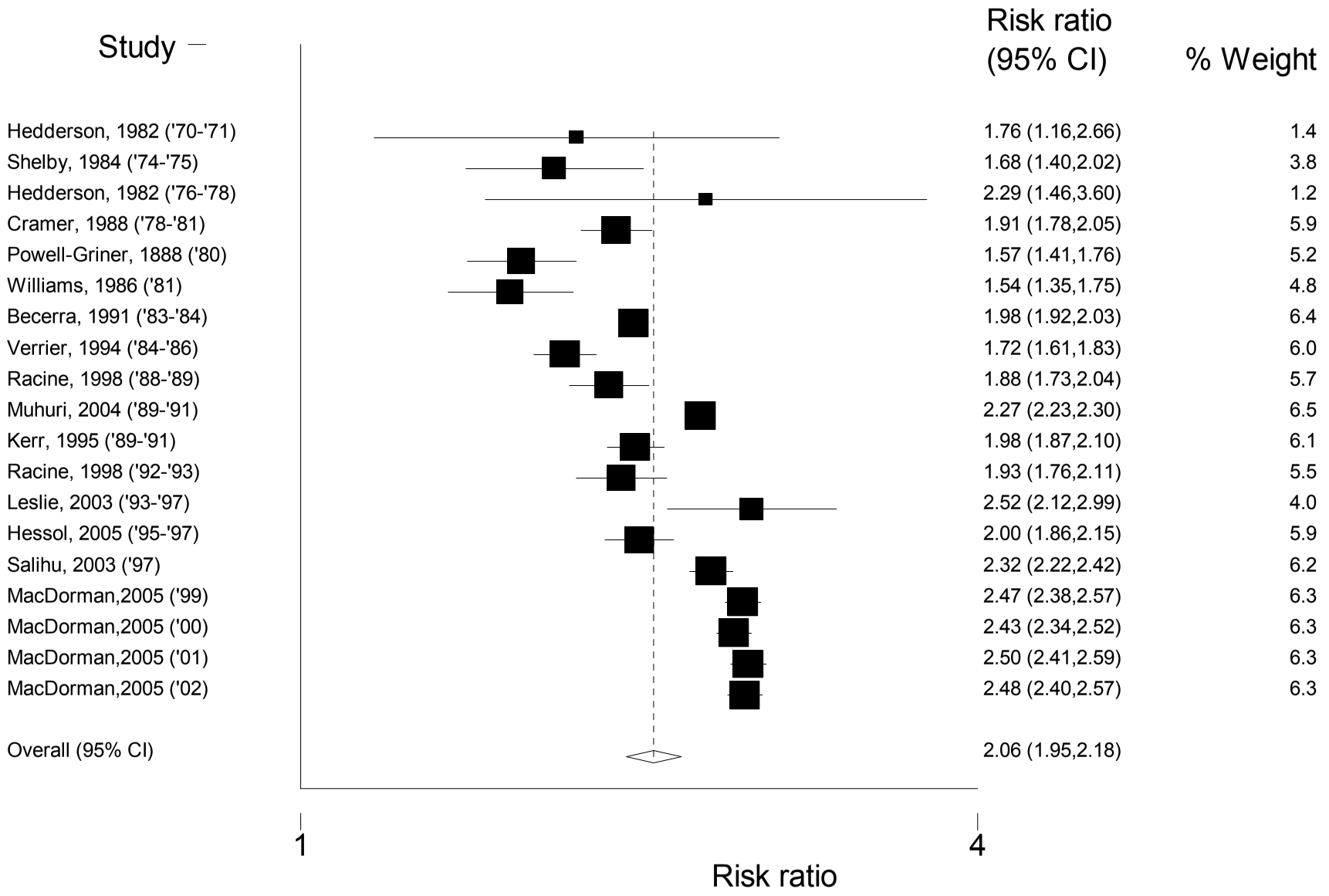


Figure 2C: Risk Ratios of Blacks to Whites by Maternal Ethnicity and Study Period