Relative Rates of Dementia 
By Multiple Case Definitions, 
Over Two Prevalence Periods, 
In Three Sociocultural Groups

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The North Manhattan Aging Project registry, using both Reporting and Survey Components, identifies dementia cases among Latino, African-American, and non-Latino white sociocultural groups (9,349 persons 65 years of age or older) in contiguous census tracts. During a 2-year prevalence period of the reporting component, 1,592 persons were reported to the Registry and screened with five widely used brief cognitive measures; 844 were evaluated in a "clinical core," and 452 met research criteria for dementia, covering all subtypes, according to DSM-III-R criteria. Thirteen different case definitions for dementia were applied to the sociocultural groups at three levels of educational achievement, examining for associations with rates of dementia cases and controlling for age. The following findings were robust across case definitions: sociocultural membership was not associated, but lower education was associated, with increased rates of recorded dementia; however, the patterns of the association with education varied across sociocultural groups. (American Journal of Geriatric Psychiatry 1995; 3:6-20)

There have been numerous attempts over the past three decades to estimate the incidence and prevalence of dementia and its subtypes. Such data are valuable for indicating the need of health services and drawing epidemiological inferences about etiology. However, in a country of great cultural diversity such as the United States, there is a particular and necessary concern that these data should be collected and

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interpreted with sensitivity to sociocultural differences.

Several studies have reported the possibility that rates of cognitive impairment and dementia may be higher in certain sociocultural groups, for example, African-American or Latino groups compared with non-Latino white subjects. However, the groups with higher rates are usually also relatively disadvantaged in education, language, and familiarity with "mainstream" American culture, and they may be disadvantaged economically and in other ways as well. Some of these features of disadvantage may confound the effect of sociocultural membership on rates of cognitive impairment and dementia. Identification of cases of dementia other than those at advanced and obvious stages may be complicated by the effects of previous levels of intelligence or education on performance in assessment procedures. Items in widely used screening tests of cognitive function appear to pose a greater degree of difficulty for poorly educated subjects, for certain sociocultural groups, and for those not educated in Western customs or who have language barriers. Not all studies agree on the importance of educational confounds, nor whether reported cross-cultural differences are real or artifactual. For example, autopsies on all available patients who died in a teaching hospital (N = 199) revealed no differences in the frequency of plaques and tangles with respect to sociocultural group. Moreover, there are usually too few diagnosed cases to allow definite differences to be demonstrated between sociocultural or educational groups. Thus, it remains unknown whether, and to what degree, reported results of cross-cultural differences in rates of cognitive impairment and dementia are real or methodological artifacts arising from bias in case ascertainment techniques.

This article offers extensive data on differences in the relative rates of cognitive impairment and dementia in three sociocultural groups: African-American, Latino, and non-Latino white subjects, when the confounding effects of education are taken into account, and with interviews conducted in the preferred language of the subject. The extent to which the findings are dependent on the method used for case ascertainment is examined by looking at consistency in the results obtained with varying techniques of case definition.

**METHODS**

**The North Manhattan Aging Project**

The North Manhattan Aging Project (NMAP) has established a registry as a record of known cases of dementia and its subtypes within a clearly bounded geographic area and among persons 65 years of age or older. The NMAP registry is planned to identify and list the great majority or all, if possible, of the cases of Alzheimer's disease and related dementias among persons 65 years of age and older in a defined geographic area of North Manhattan. Cases may be placed on the registry through means of 1) a reporting network, the Reporting Component, and 2) a survey of representative subsamples of residents in this area, the Survey Component. In future reports the interpretation of the findings based on the registry will be enhanced by comparisons of the results of the two registry components. This paper reports findings based on the reporting component.

**Geographic Area**

The target area was constructed by stitching together 13 adjacent census tracts in North Manhattan, located within the vicinity of the study's headquarters and network of service and community relations. The target area was expected to contain about 10,000 persons 65 years old and older, including about 750 eligible cases of
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dementia—a number that satisfied power calculations for detecting cross-cultural differences in rates of dementia and did not exceed the capacity of the study. Census data indicated that there would be substantial numbers of older persons in each of the Latino, African-American, and non-Latino white groups.

The boundaries of the target area are 155th to 181st Street, river to river, in North Manhattan, substantially within the domain of Washington Heights (New York City). It is multicultural, predominantly Dominican Latino and African-American, but the area also has many older non-Latino white long-term residents. The demographic features of the target area population are shown in Table 1.

There are pronounced education and age distribution differences among the three sociocultural groups in the study area. The non-Latino white group had the highest mean age, with a majority of subjects age 75 years or older. The African-Americans are the next oldest, with 46% at age 75 or older, and the Latinos have only 34.9% at age 75 and older. These figures reflect the fact that the NMAP study area is a community in transition, with many older, non-Latino white individuals remaining, whereas younger ones have moved away and been replaced by younger Latino residents. The African-American group is less mobile and resembles the age distribution of all persons age 65 and older in the United States. Differences between educational distributions among the three sociocultural groups are even more pronounced than age differences. Over 60% of the non-Latino white subjects and just over half of the African-Americans had completed 12 or more years of schooling, compared with just 17% of the Latinos. Almost one-third of the Latinos had completed less than 5 years of schooling, but over 90% of the other two groups had gone beyond this level. Poverty, crime, and unemployment rates are high in the study target area. Housing and amenities are good but often deteriorated. A single hospital (Columbia-Presbyterian Medical Center) provides almost all inpatient care and much of the ambulatory and emergency care to the study’s target area. A large contingent of Latino physicians run solo or small group practices in the neighborhood, supplemented by some multicultural large group

### TABLE 1. Demographic features of the target area population: age and education by sociocultural group, % (n)

<table>
<thead>
<tr>
<th>Age, years</th>
<th>Latino (n = 4,068)</th>
<th>African-American (n = 3,507)</th>
<th>Non-Latino White (n = 1,774)</th>
<th>Total (N = 9,349)</th>
</tr>
</thead>
<tbody>
<tr>
<td>65–74</td>
<td>65.1 (2,650)</td>
<td>56.0 (1,965)</td>
<td>41.8 (742)</td>
<td>57.3 (5,357)</td>
</tr>
<tr>
<td>75–84</td>
<td>27.4 (1,114)</td>
<td>32.1 (1,124)</td>
<td>40.8 (723)</td>
<td>31.7 (2,951)</td>
</tr>
<tr>
<td>85+</td>
<td>7.5 (304)</td>
<td>11.9 (418)</td>
<td>17.4 (309)</td>
<td>11.0 (1,031)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Years of Education</th>
<th>Latino (n = 4,068)</th>
<th>African-American (n = 3,507)</th>
<th>Non-Latino White (n = 1,774)</th>
<th>Total (N = 9,349)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–4</td>
<td>32.4 (1,317)</td>
<td>8.7 (304)</td>
<td>5.5 (97)</td>
<td>18.4 (1,718)</td>
</tr>
<tr>
<td>5–11</td>
<td>50.2 (2,043)</td>
<td>40.8 (1,432)</td>
<td>32.4 (575)</td>
<td>43.3 (4,050)</td>
</tr>
<tr>
<td>12+</td>
<td>17.4 (708)</td>
<td>50.5 (1,771)</td>
<td>62.1 (1,102)</td>
<td>38.3 (3,581)</td>
</tr>
</tbody>
</table>

a Numbers furnished by the Special Tabulations Branch of the United States Census Bureau using 1990 Census data for the 13 targeted tracts. Persons not designated Hispanic, black, or white were excluded from the tabulations.
practices. Social and community agencies are well organized and in close touch with each other.

**Reporting Component Case-Finding**

Cases are brought to the notice of the Registry through a network of reporting channels. Reporting is either through the medium of case records, key informants at the various sites, or volunteers who contact the study personnel in response to a publicity release. Study staff repeatedly scrutinize records, contact key informants, and receive telephone calls. If a report suggests that a subject is likely to be a case, then a further examination is instituted by the research team. A likely case is suspected in any of the following situations.

1) A subject is reported to be in or entering service sites having a known high rate of dementia cases. Such sites include nursing homes, formal home care services involving nursing and/or personal care, hospitals where patients require special discharge planning efforts, and outpatients in services concentrating on disorders such as Alzheimer's disease, stroke, or Parkinson's disease. 2) Case records or a key-informant report documents certain indicators of high risk for dementia. Indicators include a diagnosis of dementia, Parkinson's disease, or stroke, discharge to community-based or institutional long-term care, and behaviors associated with dementia and open to observation by professional or lay persons. Research staff routinely review the records of any centrally organized medical service in the target area, such as hospitals, outpatient clinics, and group practices; or obtain a report by regular contact with a key informant in dispersed services, such as medical practitioners, social agencies, and senior centers, or at community religious, ethnic, or housing organizations. 3) Direct appeals to the community lead to the report of a possible case by family members or self-referral. Appeals are made through health fairs, newspaper articles, speeches to religious congregations, and attendees at senior centers.

All persons defined as being at high risk according to the study definitions were screened, if they were willing, for cognitive impairment suggesting possible dementia. A proportion of persons reported as "not cases" were also screened to monitor the efficiency of the reporting system.

**Screening Instruments**

A compendium instrument was compiled from five widely used cognitive screening scales: the Kahn-Goldfarb Mental Status Questionnaire, the Short Portable Mental Status Questionnaire, the Comprehensive Assessment and Referral Interview (CARE) Cognitive Scale (Dementia Version), the Blessed Memory-Information-Concentration test, and the Mini-Mental State Examination (MMSE). The compendium instrument was organized to minimize redundancy between constituent measures and allow a smooth flow of the interview; the interview took an average of 20 minutes. A Spanish-translation version of the compendium instrument was prepared by a bilingual interviewer trained in the administration of the English version. This translation was reviewed by two bilingual professionals with extensive experience in mental testing; adjustments were made until the original and translated versions coincided. In a few items, an equivalent rather than a literal translation was chosen. Interviewers fluent in both Spanish and English were assigned to subjects according to their expressed language preference. Scales for each imbedded screening can be reconstructed from data generated by the compendium instrument.

In a pilot study of 550 older subjects, the above five screening tests incorporated in the compendium instrument were examined for sensitivity and specificity in predicting criterion diagnosis. Threshold scores on all scales were set at 90%-or-greater sensitivity because this was integral to the substantive study's aim of maximizing the
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finding of cases without losing efficiency through undue sacrifice of specificity. At this level of sensitivity, the CARE Cognitive Scale (Dementia Version) produced the lowest false-positive rates of all the scales; it was therefore selected for determining referrals to Clinical Core in the ensuing phases of the study. The full compendium instrument continues to be used in the screening interview of the Reporting Component.

Criterion Diagnosis

All persons who exceeded the 90% sensitivity threshold on the cognitive screen in the pilot study were referred to a research clinical evaluation team (the Clinical Core), who made a diagnosis according to specified research criteria for dementia. Also, a proportion of persons who fell below the critical threshold on the screen were referred, with observers blind to the screen score, to keep the diagnostic team uncertain about the range of screen scores among referred subjects. This also allows checks on the performance of all the cognitive screening scales in relation to the criterion diagnosis. Over the course of the extended prevalence period, 168 (26%) of the persons who screened negative were referred for diagnosis. Annual reassessments are carried out on criterion cases, and on all screen-positive cases, regardless of diagnosis. Autopsies are also obtained when they are allowed.

The procedures of the Clinical Core, which exclude the screening process information, were designed to replicate the diagnostic evaluation that a person might undergo at an Alzheimer's disease research center. The evaluation consists of a structured medical and neurological examination, including a short mental status evaluation, assessment of extrapyramidal signs and other involuntary movements, a history, functional evaluation, psychiatric evaluation, and a battery of neuropsychological tests. Psychiatric evaluation consists of screening items for depression, psychosis, and substance abuse, as well as a standardized interview version of the Hamilton Depression Rating Scale that is also used to fit operational criteria for depression. A neuropsychological battery consists of orientation items from the MMSE, the Selective Reminding Test, Benton Visual Retention Test, Rosen Drawing Test, Boston Naming Test, Controlled Word Association Test, Boston Diagnostic Aphasia Test, Wechsler Adult Intelligence Scale-Revised, Similarities and Non-Verbal Similarities, and a subtest of the Mattis Dementia Rating Scale. A degree of cognitive impairment sufficient for a diagnosis of dementia was determined by cutoff scores and decision rules.

After all evaluations were completed, diagnoses were assigned at a conference attended by the examining research neurol-ogist, neuropsychologist, and physician, who reviewed all available data other than the screening information. If a patient was diagnosed as having dementia, then the cause of the dementia was specified further. Cognitive change in patients without dementia was also subclassified according to its presumed cause.

Definition of a Case

The primary interest of the study is in persons who qualify as patients by virtue of the criterion diagnosis of dementia, covering all subtypes, according to DSM-III-R criteria. In this sample, 72% of criterion dementias had Alzheimer's disease. However, there is a corollary interest in persons classified with dementia in that they are cognitively impaired as assessed independently by screening scales: A minor proportion of these will not accept referral to the Clinical Core for diagnostic evaluation, and a further proportion will be determined by Clinical Core evaluation not to be cases of dementia.

Special techniques for attempting to minimize sociocultural biases in estimating
dementia case rates were based on a 23-item "culture-fair" scale derived from analysis of the other scales in the compendium instrument using NMAP data and mathematical mixture models. The results of the application of the mixture model analyses were compared with the findings from other classificatory systems.

Prevalence cases are persons who were otherwise eligible and were found to be dementia "cases," according to the research procedures, in the 18-month period between December 1st, 1989, and May 31st, 1991, the basic prevalence period, or the 24-month period that extended through November 30, 1991, the extended prevalence period. Persons who were reported and found to be cases prior to the prevalence period were also included if they were known to be living during the prevalence period.

The basic prevalence period was anticipated to be long enough to allow collection of most of the prevalence cases likely to be found through the reporting system of the Registry. Nevertheless, an appreciable number of cases continued to enter the Registry over the next 6 months, far in excess of that expected from incident cases: this incidence suggested that the majority of such newly registered cases would have been deemed dementia-positive if discovered during the prevalence period. Given this ambiguity, additional data were examined to determine whether study findings varied in any important aspect between the two prevalence periods.

Convergence of Findings by Differing Prevalence Periods and Case Definitions

Confidence in the study's findings is keyed to whether there is convergence of those findings by different methods. Accordingly, comparisons were made of 1) case rates observed in the basic and the extended prevalence periods, keeping constant the definitions of "caseness," and 2) case rates, across different definitions of caseness, at the extended prevalence period.

Denominators and Numerators. The denominators, for purposes of calculating prevalence rates, are the number of eligible persons, or subgroups of such persons, in the study target area, as derived from 1990 census data. The numerator is the number of cases identified in the total or subgroup population during the prevalence period. Persons 65 years old or older and self-identified as Latino, African-American, or non-Latino white are in the denominator, and cases are in the numerator, only if 1) they were residents in the target area during the prevalence period; or 2) they were in an institution during the prevalence period and were last residents in the target area.

The numerators were based on 13 different definitions of caseness: 1) The criterion diagnosis was used for those subjects who received a Clinical Core evaluation; 2-6) the criterion diagnosis was estimated for all persons screened by assigning to those screened but not diagnosed, the probability of dementia based on diagnoses of persons with the same screen score. This was done for each of the five conventional screens included in the study; 7-11) for all subjects who were screened, a case was defined by a score of cognitive impairment exceeding the threshold for 90% sensitivity (the reason for choosing a 90% sensitivity level has already been mentioned; furthermore, previous work showed that comparisons between scales can be most readily interpreted if sensitivity levels are kept constant; this definition was applied to each of the five conventional screens); 12) also, caseness was defined in terms of a highly specific threshold score, 8+ on the CARE; and 13) estimated number of dementias were also based on a mathematical mixture model and companion scale statistically designed to be culture-fair. These estimates are, in theory, less biased by sociocultural factors than classifications derived from
threshold values on conventional screening scales.

Sociocultural, Educational, and Age Classification

The term sociocultural is used to refer to racial and ethnic membership, to recognize that these descriptors stand for a complex set of social and cultural factors. Study procedures were modeled on those adopted by the U.S. Census Bureau for self-identification of racial and ethnic membership. An informant was consulted in cases of doubt about the validity of the information obtained from the subject. A history of educational achievement was gathered from the subject or informant. Categories of educational achievement were 0–4 years, 5–11 years, and 12 or more years of education; the category of < 5 years of schooling is of special interest in studies of dementia because illiterate or marginally literate groups have been found to perform so poorly on standardized screening instruments that they have been excluded from some studies. Therefore we have included them as a separate category rather than combine them with the next educational level or exclude a category that is found disproportionately in minority groups. Age groupings were 65–74 years, 75–84 years, and 85+ years.

RESULTS

Yield From Reporting Component

The yield from the various reporting sites is shown in Table 2. Through the last day of the extended prevalence period, 165 persons residing at nursing homes, 693 receiving home care, 484 from medical service sites, and 239 from other community sites (and individuals), were reported and screened: a total of 1,592 persons. An additional 573 persons were reported and not screened; 120 were deceased, 120 were not locatable, 40 spoke a language other than English or Spanish, 215 refused, and 16 lived in buildings considered too dangerous for access.

The yield was greatest from high-risk sites, next from other service sites, and least from non-service sites. The rank order of yields corresponds with the likely frequency of contacts with these sites by persons with dementia, as well as the probable sensitivities of the reporters at these respective sites. Moreover, the attribution of the source of a case was treated as mutually exclusive of other sources; that is, if a case was picked up in one service setting, that case was not credited to a report from another source at a later time.

Table 2 also shows the number of subjects who received a screening and a diagnostic evaluation in the Clinical Core during the basic and extended prevalence periods. Overall, an 84% rate of cooperation in screening persons who were reported as likely cases, were locatable, and were age-, residence-, and language-eligible was achieved through the basic and extended prevalence periods. There was a 73% rate of success in obtaining a diagnostic evaluation in Clinical Core on screen-positive subjects. Subjects screened during the extended prevalence period included 664 Latino, 577 African-American, and 308 non-Latino white persons. Screen-positives were 391, 355, and 162, respectively, for the three groups; diagnosed dementias were 191, 182, and 79, respectively.

Prevalence Rates By Age Groups. These rates are given for background information only. Rates for estimated dementias, based on the mathematical mixture model applied to all persons screened, ranged from 0.022 among the 65–74-year-old group during the basic prevalence period to 0.208 among those age 85 and older during the extended prevalence period. For the same two extreme age categories, rates for persons with criterion diagnoses ranged from 0.016 to
0.171, and rates for screen-positives ranged from 0.041 to 0.286. The overall estimate of dementia for the extended prevalence period was 6.5%, well within the range of estimates from other population-based studies cited in the first section, even though these were based solely on persons who were actually reported and screened; this does not include eligible persons who were reported to the Registry but whom we were unable to screen, and persons not reported to the Registry, who might have been diagnosed with dementia by our procedures. If the estimated rate in the extended prevalence period is projected (assuming that the cases reported as positive but not screened had the same rate of dementia as those reported from similar sites), the overall rate would rise to 7.6%, still within the range of other studies.

There were, as expected, slight increases in absolute rates for each case definition in all study population categories between the basic and extended periods, but no increases were statistically significant; nor were there any significant relative case rate differences between sociocultural groups in either prevalence period. All differences in rates between educational groups were significant for both prevalence periods, however, and in the same direction and order of magnitude. Given this identity of relative rates in the two prevalence periods, all subsequent analyses were based on extended prevalence period data; the latter provide slightly larger numerators.

**Statistical Analyses**

**Univariate Analyses.** Univariate differences in rates of screen-positives, criterion dementias, and estimated dementias among the three sociocultural groups were relatively small and not statistically significant. However univariate differences among the three educational groups were relatively large, and all differences were statistically significant.

**Multivariate Analyses.** The demography of both the NMAP area and the reporting component sample showed non-Latino white subjects to be the oldest and the most educated of the three sociocultural groups, and the Latinos to be the youngest and to have had the least education. Thus there is the potential for confounding of educational, sociocultural, and age effects on rates of dementia. Therefore, comparisons of rates among three subclasses in each of the sociocultural and education categories, were made, controlling for membership in the other category and for age; this orga-

**TABLE 2. Subjects from the various reporting sites: NMAP Registry, basic and extended prevalence periods**

<table>
<thead>
<tr>
<th>Type of Site</th>
<th>Prevalence Period</th>
<th>Total Screened</th>
<th>Screened Positive</th>
<th>Assessed at Core</th>
<th>Criterion Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nursing homes</td>
<td>Extended</td>
<td>165</td>
<td>145</td>
<td>110</td>
<td>89</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>160</td>
<td>141</td>
<td>106</td>
<td>85</td>
</tr>
<tr>
<td>Home health services</td>
<td>Extended</td>
<td>693</td>
<td>379</td>
<td>331</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>646</td>
<td>333</td>
<td>311</td>
<td>107</td>
</tr>
<tr>
<td>Medical/related sites</td>
<td>Extended</td>
<td>484</td>
<td>302</td>
<td>283</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>425</td>
<td>265</td>
<td>268</td>
<td>140</td>
</tr>
<tr>
<td>Non-medical community sites</td>
<td>Extended</td>
<td>239</td>
<td>115</td>
<td>117</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>220</td>
<td>107</td>
<td>113</td>
<td>42</td>
</tr>
<tr>
<td>Site not listed</td>
<td>Extended</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>11</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Totals</td>
<td>Extended</td>
<td>1,592</td>
<td>943</td>
<td>844</td>
<td>461</td>
</tr>
<tr>
<td></td>
<td>Basic</td>
<td>1,462</td>
<td>869</td>
<td>801</td>
<td>435</td>
</tr>
</tbody>
</table>
Relative Rates of Dementia

nizes data into a total of 27 cells.

Comparisons were made only where both groups being compared had denominators greater than 100. Denominators were large enough to permit paired comparisons between 18 different sociocultural groups, 17 educational groups, and 20 age groups. Denominators were too small for comparisons involving Latinos age 85 and older with 12 or more years of school completed, African-Americans age 85 and older with less than 5 years of school, and non-Latino white subjects with less than 5 years of school at all three age levels.

Comparing Relative Rates in Subgroups Using Different Criteria for Caseness. Chi-square tests were computed for differences in prevalence rates between each pair of the 27 cells defined by sociocultural, educational, and age group membership, with exclusions for inadequate cell sizes; applying each of the 13 case definitions in turn. In general, the results of comparisons of case rates among subclasses of socio-culture, education, or age were similar, regardless of which of the 13 different case definitions was applied; details are noted below.

Sociocultural Group Comparisons. Only 3 of the 18 comparisons among sociocultural group pairs within same age and educational categories resulted in statistically significant differences across all 13 definitions of caseness. Ten of the 18 sociocultural group comparisons failed to reach statistical significance in any of the 13 definitions of caseness. Two of the significant comparisons across all definitions of caseness were the result of especially high rates among African-Americans age 75–84 with 5–11 years of education, and the third resulted from higher rates among non-Latino white subjects compared with African-Americans age 85 and older with 12 or more years of education.

Education Group Comparisons. In contrast to the results for the sociocultural comparisons, 7 of the 17 educational comparisons were statistically significant across all 13 definitions of caseness, and only 6 failed to reach statistical significance in any of the 13 definitions of caseness. All educational group comparisons that reached statistical significance were in the expected direction, with lower rates among groups with higher levels of education within the same sociocultural and age group categories. Among the African-American and Latino groups, every one of the comparisons of non-adjacent levels of education reached statistical significance across nearly all 13 definitions of caseness; this comparison was not possible for the non-Latino white subjects because the cell for 0–4 years of education was of insufficient size. In comparisons of adjacent levels of education, the Latino group showed significant differences principally between the 0–4-year and 5–11-year education groups; for the African-American group the differences were mainly between 5–11 and 12+ years of education. Non-Latino white subjects showed significant differences between 5–11 and 12+ years of education, although the level of statistical significance was much weaker than for African-Americans.

Table 3 shows the educational comparisons; to simplify illustration of these data, a selection from the list of case definitions was made to reflect similarities and differences between definitions in the comparisons of case rates.

Age Group Comparisons. Age differences in rates of dementia and cognitive impairment are well known and are presented here to give perspective to the number and size of differences noted in the educational comparisons. Differences in prevalence rates among age groups within the same sociocultural and education group categories were statistically significant for 16 of the 20 paired comparisons across all 13 definitions of caseness. Only one comparison, between Latinos age 75–84 and Latinos age 85 and older with less than 5 years of
TABLE 3. Comparisons of prevalence rate differences between pairs of education groups within age levels and sociocultural groups under various definitions of caseness

<table>
<thead>
<tr>
<th>Definition of Caseness</th>
<th>Numbers in Denominators</th>
<th>Criterion Diagnosis</th>
<th>High Sensitivity CARE</th>
<th>High Specificity MMSE</th>
<th>Mathematical Model</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Numbers in Denominators</td>
<td>Diagnosis + CARE</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>CARE</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>MMSE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>CARE Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–4 vs. 5–11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latino</td>
<td>842 vs. 1,360</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65–74</td>
<td>336 vs. 575</td>
<td>C</td>
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<tr>
<td>75–84</td>
<td>139 vs. 108</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>182 vs. 837</td>
<td>C</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>65–74</td>
<td>110 vs. 459</td>
<td>C</td>
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<td></td>
<td></td>
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<tr>
<td>5–11 vs. 12+</td>
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<td>1,360 vs. 448</td>
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<tr>
<td>65–74</td>
<td>575 vs. 203</td>
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<tr>
<td>African-American</td>
<td>837 vs. 946</td>
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<tr>
<td>75–84</td>
<td>459 vs. 555</td>
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<td>0–4 vs. 12+</td>
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<td>842 vs. 448</td>
<td>C</td>
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<td>336 vs. 203</td>
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<tr>
<td>75–84</td>
<td>182 vs. 946</td>
<td>B</td>
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<tr>
<td>African-American</td>
<td>110 vs. 555</td>
<td>C</td>
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<tr>
<td>75–84</td>
<td>182 vs. 946</td>
<td>B</td>
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Note: All significant differences indicate that the lower education group has a higher prevalence rate. All groups with denominators less than 100 cases are not shown here.

A = P < 0.05; B = P < 0.01; C = P < 0.001.

Schooling failed to reach statistical significance in any of the 13 definitions of caseness. Four of the five conventional cognitive screen scales, when weighted and combined with actual diagnoses, resulted in significant differences among 19 of the 20 comparison pairs. All age group differences were in the expected direction, with higher rates in older groups within similar education and sociocultural categories.

Regression Analyses. A series of multiple regression analyses were run as a check on the study findings, entering sociocultural group, education, and age as independent variables, and dementia status, according to the various case definitions, as the dependent variable. Sociocultural membership was not significantly related to case rates, but education and age were. These results were verified by separate regressions for each of the three sociocultural groups.

DISCUSSION

The large size of the sample, the stratification by sociocultural membership, and the unusually large number of subjects given a full diagnostic evaluation are basic strengths of this study; yet certain of the 27 cells formed by intersections of sociocultural, educational, and age groupings were of insufficient size for full analysis. For example, we
were forced to omit reference to the effects of less than 5 years of education on relative prevalence rates of dementia cases in non-Latino white subjects. Moreover, unequal sizes of cells could have affected the relative strengths of the statistical associations that were found.

The Registry is bound, to a greater or lesser degree, to fall short of capturing every case in the study target area. Two consequences may follow: 1) absolute error: observed rates will be lower than actual rates; 2) relative error: the size of the discrepancy between observed and actual rates will differ across the comparison groups. In this article, attention is principally directed at gauging relative error, because the main interest is in relative case rates in the sociocultural and educational groups. Particular attention must be given to relative loss of potential cases from the higher educational groups because that could explain, to an uncertain degree, the finding of higher case rates among the lower educational groups.

The possibility that differential rates of cases between comparison groups might be caused by relatively incomplete collection of cases was explored by checking the concordance of findings from the basic and extended prevalence periods. Because efforts at case collection were sustained over both time periods, the proportion of additional cases (dementia patients) in the extended prevalence period should be less pronounced in a group where the pool of potential cases is being exhausted, as opposed to a group where the pool is relatively incompletely tapped. If that had occurred, the ratios of case rates between comparison groups would have changed across the prevalence periods. In fact, intergroup comparisons were concordant between basic and extended prevalence periods.

Selective biases arising from failures in reporting of cases, if any, would be revealed by comparisons between the results of the Reporting and the Survey Components of the Registry. The Survey Component will provide information on the number and types of subjects missed by the Registry Reporting Component. However, reporting biases are not likely to have inflated the case rates in the lower educational groups. The rates of false positive reports were about equal across the educational groups, and false negative reports were more common among the lower than the higher educational groups. Attrition caused by refusals between the reporting and screening steps, among subjects who were alive and locatable, was a modest 16%.

Only 27% of those referred to Clinical Core did not cooperate with this procedure. There was no interactional effect among educational achievement, cognitive score, and lack of cooperation with the Clinical Core evaluation.

The range of case definitions and the two prevalence periods were chosen so as to reveal findings that transcended the timing and types of assessment and the sets of classificatory criteria, on the grounds that methodological artifacts would thereby be ironed out. This strategy is dependent on the extent to which all appropriate indicators are examined. The universe of indicators included here is larger than usual but does not include biological, functional, or longitudinal indicators: these data are being gathered in the ongoing NMAP studies.

The findings of this study converge on certain conclusions: 1) With education and age controlled, very few statistically significant differences in dementia rates between sociocultural groups were found, regardless of case definition. No sociocultural group was found to have consistently higher or lower rates than any other across age, education groups, and case definitions; 2) With sociocultural membership and age kept constant, close to half of the paired rate comparisons between education groups were statistically significant: the paired cell representing lower education always showed higher rates. The various case definitions were generally concordant as to which paired comparisons were significantly different. Educational effects on rates
were about equal for the African-American and Latino groups, but the former showed differences across the boundary between 0-4 and 5-11 years of education, whereas the latter showed differences between 5-11 and 12+ years of education. Educational effects were weakest for the non-Latino white subjects, although the cell for 0-4 years of education was of insufficient size for analysis; 3) The level and number of significant differences in case rates attributable to education were much greater than those seen for sociocultural membership, and somewhat less than those seen for age effects.

**Implications of the Findings**

There has been considerable discussion in recent years as to whether differences reported in rates of dementia between minority groups and non-Latino white subjects are as real as the differences between age groups, or whether they are largely the result of cultural biases in screening instruments or other means of defining cases. However, in this study, when educational and age differences were taken into account, only a very few differences that were statistically significant remained between the case rates in Latinos, African-Americans, and non-Latino white subjects, and these differences were inconsistent as to which sociocultural group had higher rates.

Nevertheless, these data strengthen the argument that there are real differences in prevalence rates of dementia between educational groups, even when sociocultural membership and age are kept constant. Especially persuasive is the robustness of the findings across multiple case definitions, spanning diagnosis, various cognitive screens, high sensitivity, and high specificity thresholds, and a mathematical culture-fair technique. Also, many of the selective biases that might inflate case rates in lower educational groups were ruled out; and interviews were conducted in the preferred language of the subject. The educational effects were strong and consistent—only somewhat less powerful than the well-known effect of age on rates of dementia.

The possible mechanisms that might account for a spurious or a real relationship between educational achievement and rates of dementia or cognitive impairment were reviewed 15 years ago \(^4\) and have been the subject of further speculation more recently. \(^42,43\) Working hypotheses about these mechanisms should now concentrate on a real rather than a spurious relationship; hypotheses should take account of the variation found in this study across the three sociocultural groups in the strength and the timing of the educational effect. In framing these hypotheses, it is not necessary that the relationship with educational achievement be rationalized for all occurrences of dementia or cognitive impairment, just for the excess rates of these conditions at certain levels of education.

There are three broad types of competing hypotheses, which we have labeled 1) selective, 2) associational, and 3) educational.

Selective Hypothesis: A predisposition to cognitive impairment may be present in some persons from early in childhood, leading to suboptimal coping with intellectual challenges. Such challenges are particularly severe for sociocultural groups faced with barriers that impede access to educational opportunities. To overcome those barriers requires optimal coping ability. If predisposed persons dropped out of the educational stream, we would expect to see a relationship between lower educational achievement and rates of dementia. The barriers may have come very early in the educational process for this Latino cohort, and at the stage of completing high school for the African-American cohort. Non-Latino white persons are probably not confronted, during school years, by educational barriers that test coping ability to the same degree as are the minority groups; hence the weaker effect of education among non-Latino white subjects in selecting out those
Relative Rates of Dementia

with reduced coping ability.

Associational Hypothesis: Early termination of education is a marker of other life-style characteristics that may increase risk of dementia or cognitive impairment through actions at any of several stages of life. Candidate life-style characteristics might include poor nutrition, specific dietary habits, exposure to trauma or a toxic environment, alcohol or drug abuse, inadequate health care, or repeated physical and psychosocial stress. An unfavorable lifestyle leads also to dropping out of the educational process when the demands on personal and family resources rise to a critical point; these factors could tie in with the observed relationships in this study.

Educational Hypothesis: A direct effect of education per se is posited as reducing vulnerability to dementia or cognitive impairment. Education is viewed as shaping the neurobiological structure or dynamics so as to improve cognitive reserves, efficiency, and coping capacity, thus resisting or compensating for deteriorative processes. Such educational influences would act at critical stages of neurobiological development or maintenance. Beneficial effects earlier in life might be extended and magnified over time through the advantages obtained from better education in choosing intellectually stimulating occupational and leisure pursuits, and through enhanced ability to solve the problems of adaptation related to aging.

If parsimony gives strength to an explanation, then the selective hypothesis best fits the findings of this study. However, it is the most radically new hypothesis and must therefore be treated skeptically. Nevertheless, the hypothesis is worthy of further examination. Investigations into the reasons for the emergence of dementia and cognitive impairment in certain educational groups later in life should cover details of the events surrounding education in childhood and adolescence. Genetic markers of vulnerability to dementia and cognitive impairment should be examined for their influence on educational achievement. Agents and incidents known or suspected to compromise neurobiological status prior to the time of entering school, or to inhibit educational achievement, should be reexamined in relation to the emergence of manifest cognitive deterioration in later life.

Numerous alternatives might serve to mediate between life-style characteristics and cognitive consequences. This hypothesis is defended principally by complexity and vagueness; its productivity is limited because it is difficult to devise a research design to refute it. Similar objections should be leveled at explanations that embody a mix of hypotheses.

Although the educational hypothesis is the most favored in the literature, it is not readily reconciled with the present findings. Older people with 0–4 years of education clearly have had less education than those with 5–11 years, yet among the African-Americans, this lower education group is not significantly worse off cognitively than the higher educated group. Correspondingly, Latinos with 5–11 years of education do not have significantly increased rates of dementia or cognitive impairment than Latinos with 12+ years of education. In non-Latino white subjects, the educational effects are generally weak. These findings do not support a straightforward relationship between amount or quality of education and increased rates of cognitive impairment or dementia. As yet, there are no proposed modifiers of the educational hypothesis that would accord with the present findings.

We are not aware of either replication or contradiction of this study's findings in other samples representative of older populations. That would require case ascertainment of adequate numbers of subjects drawn from an older general population, with sufficient representation of each relevant education and sociocultural group, including the 0–4-years-of-education group, which has rarely been identified and studied in this way in the United States. These findings
(pending verification or refutation) call for a revision of the scope and emphases of the prevailing hypotheses about the relationship between educational achievement and rates of cognitive impairment and dementia.

Note: A description of the compendium instrument and mathematical mixture model can be obtained by writing to Dr. Robert Golden at the Kennedy Center, Albert Einstein College of Medicine, Biometrics Unit, 1300 Morris Avenue, Bronx, NY 10461.

The late Dr. W. Edwards Deming designed the sampling plan for the investigation, and The Bureau of Data Management and Strategy of the Health Care Financing Administration generously provided tape files of Medicare beneficiaries for the North Manhattan Aging Project (NMAP). We also thank Mabel Bolivar for her efficient coordination of all fieldwork.

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