Hospital Controls versus Community Controls: Differences in Inferences Regarding Risk Factors for Hip Fracture

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In case-control studies using cases identified from persons admitted to hospitals, two types of controls are most often used: persons from the communities served by the hospitals and persons admitted to the same hospitals as those to which the cases were admitted. It is often unclear which is the more appropriate choice, and whether the use of one or the other type of control group will lead to biased conclusions. The purpose of the present analysis was to determine whether the choice of hospital controls versus community controls would influence conclusions regarding risk factors for hip fracture. Cases (n = 425), hospital controls (n = 312), and community controls (n = 454) were drawn from a case-control study of risk factors for hip fracture in women. Study participants were white and black women aged 45 years or older and living in New York City or Philadelphia, Pennsylvania, who were selected between September 1987 and July 1989. Using community controls but not hospital controls, investigators would have concluded that having a fall during the previous 6 months, current smoking, and moving during the previous year were associated with an increased risk of hip fracture. Associations of hip fracture risk with stroke and prior use of ambulatory aids were stronger using community controls, but associations with estrogen use and body mass index were not influenced by choice of control group. Community controls were quite similar to representative samples of community-dwelling elderly women, whereas hospital controls were somewhat sicker and more likely to be current smokers. The authors conclude that community controls comprise the more appropriate control group in case-control studies of hip fracture in the elderly. Am J Epidemiol 1997;145:653-60.

In order to draw valid inferences from case-control studies, researchers should select controls that are representative of the population from which cases are drawn with respect to exposures of interest. For many diseases, cases are identified from hospital admissions or discharges. When cases are identified in this manner, the goal is to choose a control group consisting of individuals who would have been treated at the same hospitals had they developed the disease of interest (1). The intent is to choose a control group in which the distribution of exposures is a good approximation of the distribution of exposures in the source population from which the cases arose. To achieve this goal, two types of controls are most often used: persons from the communities served by the hospitals and persons admitted to the same hospitals as those to which the cases were admitted.

When cases are ascertained from all or most hospitals serving a defined geographic area, a probability sample of unaffected individuals from the population of that geographic region can be used to enhance the likelihood that cases and controls come from the same source population. The major problem with this approach is that response rates among community controls can be quite low (2, 3), and if there are differences in exposure rates among those who do and do not participate, study results will be biased. An alternative approach is the use of hospital controls. However, if the exposures of interest are associated with the diseases leading to hospitalization among the controls, the distribution of these exposures will not be the same as that in the source population, leading to biased results.

The purpose of the analyses presented here was to compare the distributions of exposures in two control groups, one consisting of hospitalized patients and the other of individuals from the general population, and to examine the extent to which use of only one of these control groups would have altered conclusions regard-
ing risk factors. Data for these analyses were obtained from a case-control study which was conducted to identify risk factors for hip fracture in women aged 45 years or more.

We are aware that in a study of hip fractures, which almost always lead to hospitalization (4–6), a population control group might, with little question, be considered more appropriate than a hospital control group. We are concerned here, however, with the general question of selection factors affecting two different kinds of control groups sampled from a frail, elderly population.

**MATERIALS AND METHODS**

Details on the study’s design are given elsewhere (7, 8). Briefly, cases consisted of white women and black women aged 45 years or more with a radiologically confirmed diagnosis of first hip fracture who were selected from 30 participating hospitals in New York City and Philadelphia, Pennsylvania, between September 1987 and July 1989. Hospital controls consisted of women hospitalized on either a surgical ward or an orthopedic ward who had not previously had a hip fracture or hip replacement. Toward the end of the study, the protocol was amended and controls were also drawn from medical wards. These controls (n = 89) were excluded from the present analyses. Hospital controls were frequency-matched to cases according to age (within 10-year strata), hospital, and race. Admission diagnoses among hospital controls included cardiovascular disease or peripheral vascular disease, digestive disorders, cancers, osteoarthritis or other musculoskeletal disorders, and infections.

The second control group consisted of individuals living in the communities where the cases lived. For cases aged 65 years or more (n = 374), community controls were randomly selected from Health Care Financing Administration lists of Medicare recipients and were frequency-matched to cases according to age, race, and zip code. For cases under 65 years of age (n = 51), community controls were selected by random digit dialing and were frequency-matched according to age, race, and telephone prefix. Response rates were 63 percent for cases, 57 percent for hospital controls, and 47 percent for community controls.

A proxy respondent was interviewed if the woman selected was medically incapacitated or cognitively impaired. Cognitive impairment was considered present when a woman made four or more errors on a modified version of the Kahn-Goldfarb Mental Status Questionnaire (9).

**Data collection**

In-person interviews were conducted by trained interviewers using a standardized questionnaire to ask respondents about lower-extremity function, vision, medical and surgical history, use of medications before hospitalization, dietary and reproductive history, height, weight, smoking, alcohol consumption, symptoms related to balance and gait, and sociodemographic information. Cases and hospital controls were generally interviewed in the hospital. Community controls were generally interviewed in their homes.

**Measures**

Only those measures used in the present analyses are described below.

*Lower-limb function prior to fracture.* Respondents were asked whether they needed assistance in performing four activities related to lower-limb function: walking across a small room, getting out of a chair, walking outside on level ground, and walking up or down stairs. Their scores were calculated as the total number of tasks for which assistance was needed. Respondents who had totally confined to a bed or chair were given a score of 5. A respondent’s degree of physical impairment was determined separately by assessing the need for ambulatory aids, such as a cane or walker. Respondents were also asked whether they had had problems with ambulation, balance, or lower-limb sensation in the 6 months prior to fracture (cases) or in the previous 6 months (controls).

*Health conditions.* Respondents were asked whether a doctor had ever told them that they had diabetes mellitus, stroke, cancer, Parkinson’s disease, epilepsy, kidney disease, or a heart attack. Each condition was examined individually; in addition, a summary measure indicating the presence of any one of these conditions, except for stroke, was created. Stroke was examined separately. Respondents were also asked about their history of glaucoma and cataracts. If a respondent said she had cataracts and still had them at the time of the study, she was classified as having cataracts. Respondents who reported that they could not see well enough (with glasses or contact lenses) to recognize a friend across the room were classified as having poor vision.

*Health behaviors.* For assessment of alcohol use, respondents were asked about their alcohol consumption during the previous year and their usual frequency of consumption as adults. They were classified as light, moderate, or heavy alcohol drinkers in accordance with the categories used in the Framingham Study (10). Respondents were also queried about usual cigarette smoking throughout their lives and during the...
previous year. Respondents' self-reported current height (in meters) and weight (in kilograms) were used to calculate body mass index (weight/height^2).

**Medication use.** Respondents were asked whether they had ever received postmenopausal estrogen therapy, and, if so, how recently and for how long. They were also asked about the frequency and duration of thiazide diuretic use.

**Statistical analysis**

To compare hospital and community controls with respect to possible risk factors for hip fracture, we calculated odds ratios. Unconditional logistic regression was used to adjust for the potentially confounding effects of age, education, and race. Adjustment for age was done using a continuous variable together with a set of indicator variables to account for the age strata used in the frequency matching. Analyses were initially carried out separately by race (white/black) and by the reporting status of the respondent (self vs. proxy). Since results were very similar in all subgroups, the data were combined. To examine whether the use of the different control groups would have led to different conclusions regarding risk factors for hip fracture, we compared the case group with each control group with regard to selected variables using conditional logistic regression, matching on age, race, and hospital (hospital controls) or zip code (community controls aged ≥65 years) or telephone prefix (community controls aged <65 years), and adjusting for age (in years, within the 10-year age categories) and other variables thought to affect risk of hip fracture.

To determine whether the community controls in the present study were similar to other community-dwelling individuals at risk of hip fracture, we compared our control group with women participating in the EPESE Study [Established Populations for Epidemiologic Studies of the Elderly] (11) at the New Haven, Connecticut, and East Boston, Massachusetts, sites. These are representative samples of individuals aged 65 years and over living in four US locations in 1982. We chose the EPESE women as a comparative group because their response rates were reasonably high (80-84 percent) and because a number of the questions asked in the EPESE Study were similar to those on our questionnaire. We examined data from only the New Haven and East Boston sites because we thought that respondents from these two northeastern cities would be most similar to our respondents from New York and Philadelphia.

| TABLE 1. Demographic characteristics of hospitalized women with hip fractures and two different control groups, 1987–1989 |
|---|---|---|---|
| | Cases (n = 425) | Hospital controls* (n = 312) | Community controls (n = 454) |
| Age (years) | | | |
| 45–54 | 13 | 13 | 12 |
| 55–64 | 38 | 30 | 31 |
| 65–74 | 84 | 73 | 99 |
| 75–84 | 167 | 133 | 176 |
| 85–103 | 123 | 63 | 136 |
| Marital status | | | |
| Married | 87 | 67 | 98 |
| Widowed | 264 | 182 | 273 |
| Separated/divorced | 47 | 29 | 49 |
| Never married | 47 | 33 | 34 |
| Education (years) | | | |
| 0–8 | 135 | 120 | 143 |
| 9–11 | 91 | 59 | 84 |
| 12 | 101 | 62 | 104 |
| ≥13 | 89 | 67 | 119 |
| City | | | |
| Philadelphia, Pennsylvania | 251 | 193 | 281 |
| New York, New York | 174 | 119 | 173 |
| Race | | | |
| White | 204 | 182 | 218 |
| Black | 221 | 130 | 236 |
| Proxy interview | 106 | 27 | 34 |

* Controls hospitalized on medical wards were excluded.
TABLE 2. Adjusted odds ratios comparing the odds of having various attributes in hospital controls versus community controls, 1987–1989

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Adjusted OR* †</th>
<th>95% CI†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower-limb dysfunction (yes/no)</td>
<td>1.52</td>
<td>1.06–2.18</td>
</tr>
<tr>
<td>Use of ambulatory aids during the previous 6 months</td>
<td>1.24</td>
<td>0.86–1.77</td>
</tr>
<tr>
<td>Limp during the previous 6 months</td>
<td>1.02</td>
<td>0.73–1.42</td>
</tr>
<tr>
<td>Dizziness during the previous 6 months</td>
<td>1.15</td>
<td>0.83–1.60</td>
</tr>
<tr>
<td>Balance problems during the previous 6 months</td>
<td>1.62</td>
<td>1.13–2.32</td>
</tr>
<tr>
<td>Fall during the previous 6 months</td>
<td>1.02</td>
<td>0.73–1.42</td>
</tr>
<tr>
<td>Numbness during the previous 6 months</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>1.92</td>
<td>1.15–3.20</td>
</tr>
<tr>
<td>Parkinson’s disease</td>
<td>0.53</td>
<td>0.10–2.81</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1.83</td>
<td>1.23–2.73</td>
</tr>
<tr>
<td>Heart attack</td>
<td>0.99</td>
<td>0.58–1.45</td>
</tr>
<tr>
<td>Cancer</td>
<td>2.82</td>
<td>1.89–4.20</td>
</tr>
<tr>
<td>Epilepsy</td>
<td>2.18</td>
<td>0.61–7.74</td>
</tr>
<tr>
<td>Kidney disease</td>
<td>2.01</td>
<td>0.92–4.40</td>
</tr>
<tr>
<td>Cataracts</td>
<td>0.94</td>
<td>0.67–1.30</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>0.88</td>
<td>0.55–1.40</td>
</tr>
<tr>
<td>Poor vision</td>
<td>0.57</td>
<td>0.27–1.20</td>
</tr>
<tr>
<td>Hysterectomy</td>
<td>1.17</td>
<td>0.85–1.61</td>
</tr>
<tr>
<td>Ovary removal</td>
<td>1.01</td>
<td>0.71–1.44</td>
</tr>
<tr>
<td>Summary measure of Illness‡</td>
<td>2.23</td>
<td>1.64–3.02</td>
</tr>
<tr>
<td>Weekly alcohol consumption (no. of drinks)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2–6 vs. 0–1</td>
<td>1.37</td>
<td>0.19–9.77</td>
</tr>
<tr>
<td>≥7 vs. 0–1</td>
<td>0.83</td>
<td>0.44–1.54</td>
</tr>
<tr>
<td>Use of estrogen for 1 year or longer</td>
<td>1.52</td>
<td>0.92–2.51</td>
</tr>
<tr>
<td>Use of thiazide diuretics§</td>
<td>1.29</td>
<td>0.89–1.68</td>
</tr>
<tr>
<td>Body mass index#</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;21.3</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>21.3–23.6</td>
<td>1.16</td>
<td>0.67–2.01</td>
</tr>
<tr>
<td>23.7–25.9</td>
<td>0.87</td>
<td>0.51–1.48</td>
</tr>
<tr>
<td>26.0–29.9</td>
<td>1.90</td>
<td>1.11–3.24</td>
</tr>
<tr>
<td>≥30.0</td>
<td>1.69</td>
<td>0.99–2.92</td>
</tr>
</tbody>
</table>

(Table 2 continues)

RESULTS

Characteristics of cases and controls are shown in table 1. Sixty-six percent of the participants were aged 75 years or older, with 26 percent aged 85 years or over, and the majority of respondents were widowed. The proportions of proxy interviews were similar in the two control groups, but the proportion was substantially higher among cases.

Table 2 presents adjusted odds ratios comparing hospital and community controls with regard to health conditions and habits potentially related to hip fracture risk. Each odds ratio indicates the odds that hospital controls reported the exposure of interest as compared with the odds that community controls reported that exposure. For example, line 1 of the table indicates that the odds of reporting lower-limb dysfunction were 1.52 times greater in hospital controls than in community controls. Hospital controls were more likely than community controls to report lower-limb problems in general, as indicated by the elevated odds ratios for lower-limb dysfunction, use of ambulatory aids, and recent falling. Hospital controls were also more likely to report the presence of several serious illnesses (stroke, diabetes, cancer), poor health habits (obesity and current smoking), estrogen use, and exposure to selected life events (having left a job and having moved). Hospital controls were less likely than community controls to report poor vision, difficulty getting around the neighborhood, and having a friend move during the past year.

Table 3 presents odds ratios from conditional logistic regression analyses comparing cases with each of the two control groups. The variables shown in this table were those for which odds ratios were substantially elevated or depressed in table 2. The odds ratios
TABLE 3. Adjusted* odds ratio comparing hip fracture cases with hospital controls and community controls, 1987–1989

<table>
<thead>
<tr>
<th>Condition</th>
<th>Hospital controls</th>
<th>Community controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower-limb dysfunction (yes/no)</td>
<td>1.26 (0.90–1.74)</td>
<td>1.70 (1.26–2.31)</td>
</tr>
<tr>
<td>Use of ambulatory aids during the previous 6 months</td>
<td>1.19 (0.86–1.64)</td>
<td>1.99 (1.47–2.68)</td>
</tr>
<tr>
<td>Fall during the previous 6 months</td>
<td>1.08 (0.71–1.53)</td>
<td>1.70 (1.22–2.35)</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.36 (0.87–2.11)</td>
<td>2.51 (1.60–3.94)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>0.69 (0.47–1.02)</td>
<td>1.26 (0.86–1.85)</td>
</tr>
<tr>
<td>Cancer</td>
<td>0.28 (0.19–0.43)</td>
<td>0.85 (0.54–1.32)</td>
</tr>
<tr>
<td>Poor vision</td>
<td>2.62 (1.27–5.37)</td>
<td>1.42 (0.81–2.48)</td>
</tr>
<tr>
<td>Use of estrogen for 1 year or longer</td>
<td>0.58 (0.38–0.90)</td>
<td>0.94 (0.61–1.44)</td>
</tr>
<tr>
<td>Body mass index*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.3–23.6 vs. &lt;21.3</td>
<td>0.49 (0.28–0.83)</td>
<td>0.60 (0.39–0.94)</td>
</tr>
<tr>
<td>23.7–25.9 vs. &lt;21.3</td>
<td>0.28 (0.16–0.48)</td>
<td>0.24 (0.15–0.38)</td>
</tr>
<tr>
<td>26.0–29.9 vs. &lt;21.3</td>
<td>0.14 (0.09–0.25)</td>
<td>0.29 (0.17–0.48)</td>
</tr>
<tr>
<td>≥30.0 vs. &lt;21.3</td>
<td>0.11 (0.06–0.20)</td>
<td>0.20 (0.11–0.34)</td>
</tr>
<tr>
<td>Smoking current vs. never</td>
<td>1.30 (0.85–1.98)</td>
<td>2.49 (1.61–3.83)</td>
</tr>
<tr>
<td>Former vs. never</td>
<td>1.12 (0.76–1.66)</td>
<td>1.02 (0.73–1.43)</td>
</tr>
<tr>
<td>Difficulty getting around the neighborhood</td>
<td>0.87 (0.57–1.32)</td>
<td>0.58 (0.40–0.85)</td>
</tr>
<tr>
<td>Moved during past year</td>
<td>0.90 (0.54–1.51)</td>
<td>0.38 (0.21–0.67)</td>
</tr>
<tr>
<td>Left job during past year</td>
<td>0.83 (0.41–0.97)</td>
<td>1.04 (0.69–1.57)</td>
</tr>
<tr>
<td>Friend moved during past year</td>
<td>1.36 (0.90–2.07)</td>
<td>0.69 (0.49–0.96)</td>
</tr>
</tbody>
</table>

* Adjusted for age (in the categories 45–54, 55–64, 65–74, 75–84, and 85–103 years, and as a continuous variable within those categories), race, education, body mass index, thiazide diuretic use, alcohol consumption, estrogen replacement therapy, chronic health conditions, stroke, and smoking.

† OR, odds ratio; CI, confidence interval.
‡ Also adjusted for hospital.
§ Also adjusted for zip code or telephone prefix.
¶ Weight (kg)/height (m)².

in table 3 were adjusted for demographic variables and risk factors for hip fracture, including body mass index, thiazide diuretic use, alcohol consumption, estrogen replacement therapy, chronic health conditions, stroke, and smoking. On the basis of odds ratios shown in table 3, we would have concluded that there were statistically significant associations of hip fracture risk with falling during the previous 6 months, current smoking, and moving during the past year, but we would not have reached such a conclusion using hospital controls. For stroke and use of ambulatory aids, we would have concluded that there was a greater increase in the risk of hip fracture using community controls as compared with the use of hospital controls. On the other hand, we would have concluded that there was a stronger association of poor vision with hip fracture risk using hospital controls than using community controls.

Table 4 compares controls from the present study with women participating in the EPESE Study with respect to several health conditions, smoking, and demographic characteristics. Women were asked about these items via questions similar to those used in the present study (see Appendix). To account for the different age and racial compositions of the samples, we standardized the data by age using New Haven white women as the standard population, and we stratified the data by race for the hip fracture study and for the New Haven EPESE site. (Only this site had adequate numbers of blacks to make stratification possible.) Overall, hospital controls were more likely than the EPESE women to report chronic health conditions such as a history of cancer, stroke, or diabetes (whites only) and current smoking. Community controls were more likely than EPESE women to report histories of myocardial infarction, cancer (whites only), and smoking.

**DISCUSSION**

The results of these analyses indicate that associations of hip fracture with selected putative risk factors are influenced by the choice of control group. On the basis of data from both cohort and case-control stud-
TABLE 4. Comparison of selected demographic and health characteristics of controls in a study of risk factors for hip fracture and women in the EPESE* Study, standardized by age†

<table>
<thead>
<tr>
<th></th>
<th>Hip fracture study</th>
<th>EPESE Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hospital controls</td>
<td>Community controls</td>
</tr>
<tr>
<td>Whites</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Demographic characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean height (inches)§</td>
<td>62.3</td>
<td>62.9</td>
</tr>
<tr>
<td>Mean weight (pounds)¶</td>
<td>147.1</td>
<td>138.4</td>
</tr>
<tr>
<td>Median age (years)</td>
<td>79.0</td>
<td>80.0</td>
</tr>
<tr>
<td>Percentage reporting:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>18.5</td>
<td>10.4</td>
</tr>
<tr>
<td>Heart attack</td>
<td>11.3</td>
<td>14.0</td>
</tr>
<tr>
<td>Cancer</td>
<td>36.3</td>
<td>20.1</td>
</tr>
<tr>
<td>Stroke</td>
<td>7.6</td>
<td>4.5</td>
</tr>
<tr>
<td>Smoking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ever</td>
<td>29.1</td>
<td>27.3</td>
</tr>
<tr>
<td>Current</td>
<td>19.6</td>
<td>7.7</td>
</tr>
</tbody>
</table>

| Nonwhites#                  |                    |              |
| Demographic characteristics |                    |              |
| Mean height (inches)§       | 63.4               | 63.5         | 63.6                       |                       |
| Mean weight (pounds)¶       | 157.7              | 156.5        | 155.9                      |                       |
| Median age (years)          | 75.0               | 78.0         | 72.0                       |                       |
| Percentage reporting:       |                    |              |
| Diabetes mellitus           | 21.9               | 18.6         | 21.0                       |                       |
| Heart attack                | 24.7               | 19.0         | 13.8                       |                       |
| Cancer                      | 15.9               | 4.7          | 13.7                       |                       |
| Stroke                      | 15.8               | 7.0          | 11.6                       |                       |
| Smoking                     |                    |              |
| Ever                        | 15.9               | 28.0         | 15.2                       |                       |
| Current                     | 25.2               | 11.4         | 14.6                       |                       |

* EPESE, Established Populations for Epidemiologic Studies of the Elderly. Data for the EPESE samples were obtained from Comoni-Huntley et al. (11).
† New Haven white women comprised the standard population. The exact wording of questions from the hip fracture and EPESE studies is shown in the Appendix table.
‡ The East Boston sample was predominantly white.
§ 1 Inch = 2.54 cm.
¶ 1 pound = 0.45 kg.
# The nonwhite EPESE sample was predominantly (98%) black. The nonwhite hip fracture sample was 100% black.

ies, it is widely accepted that low body mass (12–18), lack of estrogen use (12, 17, 18), cigarette smoking (12, 15, 19, 20), a history of falls in the previous year (21), and impaired vision (22) increase the risk of hip fracture. In our study, conclusions regarding body mass and estrogen would have been similar regardless of which control group was used. However, conclusions regarding smoking, falling, vision, and stroke would have been affected by the choice of control group. Had we used hospital controls alone, we would have inferred no statistically significant association of hip fracture risk with smoking and falling in the previous 6 months, and we would have found only a marginally significant association with stroke, whereas we would have inferred significant associations for all three variables using community controls. Had we used community controls alone, we would have inferred a nonsignificant association of hip fracture risk with poor vision as compared with a stronger, statistically significant association using hospital controls.

Note that certain differences between community and hospital controls that were evident in the analyses adjusted only for demographic characteristics (table 2) were no longer present when additional adjustment for hip fracture risk factors was included (table 3). This would suggest that controlling for appropriate variables, if they can be identified and measured, can reduce the effects of selection bias.

In this study, hospital controls were more likely than community controls to report many of the exposures of interest, including health problems, frailty, and unhealthy behaviors. This could have occurred because the hospital control group had a greater prevalence of health problems than the source population it was supposed to represent, or because the community con-
controls were healthier than the source population, or both.

Ideally, we would want to compare the distributions of exposures in the two control groups with the distribution of exposures in the cases' source population. However, these data were not available. We instead compared the two control groups with representative samples of elderly individuals living in two other northeastern urban areas (East Boston, Massachusetts, and New Haven, Connecticut) with higher response rates (80–84 percent). We found no evidence that the community controls were healthier than the EPESE women. In fact, community controls in the hip fracture study were more likely than the EPESE women to report a history of heart attack and cancer (whites only) and to be former smokers. (This could have obscured associations of hip fracture risk with history of heart attack or past smoking, and it might account for the observed negative association with cancer.) The community controls were quite similar to the EPESE women with respect to other health-related variables. By contrast, hospital controls in the hip fracture study were more likely than the EPESE women to report most serious health conditions, as well as current smoking. Note that hospital controls who were admitted to medical wards (as opposed to surgical wards) were excluded from the present analyses. Hence, the greater prevalence of observed medical problems is not an artifact of hospitalization for medical causes.

Olson et al. (2, 23, 24) evaluated the representativeness of hypothetical hospital and community controls aged 40–75 years by comparing health and demographic characteristics of the two control groups to the characteristics of participants in a census of the surrounding area. In general, they found both groups to be representative of the surrounding area (23, 24) and reported few differences between the hospital and community controls (2). The few differences they found were consistent (although weaker) with those in the present study; hospital controls were more likely than community controls to report disability or physical difficulty, ever smoking, current smoking, overweight, and diabetes. In a sample of women averaging 61 years of age, Hulka (25) reported more serious health problems in hospital controls than in community controls. Taken together, these findings suggest that differences between hospital and community controls may be of greater magnitude in studies of older, frailer individuals than in studies of younger people.

Some of the findings reported here are not wholly consistent with previously published results from this study (7, 8). These inconsistencies are due to several methodological differences between the present analyses and previously published data (i.e., the combination of whites and blacks, the inclusion of proxy respondents, and the use of different adjustment variables in the multivariate models). These variations resulted from the different purposes of the two studies.

The major limitation of this study is that it is impossible to ascertain definitively in which control group the distribution of exposures is closer to that of the cases' source population. If response rates had been higher and the sample size larger, we could have been more certain. However, this is exactly the problem; response rates in studies of frail, elderly individuals are typically very low (26).

Overall, our data indicate that: 1) had we used hospital controls alone, we would have missed several generally accepted risk factors for hip fracture; 2) hospital controls may be in poorer health than women in the source population from which the cases arise; and 3) community controls do not appear to be healthier than other representative samples of elderly women. We conclude that for studies of hip fractures in frail elderly populations, community controls comprise the more appropriate control group. We suspect that this is also the case for other illnesses affecting frail elderly individuals, but this assumption must be confirmed by other studies.

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REFERENCES


APPENDIX TABLE. Wording of similar questionnaire items from the hip fracture and EPESE* studies

<table>
<thead>
<tr>
<th>Hip fracture study</th>
<th>EPESE Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Please tell me if a doctor ever told you that you had any of the following conditions:</td>
<td>Has a doctor ever told you that you had:</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Diabetes, sugar in the urine, or high blood sugar?</td>
</tr>
<tr>
<td>A heart attack or heart failure</td>
<td>A heart attack, or coronary, or coronary occlusion, or myocardial infarction?</td>
</tr>
<tr>
<td>A stroke or a blood clot in the brain</td>
<td>A stroke or brain hemorrhage?</td>
</tr>
<tr>
<td>Cancer</td>
<td>Cancer, malignancy, or tumor of any type?</td>
</tr>
<tr>
<td>Have you ever smoked at least one cigarette per day for at least 6 months?</td>
<td>Did you ever smoke cigarettes?</td>
</tr>
<tr>
<td>Have you smoked during the past year?</td>
<td>Do you smoke cigarettes now?</td>
</tr>
<tr>
<td>How tall are you without shoes?</td>
<td>What is your height?</td>
</tr>
<tr>
<td>How much do you weigh?</td>
<td>What is your weight?</td>
</tr>
</tbody>
</table>

* EPESE, Established Populations for Epidemiologic Studies of the Elderly (11).