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Effect of New York State Regulatory Action on Benzodiazepine Prescribing and Hip Fracture Rates

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Background: Medicare Part D excludes benzodiazepines from coverage, and numerous state government policies limit use of benzodiazepines. No data indicate that such policies have decreased the incidence of hip fracture.

Objective: To assess whether a statewide policy that decreased the use of benzodiazepines among elderly persons by more than 50% has decreased the incidence of hip fracture.

Design: A quasi-experiment comparing changes in outcomes before and after a policy change in a study U.S. state (New York) and a control state (New Jersey).

Setting: Two U.S. state Medicaid programs, 1988–1990.

Patients: Medicaid enrollees in New York (n = 51 529) and New Jersey (n = 42 029) who received or did not receive a benzodiazepine.

Measurements: Benzodiazepine prescribing and hazard ratios for hip fracture, adjusted for age and eligibility category.

Intervention: A statewide policy, implemented in New York in 1989, that required triplicate forms for benzodiazepine prescribing to allow surveillance by health authorities.

Results: The triplicate prescription policy immediately resulted in a 60.3% (95% CI, −66.3% to −54.2%) reduction in benzodiazepine use among women and 58.5% (−64.3% to −52.8%) among men. Benzodiazepine use in New Jersey remained stable. Hazard ratios for hip fracture that were adjusted for age and eligibility category did not change in New York or New Jersey when the periods before and after use of the triplicate prescription policy were compared (change from 1.2 to 1.1 among female benzodiazepine recipients [P = 0.70], 1.3 to 1.1 [P = 0.08] among female nonrecipients, 0.8 to 1.1 [P = 0.56] among male recipients, and 1.1 to 1.3 [P = 0.46] among male nonrecipients).

Limitations: Information was lacking on race, benzodiazepine dose, and other potential determinants of continued benzodiazepine prescribing.

Conclusions: Policies that lead to substantial reductions in the use of benzodiazepines among elderly persons do not necessarily lead to decreased incidence of hip fracture. Limitations on coverage of benzodiazepines under Medicare Part D may not achieve this widely assumed clinical benefit.

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Concerns about benzodiazepine abuse, misuse, and adverse events, including hip fractures among elderly persons, have prompted state and national policies intended to regulate access to benzodiazepines. In 1990, after publication of the first landmark studies describing the risk for hip fractures associated with benzodiazepine use (1, 2), the U.S. Congress passed the Omnibus Budget Reconciliation Act, which allowed states to restrict coverage of benzodiazepines in Medicaid programs or exclude them from coverage. Although no state excluded benzodiazepines from coverage after this act, about one third of the states imposed limits on the number of prescriptions covered, required authorization before a patient could fill a prescription, or implemented other statewide policies that restricted access (3). Since January 2006, benzodiazepines have been explicitly excluded from coverage through the Medicare Part D drug benefit (4).

On 1 January 1989, the New York State Department of Health implemented a triplicate prescription policy (TPP) for benzodiazepines. Since then, all physicians in New York State are required to obtain; pay for; and use special serially numbered, triplicate forms to prescribe benzodiazepines. Pharmacists forward 1 copy of the prescription form to state health authorities for surveillance. The TPP allows monitoring of each physician's prescribing, each pharmacy's dispensing, and each patient's receipt of benzodiazepines. The policy constitutes a barrier to accessing benzodiazepines and resulted in an immediate and sustained decrease of 55% overall in the monthly number of benzodiazepine recipients in a continuously enrolled Medicaid cohort (5), and benzodiazepine prescribing decreased by 30% in a privately insured sample and by 44% statewide (6). A neighboring, demographically similar state, New Jersey, did not regulate benzodiazepine prescribing, and use of benzodiazepines did not change (5).

Perceived benefits and risks of restricted access to benzodiazepines influence the decisions to exclude benzodiazepines from coverage. Use of benzodiazepines has been associated with cognitive dysfunction and postural imbalance among elderly persons, and hip fractures are the most serious individual and public health risk because they often lead to disability and death in this group (7, 8). One expected benefit of policies that limit access to benzodiazepines is a subsequent decrease in the incidence of falls and hip fractures associated with benzodiazepine use among

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elderly persons (9). However, to date, no data demonstrate this effect from such policies.

We evaluated whether a statewide policy that suddenly decreased benzodiazepine use by more than 50% among elderly persons decreased the incidence of hip fracture in this group (5). Our hypothesis, like that of policymakers (9) and other researchers (10), was that the sudden, large, sustained decrease in benzodiazepine prescribing in New York would result in a decrease in the incidence of hip fractures, particularly among those at highest risk for hip fractures—women who use benzodiazepines—whereas rates of hip fracture would not decrease in New Jersey.

Context

Early studies showed that benzodiazepine use was associated with increased rates of hip fracture. Soon after, New York State adopted legislation to control benzodiazepine prescriptions. New Jersey did not.

Contribution

The authors observed rates of benzodiazepine prescribing and hip fractures in Medicaid patients for 12 months before and 21 months after New York began to track rates of physicians' benzodiazepine prescribing. Prescription rates decreased abruptly by 60%, but hip fracture rates did not change. In New Jersey, concurrent hip fracture rates did not change.

Caution

Prescribed dosages of benzodiazepines were unknown.

Implication

Controlling benzodiazepine prescribing may not reduce hip fractures, possibly because the 2 are not causally related.

—The Editors

METHODS

Design

Using a longitudinal, controlled, quasi-experimental design (11, 12), we compared monthly rates of benzodiazepine use and hazard ratios for hip fracture among elderly Medicaid enrollees in New York (the intervention state) and New Jersey (the comparison state) during the 12 months before and the 21 months after implementation of the New York TPP.

Cohort

The study sample consisted of elderly Medicaid recipients (≥65 years of age on 1 January 1988) in New York and New Jersey. Eligible enrollees received benefits under the Aid to the Permanently and Totally Disabled or the Old Age Assistance programs. We required cohort members to have been enrolled in Medicaid for at least 10 of 12 months in the year before the TPP, with no period of residence in a long-term care facility. Because the New York State Medicaid program is about 4 times larger than that of New Jersey and the New York State Medicaid office preferred not to provide a large data set on its entire population, the New York data are derived from a 25% random sample of Medicaid enrollees.

Data Sources

Medicaid enrollment files were used to obtain complete and reliable monthly data on patient age and sex (13). Reimbursement claims from pharmacies provide valid measures of prescription medications dispensed to Medicaid patients that have been shown to be internally consistent and stable over time for both individual drugs and broader therapeutic classes (13–15). Medicaid and Medicare claims for acute care inpatient services, which contain admission and discharge dates and multiple discharge diagnoses, were used to identify hip fractures.

Benzodiazepine Use

We linked Medicaid medication claims to historically complete National Drug Code Files (16) to identify dispensed benzodiazepines. At least 1 dispensed benzodiazepine (alprazolam, chlordiazepoxide, clonazepam, clorazepate, diazepam, flurazepam, halazepam, lorazepam, oxazepam, prazepam, quazepam, temazepam, triazolam) defined a benzodiazepine recipient in a given month. We defined benzodiazepine recipients and nonrecipients in the year before the TPP as persons who received or did not receive, respectively, at least 1 dispensed benzodiazepine in that period.

Hip Fracture

Similar to other studies (1, 2, 17), we defined hip fractures on the basis of Medicaid or Medicare claims for acute care hospitalizations that lasted longer than 1 day (to avoid misclassifying admission to the emergency department to rule out hip fracture as admission for hip fracture treatment) and involved a primary discharge diagnosis of hip fracture (*International Classification of Diseases, 9th Revision, Clinical Modification* codes 820.xx) or a secondary diagnosis of hip fracture with a primary diagnosis of fracture of other and unspecified parts of the femur (code 821.xx) or fracture of unspecified bones (code 829.xx). We defined eligible hip fractures as first hip fractures that occurred during the study period. We excluded hip fractures that occurred on days when patients were not enrolled in Medicaid. The hospital admission date was used as the date of the hip fracture.

Statistical Analysis

We used SAS software, version 8.02 (SAS Institute, Inc., Cary, North Carolina), for all analyses (18). We first compared baseline demographic characteristics (age, sex, Medicaid eligibility category) in the intervention and control cohorts. We then used segmented regression analyses to estimate the relative change in benzodiazepine use after the TPP compared with before, taking into account pre-TPP benzodiazepine use and trend (12). Using life-table

Table 1. **Age, Sex, and Eligibility Categories of Medicaid Enrollees in 1988 in New York and New Jersey**

Characteristic	New York	New Jersey
Sample, *n*	51 529	42 029
Age on 1 January 1988, %		
65–74 years	49.2	60.4
75–84 years	35.7	28.8
≥85 years	15.2	10.8
Female sex, %	77.3	77.2
Eligibility category as of June 1988, %		
Aid to the Permanently and Totally Disabled	8.2	24.9
Old Age Assistance	91.8	75.1

estimates, we calculated crude hip fracture hazard rates by sex, state, and pre-TPP use of benzodiazepines (19). We fit extended piecewise Cox models (20), which allow for fixed and time-dependent covariates and for different hazard ratios in different time segments, to determine whether hip fracture hazard rates differed between states before the New York TPP was implemented and whether post-TPP hazard ratios between states differed from pre-TPP hazard ratios. In separate models for women and men, we modeled time in months to first hip fracture, censoring patients when they disenrolled from Medicaid for the remainder of the study period. Each model contained both states and the pre- and post-TPP periods and controlled for age and Medicaid eligibility category (Aid to the Permanently and Totally Disabled or Old Age Assistance). We assumed that the hazard ratios for hip fracture in New York compared with New Jersey were constant within the pre- and post-TPP segments, given the same age and Medicaid eligibility category. We used the Wald chi-square statistic to test whether the hazard ratios for hip fracture changed significantly from before to after the TPP, comparing New York and New Jersey enrollees.

The institutional review board of Harvard Medical School exempted the study from human subjects review.

Role of the Funding Sources

The study sponsors were not involved in the design and conduct of the study; collection, management, analysis, or interpretation of the data; or preparation, review, or approval of the manuscript. The authors had full access to the study data and were responsible for statistical analysis, reporting of data, and manuscript submission.

RESULTS

Study Cohorts

Table 1 shows characteristics of the cohorts of elderly Medicaid enrollees in New York (n = 51 529) and New Jersey (n = 42 029) in 1988. Compared with New Jersey enrollees, New York enrollees were older and a greater percentage was eligible for benefits under the Old Age Assistance Program. Sex distribution (77% women) was the same between states. Overall, 23% of New York enrollees and 24% of New Jersey enrollees received at least 1 dispensing of benzodiazepine in 1988.

Table 2 shows the number of benzodiazepine recipients and nonrecipients before and after the TPP, by sex and state. During the 33 study months, 11 221 (21.8%) Medicaid enrollees in New York and 7848 (18.7%) in New Jersey exited the study sample. Medicaid enrollees in New York had 958 first hip fractures, and New Jersey enrollees had 651.

Change in Benzodiazepine Use after the Triplicate Prescription Policy

Panel A in **Figures 1** and **2** shows the abrupt and sustained decreases in benzodiazepine use among Medicaid-enrolled women and men in New York who had received at least 1 benzodiazepine in the year before the TPP. Benzodiazepine use in New York decreased abruptly from about 40% of enrollees each month before the TPP to about 15% after the TPP (change, −60.3% [95% CI, −66.3% to −54.2%]) among women and −58.5% [CI, −64.3% to −52.8%] among men). In contrast, benzodiazepine dispensing remained constant in New Jersey.

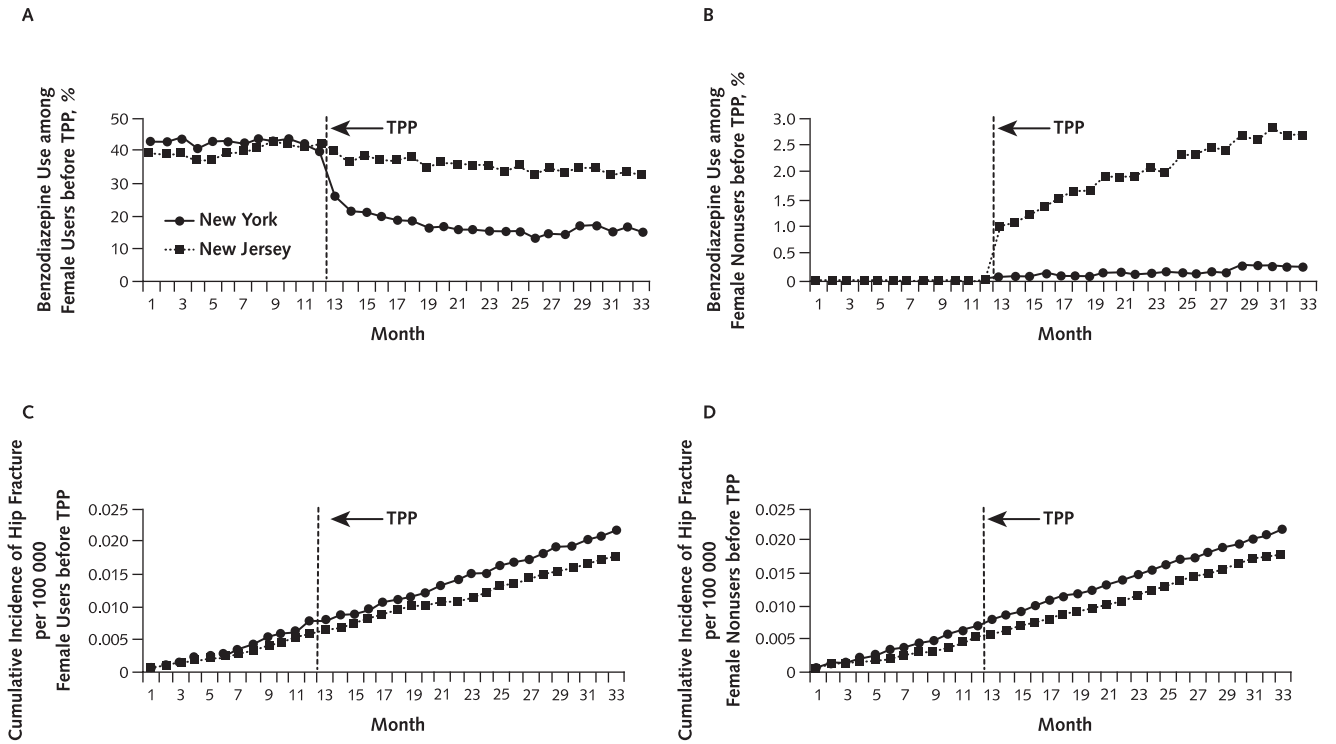
Panel B in **Figures 1** and **2** shows the change in benzodiazepine use over time among enrollees who had not received any benzodiazepine in the year before the TPP. By the end of the study period, about 2.5% of benzodiazepines nonrecipients at baseline in New Jersey had received a benzodiazepine, compared with fewer than 0.5% of nonrecipients at baseline in New York. The substantial relative decrease in benzodiazepine use after the TPP among Medicaid enrollees in New York is consistent with the decreases reported for the entire Medicaid population (5) and for

Table 2. **Medicaid Enrollees Who Did or Did Not Receive a Benzodiazepine before and after Implementation of the New York Triplicate Prescription Policy***

Medicaid Enrollees	Pre-TPP Benzodiazepine Recipients		Pre-TPP Benzodiazepine Nonrecipients		Post-TPP Benzodiazepine Recipients		Post-TPP Benzodiazepine Nonrecipients	
	New York	New Jersey	New York	New Jersey	New York	New Jersey	New York	New Jersey
Women	9921	8255	29 934	24 210	4623	8284	27 148	18 464
Men	2050	1775	9624	7789	860	1779	7677	5654

* The study period includes the 12 months before and the 21 months after implementation of the policy in 1989. TPP = triplicate prescription policy.

Figure 1. **Benzodiazepine use and cumulative incidence of hip fracture before and after the New York triplicate prescription policy (*TPP*) among women enrolled in Medicaid who did or did not receive at least 1 dispensed benzodiazepine before the policy was implemented.**



subgroups of patients with chronic psychiatric and neurologic disorders (21).

Cumulative Incidence of Hip Fracture over Time

The cumulative incidence of hip fractures among women who received a benzodiazepine before the TPP (**Figure 1**, *panel C*) and those who did not (**Figure 1**, *panel D*) over the 33-month study period is similar, with slightly higher rates both before and after the TPP in New York. In contrast to the sudden, large reductions in rates of benzodiazepine use, the rates at which hip fractures accumulate did not change after the policy was implemented. Although the sample sizes and numbers of hip fractures are smaller among men, the same patterns hold (**Figure 2**, *panels C and D*).

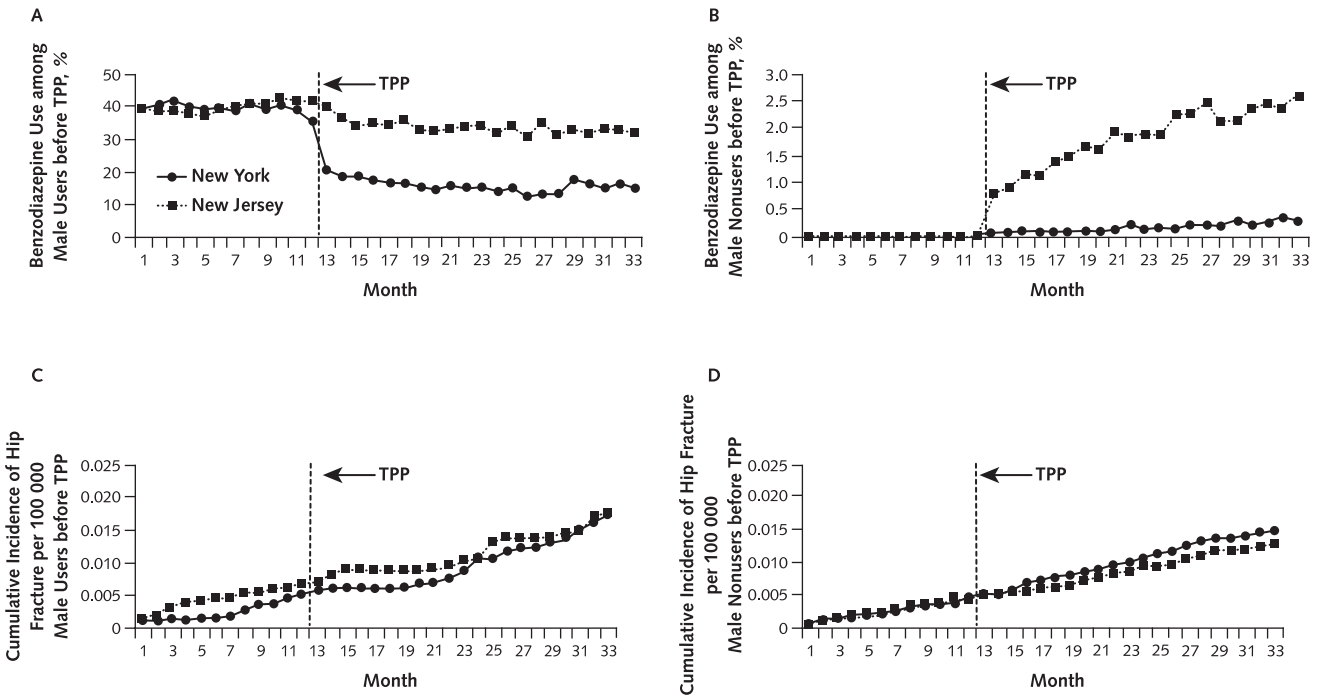
Crude hazard rates of hip fracture ranged from 30 per 100 000 (CI, 20 per 100 000 to 41 per 100 000) among men who did not receive a benzodiazepine before the TPP in New York (**Table 3**) to 73 per 100 000 (CI, 66 per 100 000 to 80 per 100 000) among women who did not receive a benzodiazepine before the TPP in New York (**Table 4**). Hazard ratios for hip fracture comparing New York and New Jersey that were adjusted for age and eligibility category did not significantly differ before or after the implementation of the TPP in New York (**Tables 3** and **4**).

Discussion

Consistent with the limited data available on changes in rates of benzodiazepine-associated adverse events after the TPP in New York (10, 22), we found that the TPP substantially decreased rates of continued and new use of benzodiazepines but did not decrease the incidence of hip fracture. The only published uncontrolled ecological study of the effect of the TPP on the incidence of hip fracture (10) (which found no effect among elderly persons in New York overall) was not likely to detect an effect, because the investigators did not have access to data on benzodiazepine exposure and could not assess changes in hip fracture rates among subgroups at risk. Our controlled study shows a lack of effect of the TPP in the subgroups at highest risk for hip fractures, defined by female sex and pre-TPP use of benzodiazepines.

There are several possible explanations for our findings. First, the TPP may not affect benzodiazepine use among persons who are most at risk for benzodiazepine-associated hip fractures. For example, elderly white women, who are at highest risk for a fracture (23), may have continued to receive a benzodiazepine or started to receive a new benzodiazepine after the TPP, whereas the dramatic changes in benzodiazepine use after the TPP may

Figure 2. **Benzodiazepine use and cumulative incidence of hip fracture before and after the New York triplicate prescription policy (*TPP*) among men enrolled in Medicaid who did or did not receive at least 1 dispensed benzodiazepine before the policy was implemented.**



have affected only those at lower risk for hip fractures (for example, men and black women) (23). However, as shown here and in another study (5), women experienced greater overall reductions in benzodiazepine prescribing than did men, and people in predominantly black and Hispanic neighborhoods experienced greater reductions than did those in white neighborhoods (5, 24). We found a substantial (about 60%) decrease in benzodiazepine use among older women receiving benzodiazepines but no corresponding decrease in the incidence of hip fracture. We did not assess the effect of the TPP among subgroups by race because the sample of women in black neighborhoods was relatively small and the number of hip fractures was limited; however, it is unlikely that reductions in benzodiazepine use would have affected only black women. Because the TPP was a statewide policy that affected all benzodiazepine prescribing, including that in nursing homes (25), it is unlikely that institutionalized patients in New York, who are at high risk for hip fractures, preferentially continued to receive benzodiazepines.

Similarly, it is possible that after the TPP, physicians preferentially discontinued benzodiazepine therapy for patients receiving lower doses and that patients receiving higher doses, which are associated with an increased risk for hip fractures (26, 27), continued to receive benzodiazepines. However, use of high-dose benzodiazepines (maximum daily dose >10 mg equivalent of diazepam in elderly persons) was infrequent in the study sample before and after the TPP (67 per 1000 vs. 92 per 1000 benzodiazepine recipients, respectively), and the TPP did not significantly change the prevalence of use of high doses (5).

Second, in lieu of benzodiazepines, prescribers may have substituted psychoactive medications that carry a risk for hip fracture similar to that of benzodiazepines. Studies have shown that the TPP led to slightly increased use of nonbenzodiazepine sedatives, mainly chloral hydrate, meprobamate, and buspirone (5). Some substitute nonbenzodiazepine sedatives may increase the risk for hip fracture (1). However, increases in use of substitute medications were modest (up to 15% among benzodiazepine recipients in 1988 [9]) and did not offset the abrupt decreases of greater than 50% in benzodiazepine use (5, 28).

Finally, benzodiazepines may not actually be associated with hip fractures, or at least not to the extent reported in some studies. The relationship between benzodiazepine use and the incidence of hip fracture among older people has been the focus of many studies that have conflicting results. Some investigators have suggested increased falls and risk for hip fracture with use of any benzodiazepine (29–32); others have found this effect only with benzodiazepines that have a long elimination half-life (1, 2, 33–35) or those with a short elimination half-life (26, 36); and still others found the greatest risk associated with nonoxidative metabolized benzodiazepines (37), or selected in-

Table 3. **Cumulative Number of Hip Fractures, Crude Hazard Rates, and Adjusted Hazard Ratios among Male Medicaid Enrollees in New York and New Jersey before and after Implementation of the New York Triplicate Prescription Policy***

State	Pre-TPP Benzodiazepine Recipients						Pre-TPP Benzodiazepine Nonrecipients					
	Fractures, *n*†	Hazard Rate, *n per 100 000 enrollees*‡		Hazard Ratio§		*P* Value‖	Fractures, *n*†	Hazard Rate, *n per 100 000 enrollees* ‡		Hazard Ratio§		*P* Value‖
		Before TPP	After TPP	Before TPP	After TPP			Before TPP	After TPP	Before TPP	After TPP	
New York	30	38 (13–62)	54 (31–78)	0.8 (0.33–1.85)	1.1 (0.55–2.09)	0.56	129	30 (20–41)	54 (43–66)	1.1 (0.67–1.69)	1.3 (0.94–1.86)	0.46
New Jersey	27	48 (18–77)	52 (27–77)				89	34 (22–45)	38 (28–48)			

* The study period includes the 12 months before and the 21 months after implementation of the policy in 1989. Values in parentheses are 95% CIs. TPP = triplicate prescription policy.
† Cumulative number of hip fractures over the study period.
‡ Crude hazard rate of hip fracture from life-table estimate.
§ Hazard ratios for hip fracture in New York compared with New Jersey, controlled for age and eligibility category.
‖ *P* value for the difference between pre-TPP and post-TPP hip fracture hazard ratios of New York compared with New Jersey.

dividual benzodiazepines regardless of metabolism and half-life (38, 39). In addition to type of benzodiazepine, some studies have suggested a relationship with dose (26, 27) or duration of therapy (26, 36). Several studies found no relationship at all between benzodiazepine use and risk for hip fracture (40–45).

If benzodiazepine use and risk for hip fracture are not associated, lack of control for unmeasured confounders would be the most likely explanation for the results of studies that did show an association (46, 47). Studies that controlled for potential confounders have consistently shown diminished associations in multivariate analyses compared with uncontrolled analyses (36, 39, 45), demonstrating that confounding by indication accounts for at least part of the observed relationship. Recently, Schneeweiss and Wang (47) used survey data to determine that 5 potential confounders (body mass index, smoking, activity and daily living score, cognitive impairment, and a physical impairment scale score), which are unmeasured in claims data studies, may result in net confounding of 9.8% (range, 0% to 39%) in the relationship between benzodiazepine use and hip fractures. When these investigators corrected a claims data–based estimate (26) for confounding bias, they found a substantially reduced but still significant moderate association between benzodiazepine use and hip fractures (47). However, these 5 confounders do not account for all potential unmeasured confounders, and the risk for hip fracture with benzodiazepine use may be small.

Given our study's longitudinal, quasi-experimental design, we believe that it is the strongest study to date in controlling for unmeasured confounders. For these confounders to affect our estimates, they would have to be associated both with risk for hip fracture and the likelihood of receiving a benzodiazepine after the TPP policy. Although some variation was observed, we found large decreases in benzodiazepine use in all demographic subgroups, ranging from 41.8% in neighborhoods with the least poverty to 69.1% among younger enrollees in the Medicaid Aid to Families with Dependent Children eligibility category (5). If the potential risk for hip fracture associated with benzodiazepine use were large, we would expect to have observed it in our data. If the relationship is very small, our study may still lack power to detect an effect of the TPP on the incidence of hip fracture, despite its large sample and strong design. However, the fact that rates of hip fracture in New York were increasing while benzodiazepine use dramatically decreased makes it unlikely that a lack of power explains our findings.

The age of the data used in our study (1988 through

Table 4. **Cumulative Number of Hip Fractures, Crude Hazard Rates, and Adjusted Hazard Ratios among Female Medicaid Enrollees in New York and New Jersey before and after Implementation of the New York Triplicate Prescription Policy***

State	Pre-TPP Benzodiazepine Recipients						Pre-TPP Benzodiazepine Nonrecipients					
	Fractures, *n*†	Hazard Rate, *n per 100 000 enrollees*‡		Hazard Ratio§		*P* Value‖	Fractures, *n*†	Hazard Rate, *n per 100 000 enrollees*‡		Hazard Ratio§		*P* Value‖
		Before TPP	After TPP	Before TPP	After TPP			Before TPP	After TPP	Before TPP	After TPP	
New York	199	53 (39–66)	72 (60–84)	1.2 (0.80–1.66)	1.1 (0.80–1.40)	0.70	600	53 (45–60)	73 (66–80)	1.3 (1.07–1.68)	1.1 (0.90–1.23)	0.08
New Jersey	135	42 (29–55)	58 (46–70)				400	36 (29–43)	64 (56–71)			

* The study period includes the 12 months before and the 21 months after implementation of the policy in 1989. Values in parentheses are 95% CIs. TPP = triplicate prescription policy.
† Cumulative number of hip fractures over the study period.
‡ Crude hazard rate of hip fracture from life-table estimate.
§ Hazard ratios for hip fracture in New York compared with New Jersey, controlled for age and eligibility category.
‖ *P* value for the difference between pre-TPP and post-TPP hip fracture hazard ratios of New York compared with New Jersey.

1990, which includes the 12 months before and the 21 months after the TPP was implemented in New York in 1989) affects the interpretation of the study results only positively. Because the data predate the landmark publications reporting increased risk for hip fracture associated with benzodiazepine use (1, 2), the results are not subject to bias through preferred prescribing of benzodiazepines to persons at lower risk for hip fracture.

The Prescription Drug Improvement and Modernization Act, in effect since January 2006, explicitly excludes benzodiazepines from coverage, even for appropriate indications, such as seizure, panic, and bipolar disorders. Many elderly, poor, and disabled Medicare beneficiaries who received benzodiazepines before 2006 through Medicaid suddenly lost coverage (4, 48). The policymakers responsible for this act may expect that reducing access to benzodiazepines will improve residents' quality of life by decreasing risk for hip fracture (48). According to our analyses, this expectation may not be justified. At the same time, the Prescription Drug Improvement and Modernization Act may constitute a more recent natural experiment than the New York TPP to assess whether a policy that abruptly decreases benzodiazepine use also results in decreased incidence of hip fractures.

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Disclaimer: The conclusions derived in this manuscript are those of the authors and not of the New York State Department of Health.

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