Most reports of the decrease in age-adjusted coronary heart disease (CHD) are based on databases with upper age cut-offs that exclude approximately half of the events. We report changes in rates of acute myocardial infarction (AMI) and of out-of-hospital coronary death between 1986 and 1996 among New Jersey residents ≥15 years old. Data on patients discharged with the diagnosis of AMI from nonfederal acute care hospitals in the state (n = 270,091) and all records in the New Jersey death registration files with CHD (n = 172,175) listed as the cause of death from 1986 to 1996 (total study n = 442,266) were analyzed. The rate of hospitalized AMI cases in the state remained essentially unchanged during these 11 years, whereas in-hospital and 30-day case fatality among all age groups and both sexes declined. Age-adjusted CHD rates showed a decrease in fatal events, a smaller decrease in total events, and a slight increase in nonfatal events. The proportion of fatal CHD events occurring out-of-hospital decreased especially among men. The median age at occurrence of events increased by 1 year. Despite a decrease in CHD mortality, the rate of nonfatal events increased, especially among persons ≥75 years old. Thus, the decrease in age-adjusted CHD mortality is not all due to treatment and true prevention of CHD, but the disease simply occurs at an older age.

The detailed methods used in MIDAS have been previously published. For this study, MIDAS included 11 years of claims data (MIDS/UB82/UB92) on all New Jersey residents who were discharged with the diagnosis of AMI (International Classification of Diseases, 9th Edition [ICD-9], CM code 410 in any position) from nonfederal acute care hospitals in New Jersey (n = 286,569) and all records in the New Jersey death registration files with CHD (ICD-9 CM codes 410 to 414, or 429.2) as the underlying cause of death (n = 214,517) from 1986 to 1996. Of these, 44,703 cases died in hospital after admission for AMI. Thus, the total fatal and nonfatal CHD events included in this study is 456,383. The confidentiality of records was maintained and the State of New Jersey Institutional Review Board approved the study.

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Exclusions: CHD events among persons <15 years of age were excluded, as were events in persons who were not New Jersey residents (approximately 5% of the events)—these were mostly persons from New York (2.2%) and Pennsylvania (1.1%)—leaving 442,266 cases on which the present analysis is based. Inclusion of the cases hospitalized in Pennsylvania and New York in the analyses did not appreciably change the results presented in this study. The total number of "out migration" cases corresponds to approximately 4.1% of the cases as estimated by auditing of 738 AMI deaths using the National Death Index. Both first events and recurrent events are included in the analysis. First hospitalizations comprised 86.5% of the total in the 1986 to 1987 MIDAS pilot dataset.

Data auditing: To verify the presence or absence of AMI and the accuracy of the information included in the database, chart review was performed on a random sample of 669 charts from the 1986 to 1987 data, comparing the information in MIDAS to that written in the hospital charts. A 2-stage random sampling strategy was used to effect equal probability of each case being selected for the audit. First, a sample of 12 hospitals were picked at random with probability proportional to the number of annual AMI admissions. Second, the charts to be audited were selected from all discharges with a 410 diagnostic code from these hospitals by simple random sampling without replacement. A sample of 700 charts was considered appropriate; of these, 31 were not audited because they represented transfers or could not be found, leaving 669 events. The same number of charts chosen by the same method was audited from the 1994 database. Charts without ICD-9 code 410 were not audited. Charts were classified as definite AMI, probable AMI, recent AMI, or no AMI. Clinical and enzyme data and electrocardiograms available in the chart were examined by 2 members of the investigating team using criteria modified from the Beta Blocker Heart Attack Trial, based on symptoms, enzyme levels, and electrocardiographic evidence. The accuracy of the diagnosis of AMI in hospitalized patients was similar in 1986 and 1994. Evidence of definite or probable infarction was found in 83.7% of the audited 1986 charts and in 83.0% of the 1994 charts; 9.4% of the charts in 1986 and 10.2% in 1994 did not include evidence of infarction. A recent myocardial infarction, but not an AMI, was seen in 6.9% of the charts in 1986 and 6.8% in 1994. The accuracy of diagnosis (definite or probable) was slightly lower in older patients: 78.8% in those >75 years old and 82.5% in those <75 years old. Vital status audit was performed by linkage to New Jersey death registration files using an automated record linkage system, Automatch (Datatrac, Inc., Silver Spring, Maryland). The sensitivity of the MIDAS database for in-hospital mortality was 96.8% and the specificity was 100%. The current database does not include hospitalization linkage to allow study of incidence.

Statistical analysis: The analysis of event rates from 1986 to 1996 was performed using 3 age strata: 15 to 64 years, 65 to 74 years, and ≥75 years. Direct age adjustment was by 10-year age groups against the 2000 standard United States population. All statistics were determined using SAS software, version 6.12 (SAS Institute Inc., Cary, North Carolina). Average annual percentage changes were computed by fitting a Poisson regression model.
RESULTS

The total population in New Jersey increased 5% from 7,622,150 in 1986 to 8,001,850 in 1996. Population growth was higher among men compared with women, especially among those aged ≥75 years (36% increase in men compared with a 26% increase in women).

Age-adjusted CHD rates showed a decrease in fatal events, a smaller decrease in total events, and an increase in nonfatal events (Figure 1). Fatal events included out-of-hospital CHD deaths and AMI deaths in the hospital. Nonfatal events included patients with AMI who were discharged. The age-adjusted rate for AMI hospitalization remained stable, whereas the out-of-hospital death rate decreased (Figure 1). The aggregate number of fatal and nonfatal CHD events in the state remained relatively unchanged at approximately 40,000 events per year during the 11 years under study (data not shown). The rate of fatal events decreased (−2.3% per year, 95% confidence intervals [CI] −3.0 to −1.7, p < 0.0001), but the rate of nonfatal events had an increase (2.0% per year, 95% CI 1.5 to 2.4, p < 0.0001), including among those who were ≥75 years old (1.9% per year, 95% CI 0.8 to 2.9, p = 0.0004). Similar trends were observed in men and women. The median age at the time of CHD events increased from 68 to 70 years in men and from 78 to 79 years in women.

The age-specific rate of all CHD events decreased especially in the older age group (Figure 2). The rate of fatal CHD events per 1,000 persons decreased in both sexes and all 3 age groups (Figure 2). In contrast, the age-specific rate for nonfatal CHD events increased, especially in the older age groups (Figure 2).

The age-specific rate of hospitalized AMI remained essentially unchanged from 1986 to 1996, whereas in-hospital case fatality decreased in all 3 age groups (Figure 3). The decrease in case fatality accompanied a decrease in the length of hospital stay (from 11.9 ± 4.5 days in 1986 to 8.1 ± 4.5 days in 1996). Thus, a significant part of the decrease in case fatality of persons hospitalized for infarction (30.2% decrease from 1986 to 1996) was due to earlier discharge, displacing some deaths to the outpatient setting. At 30 days after admission, mortality of hospitalized AMI was decreased by 17.3%.

The decrease in the fatal event rate was related both to a decrease in out-of-hospital coronary deaths and to a lower case fatality of hospitalized AMI. Appreciable changes in the proportions of fatal and nonfatal CHD events occurred between 1986 and 1996 (Figure 4). The percentage of events that were nonfatal (survived to discharge) increased from 39% to 48% in women and from 50% to 61% in men, whereas the percentage of in-hospital fatal events decreased from 29% to 21% of events in women and from 22% to 17% in men. The percentage of CHD events that were out-of-hospital deaths decreased from...
28% to 22% in men, although there was no appreciable change in women.

DISCUSSION

A decrease in age-adjusted CHD mortality has been previously reported.\(^1\)\(^-\)\(^7\) However, in this study, an increase in nonfatal events was observed, especially among the elderly. In previous studies, upper age limit cutoffs of 64 years in MONICA\(^1\)\(^1\) and 75 years in ARIC and the Minnesota Heart Survey\(^1\)\(^0\),\(^1\)\(^2\) resulted in exclusion of a significant number of coronary events from the analyses. Applying the MONICA upper age cutoff of 64 years to myocardial infarctions in the State of New Jersey would exclude 83% of the events in women and 61% of the events in men. This may account for the lack of increase in nonfatal events reported in MONICA. The decrease in the number of fatal events is consistent with previous studies and evident in all age groups, including the oldest one. This occurred despite an increase in size and age of the population. Therefore, age-specific death rates and age-adjusted CHD death rates showed significant decreases (33% in 11 years for age-adjusted rates). Decreases in both out-of-hospital cardiac death, and AMI in-hospital case fatality and 30-day case fatality contributed to the reduction in the number and rate of fatal events.

The increase in number of nonfatal events highlights the need for facilities and procedures for the care of patients with CHD, and that despite improvements in CHD prevention and treatment, CHD remains an important cause of morbidity as well as mortality.\(^1\)\(^5\) Limitations of this study are that information on potential determinants of the observed trends is not available, that it does not include data on incidence, and that it is based on administrative data.\(^1\)\(^6\) However, a random subset of the data of hospitalized patients with AMI was audited and found to have good accuracy and the information in death certificates was reported to be valid in most of the cases.\(^1\)\(^7\) In contrast, charts without AMI diagnosis were not audited. In addition, the validity of the diagnosis of AMI is weaker in older persons and may in part account for the increased rate seen in the present study. However, the difference of the accuracy of all diagnoses between those \(\geq 75\) years old and younger patients in the audited set was small (82.5% vs 78.8%).

The observations presented here on 442,266 records from the State of New Jersey without an upper age limit give a more complete picture of the occurrence and mortality of CHD than did the previous studies with upper age cutoffs (e.g., Minnesota Heart Survey, MONICA, and ARIC\(^1\)\(^0\),\(^1\)\(^2\)). Similar data (with no upper age limit) were also reported from the Worcester Heart Attack Study on 5,270 AMIs that occurred between 1975 and 1995 in the Worcester, Massachusetts metropolitan area.\(^6\) The Worcester study and the information presented here, in conjunction with the other reports mentioned above, indicate that in the United States CHD mortality has decreased due to both a decrease in prehospital CHD death and a more pronounced decrease in case fatality of hospitalized AMI. Conversely, the number and rate of non-
fatal events has increased, especially among those ≥75 years old. Thus, in this population, the decrease in age-adjusted rate of CHD is not all due to true prevention but also to the occurrence of the disease at an older age. This carries important clinical (e.g., increased prevalence of heart failure), 18 health care planning, and economic implications, and underscores the need for research into methods for transferring current knowledge to clinical practice as well as for more basic and clinical research on the prevention of CHD.

Acknowledgment: We wish to thank Kenneth O’Dowd, PhD, and the New Jersey Department of Health and Senior Services for his advice on MIDAS and Joseph Naus, PhD, of Rutgers University for his help in structuring the sampling strategy of the audited subset.