THE COMPARATIVE EFFECT OF EPISODES OF CHIROPRACTIC AND MEDICAL TREATMENT ON THE HEALTH OF OLDER ADULTS

Paula A Weigel, MS,[a] Jason Hockenberry, PhD,[b] Suzanne E. Bentler, PhD,[c] and Fredric D. Wolinsky, PhD[d]

ABSTRACT

Objectives: The comparative effect of chiropractic vs medical care on health, as used in everyday practice settings by older adults, is not well understood. The purpose of this study is to examine how chiropractic compares to medical treatment in episodes of care for uncomplicated back conditions. Episodes of care patterns between treatment groups are described, and effects on health outcomes among an older group of Medicare beneficiaries over a 2-year period are estimated.

Methods: Survey data from the nationally representative Survey on Assets and Health Dynamics among the Oldest Old were linked to participants' Medicare Part B claims under a restricted Data Use Agreement with the Centers for Medicare and Medicaid Services. Logistic regression was used to model the effect of chiropractic use in an episode of care relative to medical treatment on declines in function and well-being among a clinically homogenous older adult population. Two analytic approaches were used, the first assumed no selection bias and the second using propensity score analyses to adjust for selection effects in the outcome models.

Results: Episodes of care between treatment groups varied in duration and provider visit pattern. Among the unadjusted models, there was no significant difference between chiropractic and medical episodes of care. The propensity score results indicate a significant protective effect of chiropractic against declines in activities of daily living (ADLs), instrumental ADLs, and self-rated health (adjusted odds ratio [AOR], 0.49; AOR, 0.62; and AOR, 0.59, respectively). There was no difference between treatment types on declines in lower body function or depressive symptoms.

Conclusion: The findings from this study suggest that chiropractic use in episodes of care for uncomplicated back conditions has protective effects against declines in ADLs, instrumental ADLs, and self-rated health for older Medicare beneficiaries over a 2-year period. (J Manipulative Physiol Ther 2014;37:143-154)

Key Indexing Terms: *Chiropractic; Medicare; Episode of Care; Activities of Daily Living; Mobility Limitation*

The therapeutic and restorative benefit of chiropractic on functional abilities has been well established in clinical efficacy studies.[1-15] However, what is not known is the comparative effectiveness of chiropractic vs other common medical treatments for similar clinical conditions over time, especially among Medicare beneficiaries receiving their care in everyday practice settings. For uncomplicated back conditions (eg, strains and sprains, and nonspecific back disorders), Medicare patients have a variety of provider choices, including doctors of chiropractic (DCs), physical therapists, internists, neurologists, interventional pain providers, and orthopedists to name a few. Understanding which providers and treatments Medicare beneficiaries seek, how often they seek those treatments, and the effect of that care on health outcomes would inform clinicians and policy makers alike about the

[a] Candidate for PhD, Department of Health Management and Policy, College of Public Health, The University of Iowa, Iowa City, IA.

[b] Assistant Professor, Health Policy and Management, Rollins School of Public Health, Emory University, Atlanta, GA.

[c] Candidate for PhD, Department of Health Management and Policy, College of Public Health, The University of Iowa, Iowa City, IA.

[d] Professor, John W. Colloton Chair of Health Management and Policy, Department of Health Management and Policy, College of Public Health, The University of Iowa, Iowa City, IA.

Submit requests for reprints to: Paula A. Weigel, MS, 105 River St, N275 CPHB, Iowa City, IA 52242. (e-mail: *Paula-Weigel@uiowa.edu*).

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comparative effectiveness of various treatments for uncomplicated back conditions provided in everyday settings.

Investigating how chiropractic care is delivered to Medicare beneficiaries in everyday practice is especially important because treatment patterns there deviate substantially from those delivered under controlled clinical trial conditions, where the intent is to prove treatment efficacy.[16,17] As a result, the health effects that a patient actually realizes from chiropractic may differ from effects observed in more controlled research settings. Furthermore, understanding how chiropractic care episodes compare to medical care episodes on patient-reported health outcomes sheds light on whether the therapeutic benefits patients perceive is the same, better, or worse.[18]

Functional health changes are measured by the number of limitations in activities of daily living (ADLs), instrumental ADLs (IADLs), and lower body function (LBFs), and changes in well-being are measured by self-rated health and depressive symptoms. The 3 functional measures are standard disability indicators, and the 2 well-being measures are closely associated with future functional decline, dependency, and mortality.[19-26] Slowing the rate of functional decline, disability, and dependency among community-dwelling older adults reduces the threat of institutionalization and preserves autonomy and well-being, both of which are long-standing public health policy goals in the United States.[27]

In this study, we use Medicare provider claims linked to a national longitudinal survey of community-dwelling older adults to examine the use of chiropractic and medical treatments in back care episodes that are comparable based on clinical presentation. The purpose of this study is 2-fold: to describe back care episodes in terms of visit patterns and duration among a clinically homogeneous population of older Medicare beneficiaries and to examine whether care episodes involving chiropractic visits result in the same, better, or worse changes in functional health and well-being relative to medical-care-only episodes.

Methods

Study Population

Survey data from the nationally representative Survey on Assets and Health Dynamics among the Oldest Old (AHEAD) were linked to participants' Medicare Part B claims under a restricted Data Use Agreement with the Centers for Medicare and Medicaid Services[28] (additional documentation concerning the AHEAD, including its objectives, survey design, and description of the data can be found elsewhere[20,29-31]). The AHEAD survey data are rich, containing not only demographic and socioeconomic information but also details about a participant's physical and cognitive health status, disease history, and lifestyle behaviors that characterize how people age in the United States. Because the same participants were reinterviewed biennially, these data may be used to evaluate changes in older adults' health over time.

The AHEAD participants were 70 years or older when their baseline interviews were conducted between October 1993 and February 1994. In 1995, a survey question with important implications for functional health trajectories was added to the follow-up interviews ("On average over the last 12 months, have you participated in vigorous physical activity or exercise three times a week or more?"). Therefore, we used the 1995 follow-up interview as our starting point, along with the subsequent reinterviews conducted through 2006. Each pair of contiguous interviews (ie, 1995-1998, 1998-2000, 2000-2002, 2002-2004, and 2004-2006) defines an observation window for this study during which an uncomplicated back condition may have occurred. To be included in the analyses, participants had to have had at least 1 contiguous pair of interviews between 1995 and 2006.

In 1993, there were 7447 AHEAD participants. Of these, 774 did not provide consent to have their survey data linked to their Medicare claims, and linkage errors arose for 28 consenting participants. Another 774 participants had no follow-up interviews after baseline, either because of dying before the 1995 follow-up interview or for other reasons. Thus, the potentially available number of AHEAD participants for our study was 5871.

Sample Selection

To create a sample that was clinically homogenous and, therefore, comparable between treatments, we included only those AHEAD participants that met the following conditions. First, participants had to present to a clinician for 1 of 29 back-related conditions (Supplementary Table 1) in between contiguous interviews (eg, 1995-1998, 1998-2000, etc). Second, participants could only have experienced 1 back-related episode between those contiguous interviews. Third, participants could only have 1 pair of contiguous interviews with a back episode over the entire study period. This resulted in a constant 2-year observation window for contiguous interviews, eliminated clinical patterns suggesting more complex chronic or recurring back problems, and focused on participants having a single back condition episode that was more likely to have been acute.

Episodes of care were bounded by the first "from date" to the last "thru date" for Medicare claims having any of the diagnosis codes in Supplementary Table 1 occurring consecutively within 60 days of one another. For example, if a person's index visit to a clinician occurred on March 1 and the person had a subsequent provider claim with any of the back-related diagnosis codes before May 1 of the same year, these 2 claims would be considered part of the same care episode. If there was a third back-related claim with a date greater than 60 days from the second claim, the third

claim would be the start of a new episode. Under this algorithm, claims following in close proximity to each other were considered related and, therefore, part of the same back care episode. Because studies have shown that effective chiropractic therapy for back care may require up to 12 visits over several weeks,[32,33] multiple claims occurring within 60 days of each other would suggest a therapeutic plan for a single back problem episode rather than multiple back problem episodes. Medical treatments for the initial presentation of a nonspecific back condition, however, typically involve only 1 or 2 visits to the primary care provider and/or imaging specialist within 60 days of each other. Thus, medical care claims for a particular back episode would likely cluster together in a shorter time frame, whereas chiropractic claims for discrete episodes of back problems would likely cluster together over a longer time frame.

After all of the inclusion and exclusion criteria were applied, 1057 unique individuals experiencing only 1 episode of care for a back problem occurring between 2 contiguous interviews were identified. These 1057 participants account for 77% of the single back condition episodes in the data set.

Outcome Assessment

The 5 health outcomes on which we compared treatments were declines between contiguous interviews in ADL, IADL, and LBF abilities; declines in self-rated health; and increased depressive symptoms. Declines over the 2-year period between contiguous interviews were defined as the onset of an additional ADL, IADL, or LBF activity limitation, a 0.5 SD or more poorer rating on the Diehr-transformed self-rated health question or the onset of additional depressive symptoms on the Center for Epidemiological Studies of Depression (CES-D) 8 scale.[20] The 5-item ADL scale includes difficulties (or the inability of) getting across a room, getting dressed, bathing or showering, eating, and getting in or out of bed. The 5-item IADL scale includes difficulties (or the inability of) using a telephone, taking medication, handling money, shopping, and preparing meals. The 4-item LBF scale includes difficulties (or the inability of) climbing up and down 1 flight of stairs, walking several blocks, pushing or pulling heavy objects, and lifting or carrying 10 lb or more. The self-rated health question asks participants how they would rate their overall health, with response options of excellent (95), very good (90), good (80), fair (30), or poor (15). The CES-D 8 is scored as 1 point for each depressive symptom endorsed, including feeling depressed, feeling that everything was an effort, restless sleep, feeling happy, feeling lonely, enjoying life, feeling sad, and feeling that he/she could not get going.[34] Because the CES-D 8 was only obtained for self-respondents, the analytic sample for this outcome was restricted to the 951 self-respondents.

Focal Variable

The variable of interest is the type of treatment that an individual received during their back care episode. Episodes with 1 or more chiropractic treatments were characterized as chiropractic care episodes. Episodes without any chiropractic treatments were characterized as medical services only back care episodes. Because our objective is to capture differential effects of chiropractic during back care episodes, chiropractic episodes could consist only of chiropractic services or of chiropractic and medical treatments. Although this approach might lead to misclassification (heterogeneity), the number of episodes with co-occurring treatment types was assumed to be small, and the proportion of chiropractic visits within those integrated episodes was assumed to be large.[17] In the final analysis, each individual was classified as either having chiropractic or medical-only treatment episodes.

Covariates

All models included covariates to adjust for differences in predisposing, enabling, and need characteristics identified in the behavioral model of health services use.[35,36] Predisposing characteristics included age, sex, race, and marital status. Enabling characteristics included level of education achieved, income quintiles, whether an individual had additional health insurance policies, and employment status at the time of the first interview. Need characteristics at the beginning of a contiguous pair of interviews included whether a person had 3 or more comorbid health conditions, 10 disease history indicators, pain, vision and hearing status, physical function, self-rated health, healthy lifestyle (engaging in vigorous exercise, body mass, smoking status, and alcohol consumption), prior hospitalizations, and back care episodes during 1993 to 1995. Respondent status (self-respondent or proxy) at both contiguous interviews was also included to adjust for differences in source data over time. Further detail on all of these measures, including interaction terms between respondent status and functional abilities at the first of the contiguous pair of interviews, can be found in Wolinsky et al.[20]

Analysis

The comparative effectiveness of chiropractic care episodes to medical-only episodes on declines in function and well-being is assessed using multivariable logistic regression. The model is estimated in 2 ways. The first assumes that there was no selection bias between individuals who chose chiropractic in an episode of care vs individuals who chose only medical care for their episode of care. The second approach uses propensity score methods to adjust for potential selection bias between individuals and their treatment choices. Modeling treatment selection yields a propensity score for each individual that reflects his

or her likelihood of choosing a particular treatment type. The propensity score weighted regression models use the inverse of the estimated propensity scores to adjust the traditional population sampling weights for the AHEAD in the logistic regression analyses, taking into account each person's estimated probability of choosing a particular treatment type when modeling the outcome-treatment relationship.[37-41]

The propensity score estimates, $\hat{p}$, were obtained by regressing the treatment group a person was in (chiropractic vs medical-only care episodes) on all of the observable covariates at the first of the 2 contiguous interviews, plus several provider supply and county-level area variables shown to be predictive of chiropractic use that were available at the baseline AHEAD interview.[42-45] Propensity score weights were then calculated by inverting the probability of choosing chiropractic care ($1/\hat{p}$) or medical-only care ($1/1 - \hat{p}$) and subsequently using these weights to adjust the population sampling weights by multiplying the 2 weights together. The propensity score adjusted weights were then used to weight all outcome regression models.

Human Subjects Approval

This research was supported by grants R01 AG022913 and R21 AT004578 from the National Institutes of Health (NIH) to Dr Wolinsky. The human subject protocol was fully approved by the University of Iowa Institutional Review Board in March 2003 and annually thereafter. A restricted data agreement with the University of Michigan Survey Research Center (2003-006) and subsequent completion and approval of a data use agreement with the Centers for Medicare and Medicaid Services (DUA 14807) were approved in March 2005 with subsequent modifications and extensions through 2014. Written informed consent was obtained from all AHEAD participants.

Results

Descriptive Data

Of the 1057 persons in the sample, 174 (16.5%) had episodes of care containing at least 1 visit to a DC. The mean age was 82 years. Thirty-three percent were men, and 89% percent were white. Thirty-eight percent had 3 or more comorbid health conditions, and nearly half were overweight or obese. The mean number of limitations in ADLs was 0.58 (of 5), the mean number of limitations in IADLs was 0.54 (of 5), and the mean number of limitations in LBFs was 1.39 (of 4). Sixty-two percent of the sample rated their health as good or better at their first contiguous interview, and the mean number of depressive symptoms was 1.70 (of 8, among self-respondents). Table 1 provides mean values at the first contiguous interview and separately for chiropractic vs medical care episodes. Significance tests illustrate major differences between treatment groups.

Demographically, a statistically greater proportion of persons having chiropractic care in their back episode were men, white, married, completed high school, and in the highest income quintile compared with those receiving only medical care during their episodes. Among those older adults choosing chiropractic, there was a lower proportion of persons with angina and fewer ADL limitations (0.27 vs 0.64), IADL limitations (0.28 vs 0.60), and LBF limitations (0.99 vs 1.48) at the first contiguous interview. Self-rated health was statistically higher in the chiropractic care group, with 71% rating their health good or better compared with 59% for those with medical-only care. Of the self-respondents in each treatment group, the mean number of endorsed depressive symptoms was lower in the chiropractic care group (1.42 vs 1.76). Only 25% of persons in the chiropractic care group reported pain at the first of the contiguous interviews vs 38% in the medical-only group. Of the lifestyle factors, 40% of the chiropractic care group reported engaging in vigorous exercise, relative to only 27% in the medical-only care group, yet 59% of the persons in the chiropractic group were overweight or obese relative to 47% in the medical-only group. Thirty-two percent of chiropractic care users reported drinking more than 1 alcoholic drink per day vs 20% in the medical-only group. A lower proportion of chiropractic care users were hospitalized in the year before their first interview (30% vs 38%), and a greater proportion were self-respondents at both interviews of the contiguous surveys (88% vs 82%).

Table 2 summarizes the episode characteristics by treatment group and illustrates that care episodes were quite different in terms of duration and provider visits. The chiropractic care episodes averaged 125 days in duration or roughly 4 months, compared with medical-care-only episodes that averaged approximately 15 days. The chiropractic care episodes averaged 9 provider visits, of which 8 were to DCs. Medical-care-only episodes averaged 2.4 provider visits, with 1 visit to a primary care provider and the remainder distributed across physicians specializing in imaging, orthopedics, interventional pain management, and other services.

A simple χ^2 test of proportions between care groups and health outcomes showed significant differences between type of care episode and decline in function and well-being. More than 30% of individuals with medical-care-only episodes declined in ADLs vs only 19% of persons with chiropractic care episodes ($P = .003$). For IADLs, 29% of individuals with medical-only episodes declined vs approximately 18% of those with chiropractic care episodes ($P = .002$). Lower body function decline also differed by treatment group, with almost 38% of individuals with medical-only episodes having declined vs 30% of individuals with chiropractic care episodes ($P = .05$). There were no significant differences between care groups and declines in self-rated health (38.4% medical-only vs 36.5% chiropractic) or worsening depressive symptoms (33.4% medical-only vs 33.8% chiropractic).

Table 1. *Mean Values of Entire Sample and by Episode Group*

	Entire Analytic Sample (n = 1057)	Persons With Chiropractic Episodes [a] (n = 174)	Persons With Medical-Care-Only Episodes (n = 883)
Age	81.7	81.0	81.8
Male	0.33	0.45 [c]	0.30
Race			
White	0.89	0.96 [c]	0.87
African American	0.07	0.01 [c]	0.08
Hispanic	0.04	0.02	0.04
Married	0.45	0.55 [c]	0.43
Education			
Grade school	0.21	0.17	0.22
Some high school	0.16	0.12	0.16
High school	0.33	0.39 [d]	0.32
Some college	0.30	0.32	0.30
Income quintile			
First (lowest)	0.11	0.05 [c]	0.12
Second	0.25	0.18 [d]	0.26
Third	0.12	0.13	0.12
Fourth	0.19	0.22	0.19
Fifth (highest)	0.33	0.41 [c]	0.31
More than 1 insurance policy	0.04	0.04	0.04
Working	0.06	0.07	0.06
Health status in 1995			
Three or more comorbid conditions	0.38	0.34	0.39
Angina	0.10	0.06	0.11
Arthritis	0.65	0.58 [d]	0.67
Cancer	0.17	0.18	0.17
Diabetes	0.12	0.12	0.12
Heart attack	0.04	0.03	0.04
Hip fracture	0.02	0.02	0.03
Hypertension	0.55	0.53	0.55
Lung disease	0.10	0.12	0.09
Psychological problems	0.12	0.08	0.12
Stroke	0.14	0.13	0.14
Prior fall	0.38	0.32	0.40
ADL limitations	0.58	0.27 [e]	0.64
IADL limitations	0.54	0.28 [e]	0.60
LBF limitations	1.39	0.99 [e]	1.48
Self-rated health good or better	0.62	0.71 [c]	0.59
Depressive symptoms [b]	1.70	1.42 [d]	1.76
Good vision	0.45	0.46	0.44
Good hearing	0.46	0.45	0.46
Pain	0.36	0.25 [c]	0.38
Lifestyle factors in 1995			
Vigorous activity	0.29	0.40 [e]	0.27
Overweight/obese	0.49	0.59 [c]	0.47
Former smoker	0.45	0.50	0.44
Current smoker	0.05	0.04	0.05
Drink >1 alcoholic drink per day	0.22	0.32 [c]	0.20
Health services use			
Prior hospitalization	0.37	0.30 [d]	0.38
Prior back condition episode	0.14	0.18	0.13
Respondent status			
Self-respondent at survey 1 and survey 2	0.83	0.88 [d]	0.82
Self-respondent at survey 1, proxy at survey 2	0.08	0.06	0.08
Proxy at survey 1, self-respondent at survey 2	0.02	0.03	0.02
Proxy at survey 1, proxy at survey 2	0.07	0.03 [d]	0.08

ADL, activities of daily living; *IADL*, instrumental activities of daily living; *LBF*, lower body function.

[a] χ^2 Test of proportions used for categorical variables, *t* tests used for continuous.

[b] Depressive symptoms count was asked only of self-respondents (n = 951).

[c] Statistical significance at $P < .01$.

[d] $P < .05$.

[e] $P < .0001$.

Table 2. *Episode Description by Group*

	n	Mean Days in Episode	Mean Provider Visits in Episode	Provider Type				
				Mean Number of Visits to DC	Mean Number of Visits to Primary Care	Mean Number of Visits to Imaging	Mean Number of Visits to Orthopedist	Mean Number of Visits to Interventional Pain Physicians
Chiropractic episodes [a]	174	125.4	8.8	7.8	0.5	0.2	0.1	0.2
Chiropractic only	130	106.3	7.0	7.0	0	0	0	0
Chiropractic + medical	44	185.8	14.6	10.3	2.2	0.8	0.3	0.8
Medical-only episodes	883	14.9	2.4	0	1	0.4	0.3	0.2

DC, doctor of chiropractic.
[a] Chiropractic episodes include episodes with chiropractic services only (73%) and episodes that have chiropractic and medical services (24%).

Model Results

The effect of chiropractic relative to medical-care-only episodes on declines in function and well-being for the models assuming no selection bias vs the propensity score adjusted models is shown in Table 3. Among the models assuming no selection bias, the adjusted odds ratio (AOR) for chiropractic (vs medical only) care episodes and declines in function and well-being revealed no statistically significant differences between care types. In the propensity score weighted models, chiropractic care had a statistically significant protective effect against ADL declines (AOR, 0.49; $P = .003$), IADL declines (AOR, 0.62; $P = .04$), and declines in self-rated health (AOR, 0.59; $P = .008$).

Both sets of models fit the data well, with C-statistics ranging from a low of 0.703 (decline in depressive symptoms model) to 0.799 (decline in IADLs). The Hosmer-Lemeshow statistics, however, were significant for the propensity score weighted model predicting decline in ADLs and for the decline in depressive symptoms model unadjusted for selection bias, suggesting heteroscedastic error.[46] The propensity score models achieved balance in covariate mean values at the first of the contiguous interviews compared with the original baseline mean values (Supplementary Table 2). Full regression results for the 10 models are available from the first author upon request.

Discussion

This study was built upon a previously developed algorithm to define episodes of chiropractic care for back problems.[17] Applying this algorithm to a nationally representative sample of older Medicare beneficiaries resulted in 1057 individuals having clinically similar presentations of back problems occurring in between 2 interviews that were all 2 years apart. The pattern of chiropractic care episodes closely aligned with reports from other studies demonstrating chiropractic efficacy and was also consistent with research that showed little overlap between care provided by DCs and care provided by medical providers during back episodes.[1,2,17,33,47-49] Within an average chiropractic care episode, only 1 of 9 visits was to a nonchiropractic provider, reflecting the fact that individuals clearly had strong preferences for either chiropractic care or medical care, but not an admixture of the two.

Without adjusting for potential selection bias into chiropractic vs medical care episodes, our findings revealed no statistically significant differences between chiropractic treatment and medical care only in single, nonrecurring episodes of back conditions over a 2-year period. After reweighting the data for individual propensities to use chiropractic vs medical care, however, we observed a protective effect of chiropractic against declines in ADLs, IADLs, and declines in self-rated health. The propensity score weighted model results are particularly interesting because they statistically balanced the groups using propensity scores to remove the preexisting functional and self-rated health advantages among individuals choosing chiropractic care, and the effect of chiropractic care on function and health became significantly protective. These results suggest that when chiropractic care is delivered in practice at care levels comparable to those used in clinical trials and relative to the types of services delivered within an episode of medical care only, chiropractic confers significant and substantial benefits to older adult functional ability and self-rated health.

We found no differential effects on declines in LBF or depressive symptoms between chiropractic and medical services only episodes. This indicates that although chiropractic care was not significantly more beneficial for these health outcomes, chiropractic care did provide comparable benefits compared with medical care only on these 2 health outcomes.

Limitations

There are several limitations to this study, the first of which concerns the clinical homogeneity of the sample. We assumed that our sample selection criteria that identified

Table 3. *Adjusted Odds Ratios of Chiropractic Care Episodes Relative to Medical-Only Episodes on Declines in Health*

	Decline in ADLs	Decline in IADLs	Decline in LBF	Decline in Self-Rated Health	Decline in Depressive Symptoms
Ignoring selection bias model					
Chiropractic care episodes	0.66	0.69	0.72	0.71	0.95
95% confidence interval	0.416-1.058	0.427-1.121	0.489-1.055	0.493-1.035	0.650-1.380
P	.08	.13	.09	.08	.77
Propensity score model					
Chiropractic care episodes	0.49 [a]	0.62 [a]	0.74	0.59 [a]	1.06
95% confidence interval	0.307-0.788 [a]	0.383-0.988 [a]	0.505-1.097	0.397-0.868 [a]	0.723-1.54
P	.003 [a]	.04 [a]	.14	.008 [a]	.78

ADL, activities of daily living; *IADL*, instrumental activities of daily living; *LBF*, lower body function.
[a] Statistical significance at $P < .05$.

only those individuals presenting to clinicians with any of the 29 back conditions for a single episode of care in between the contiguous survey interviews resulted in homogeneity in terms of the nonspecificity, complexity, and chronicity of their conditions. Medicare claims, however, are simply not sufficiently granular to empirically demonstrate this assumption.

A second limitation pertains to how the episodes of care were defined. The algorithm used here operated under a 60-day gap between sequential claims to determine the end of an episode and the start of a new one. In previous sensitivity analyses using different gap lengths, we examined the effect on episode duration and provider distribution and found shorter gaps left many imaging claims unlinked to other services. Although future studies might find that different claims-bundling strategies for defining episodes of care result in different mean episode characteristics, our results are consistent with other research, particularly among the AHEAD sample.

A third limitation with our analysis is combining episodes of care containing medical and chiropractic services with chiropractic-only episodes of care. These types of episodes may be very different from one another in their effect on health. Moreover, the episode descriptives for chiropractic-integrated care illustrate a greater number of chiropractic services and longer episode duration than those in the pure chiropractic services-only episodes, indicating the possibility of more complex back conditions. Thus, heterogeneity resulting from combining these episode types may resulted in underestimating the magnitude of the beneficial effect of chiropractic.

A fourth limitation to this study is the temporal relationship between the effect of treatment for back care and the ascertainment of health outcomes. We did not account for the timing of the back treatment within the 2-year window between survey interviews. This creates the possibility that other factors besides back problems may influence responses to the survey questions measuring ADLs, IADLs, LBFs, self-rated health, and depressive symptoms.

An additional limitation is that although we have addressed selection bias by using propensity score methods, this approach may not have adjusted for unobserved confounders that could affect the care episode type and health outcome relationship (eg, a preference for health that drives other unobserved behaviors affecting functional ability). As a result, selection bias may still be affecting the protective effects of chiropractic care that we observed.

Conclusion

This study provides evidence of the comparative effectiveness of chiropractic care relative to medical-only services on the functional health of older adults during acute episodes of back care. Our results are the first to show the importance of examining chiropractic use within an episode of care in traditional practice settings, rather than focusing on visit frequency alone. Moreover, we evaluated the effects of the treatments received during the episodes on ADLs, IADLs, and LBFs, which are critically important measures that inform patients, clinicians, and payers about the benefits and harms of certain treatments relative to others. Given the literature supporting a minimally effective chiropractic treatment level for back problems, this research provides additional support that such therapeutic levels are indeed beneficial in terms of protecting older persons from functional declines and self-rated health over as much as 2 years.

Practical Applications

- Chiropractic episodes were longer in duration and contained more visits to providers than those that were medical-only episodes.
- Chiropractic care episodes are protective against 2-year declines in ADLs among older adults.
- Chiropractic care episodes are protective against 2-year declines in LBF among older adults.
- No comparative benefit or harm of chiropractic episodes on declines in instrumental ADLs, self-rated health, and depressive symptoms among older adults.

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Contributorship Information

Concept development (provided idea for the research): FDW, JH, PW, SB.

Design (planned the methods to generate the results): PW, FDW, JH.

Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): FDW.

Data collection/processing (responsible for experiments, patient management, organization, or reporting data): SB, PW.

Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): PW

Literature search (performed the literature search): PW

Writing (responsible for writing a substantive part of the manuscript): PW, FDW.

Critical review (revised manuscript for intellectual content, this does not relate to spelling and grammar checking): JH, SB.

References

1. Bronfort G, Haas M, Evans R, Kawchuk G, Dagenais S. Evidence-informed management of chronic low back pain with spinal manipulation and mobilization. Spine J 2008;8:213-25. http://dx.doi.org/10.1016/j.spinee.2007.10.023 [Epub 2008/01/01. PubMed PMID: 18164469].
2. Bronfort G, Haas M, Evans R, Leininger B, Triano J. Effectiveness of manual therapies: the UK evidence report. Chiropr Osteopat 2010;18:3. http://dx.doi.org/10.1186/1746-1340-18-3 [Epub 2010/02/27. PubMed PMID: 20184717; PubMed Central PMCID: PMC2841070].
3. Bronfort G, Maiers MJ, Evans RL, et al. Supervised exercise, spinal manipulation, and home exercise for chronic low back pain: a randomized clinical trial. Spine J 2011;11:585-98. http://dx.doi.org/10.1016/j.spinee.2011.01.036 [Epub 2011/05/31. PubMed PMID: 21622028].
4. Evans R, Bronfort G, Schulz C, et al. Supervised exercise with and without spinal manipulation perform similarly and better than home exercise for chronic neck pain: a randomized controlled trial. Spine 2011. http://dx.doi.org/10.1097/BRS.0b013e31823b3bdf [Epub 2011/10/26. PubMed PMID: 22024905].
5. Lawrence DJ, Meeker W, Branson R, et al. Chiropractic management of low back pain and low back-related leg complaints: a literature synthesis. J Manipulative Physiol Ther 2008;31:659-74. http://dx.doi.org/10.1016/j.jmpt.2008.10.007 [Epub 2008/11/26. PubMed PMID: 19028250].
6. Leininger B, Bronfort G, Evans R, Reiter T. Spinal manipulation or mobilization for radiculopathy: a systematic review. Phys Med Rehabil Clin N Am 2011;22:105-25. http://dx.doi.org/10.1016/j.pmr.2010.11.002 [Epub 2011/02/05. PubMed PMID: 21292148].
7. Standaert CJ, Friedly J, Erwin MW, et al. Comparative effectiveness of exercise, acupuncture, and spinal manipulation for low back pain. Spine 2011;36:S120-30. http://dx.doi.org/10.1097/BRS.0b013e31822ef878.
8. Goertz CM, Long CR, Hondras MA, et al. Adding chiropractic manipulative therapy to standard medical care for patients with acute low back pain: results of a pragmatic randomized comparative effectiveness study. Spine 2013;38:627-34. http://dx.doi.org/10.1097/BRS.0b013e31827733e7 [Epub 2012/10/13. PubMed PMID: 23060056].
9. Hondras MA, Long CR, Cao Y, Rowell RM, Meeker WC. A randomized controlled trial comparing 2 types of spinal manipulation and minimal conservative medical care for adults 55 years and older with subacute or chronic low back pain. J Manipulative Physiol Ther 2009;32:330-43. http://dx.doi.org/10.1016/j.jmpt.2009.04.012 [Epub 2009/06/23. PubMed PMID: 19539115].
10. Chou R, Huffman LH. Nonpharmacologic therapies for acute and chronic low back pain: a review of the evidence for an American Pain Society/American College of Physicians clinical practice guideline. Ann Intern Med 2007;147:492-504 [Epub 2007/10/03. PubMed PMID: 17909210].
11. Haldeman S, Dagenais S. What have we learned about the evidence-informed management of chronic low back pain? Spine J 2008;8:266-77. http://dx.doi.org/10.1016/j.spinee.2007.10.026 [Epub 2008/01/01. PubMed PMID: 18164475].
12. Hurwitz EL, Morgenstern H, Harber P, et al. A randomized trial of medical care with and without physical therapy and chiropractic care with and without physical modalities for patients with low back pain: 6-month follow-up outcomes from the UCLA low back pain study. Spine 2002;27:2193-204. http://dx.doi.org/10.1097/01.BRS.0000029253.40547.84 [Epub 2002/10/24. PubMed PMID: 12394892].
13. Walker BF, French SD, Grant W, Green S. A Cochrane review of combined chiropractic interventions for low-back pain. Spine 2011;36:230-42. http://dx.doi.org/10.1097/BRS.0b013e318202ac73 [Epub 2011/01/21. PubMed PMID: 21248591].
14. Rubinstein SM, van Middelkoop M, Assendelft WJ, de Boer MR, van Tulder MW. Spinal manipulative therapy for chronic low-back pain: an update of a Cochrane review. Spine 2011;36:E825-46. http://dx.doi.org/10.1097/BRS.0b013e3182197fe1 [Epub 2011/05/20. PubMed PMID: 21593658].
15. Lefebvre R, Peterson D, Haas M. Evidence-based practice and chiropractic care. J Evid Based Complementary Altern Med 2012;18:75-9. http://dx.doi.org/10.1177/2156587212458435 [Epub 2013/07/23. PubMed PMID: 23875117, PubMed Central PMCID: PMC3716373].
16. Weigel P, Hockenberry JM, Bentler SE, et al. A longitudinal study of chiropractic use among older adults in the United States. Chiropr Osteopat 2010;18:34. http://dx.doi.org/10.1186/1746-1340-18-34 [Epub 2010/12/24. PubMed PMID: 21176137; PubMed Central PMCID: PMC3019203].
17. Weigel PA, Hockenberry JM, Bentler SE, Kaskie B, Wolinsky FD. Chiropractic episodes and the co-occurrence of chiropractic and health services use among older Medicare beneficiaries. J Manipulative Physiol Ther 2012. http://dx.doi.org/10.1016/j.jmpt.2012.01.011 [Epub 2012/03/06. PubMed PMID: 22386915].
18. Johnson C. Comparative effectiveness research and the chiropractic profession. J Manipulative Physiol Ther 2010;33:243-50.

19. Reuben DB, Valle LA, Hays RD, Siu AL. Measuring physical function in community-dwelling older persons: a comparison of self-administered, interviewer-administered, and performance-based measures. J Am Geriatr Soc 1995;43:17-23 [Epub 1995/01/01. PubMed PMID: 7806733].
20. Wolinsky FD, Bentler SE, Hockenberry J, Jones MP, Obrizan M, Weigel PA, et al. Long-term declines in ADLs, IADLs, and mobility among older Medicare beneficiaries. BMC Geriatr 2011;11:43-55. http://dx.doi.org/10.1186/1471-2318-11-43 [Epub 2011/08/19. PubMed PMID: 21846400; PubMed Central PMCID: PMC3167753].
21. Katz S. Assessing self-maintenance: activities of daily living, mobility, and instrumental activities of daily living. J Am Geriatr Soc 1983;31:721-7 [Epub 1983/12/01. PubMed PMID: 6418786].
22. Idler EL, Benyamini Y. Self-rated health and mortality: a review of twenty-seven community studies. J Health Soc Behav 1997;38:21-37 [PubMed PMID: 9097506].
23. Idler EL, Kasl SV. Self-ratings of health: do they also predict change in functional ability? J Gerontol B Psychol Sci Soc Sci 1995;50:S344-53 [PubMed PMID: 7583813].
24. Lenze EJ, Rogers JC, Martire LM, Mulsant BH, Rollman BL, Dew MA, et al. The association of late-life depression and anxiety with physical disability: a review of the literature and prospectus for future research. Am J Geriatr Psychiatr 2001;9:113-35 [PubMed PMID: 11316616].
25. Lenze EJ, Schulz R, Martire LM, Zdaniuk B, Glass T, Kop WJ, et al. The course of functional decline in older people with persistently elevated depressive symptoms: longitudinal findings from the Cardiovascular Health Study. J Am Geriatr Soc 2005;53:569-75. http://dx.doi.org/10.1111/j.1532-5415.2005.53202.x [PubMed PMID: 15817000].
26. Benyamini Y. Why does self-rated health predict mortality? An update on current knowledge and a research agenda for psychologists. Psychol Health 2011;26:1407-13. http://dx.doi.org/10.1080/08870446.2011.621703 [PubMed PMID: 22111660].
27. Healthy People 2020. In: Services USDoHaH, editor. Washington, DC: Office of Disease Prevention and Health Promotion.
28. Weigel PA, Hockenberry J, Bentler S, Wolinsky FD. Chiropractic use and changes in health among older Medicare beneficiaries: a comparative effectiveness observational study. J Manipulative Physiol Ther 2013;36:572-84. http://dx.doi.org/10.1016/j.jmpt.2013.08.008 [PubMed PMID: 24144425].
29. Juster F, Suzman R. An overview of the Health and Retirement Study. J Human Resources 1995;30:S7-S56 [PubMed PMID: doi:10.2307/146277].
30. Myers G, Juster F, Suzman R. Asset and Health Dynamics Among the Oldest Old (AHEAD): initial results from the longitudinal study. J Gerontol: Psych, Soc Sc 1997;52B(Special).
31. Health and Retirement Study (HRS), Data Description: Assets and Health Dynamics Among the Oldest Old (AHEAD). University of Michigan. Ann Arbor: MI; 1998.
32. Descarreaux M, Blouin JS, Drolet M, Papadimitriou S, Teasdale N. Efficacy of preventive spinal manipulation for chronic low-back pain and related disabilities: a preliminary study. J Manipulative Physiol Ther 2004;27:509-14. http://dx.doi.org/10.1016/j.jmpt.2004.08.003 [Epub 2004/10/29. PubMed PMID: 15510094].
33. Haas M, Groupp E, Kraemer DF. Dose-response for chiropractic care of chronic low back pain. Spine J 2004;4:574-83. http://dx.doi.org/10.1016/j.spinee.2004.02.008 [Epub 2004/09/15. PubMed PMID: 15363431].
34. RB Wallace AH, MB Ofstedal, D Steffick, S Fonda, K Lange. Health and Retirement Study (HRS), Documentation of Affective Functioning Measures in the HRS (2000), University of Michigan, Ann Arbor, MI. Ann Arbor, MI: University of Michigan, U01AG009740) NIoAgnN; 2000 Contract No.: DR-005.
35. Aday LA, Andersen RM. Health Care Utilization and Behavior, Models of. 2005. Encyclopedia of Biostatistics [Internet]. John Wiley & Sons, Ltd; 2005.
36. Andersen R. Revisiting the behavioral model and access to medical care: does it matter? J Health Soc Behav 1995;36:1-10. http://dx.doi.org/10.2307/2137284 [PubMed PMID].
37. Austin PC. Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. Stat Med 2009;28:3083-107. http://dx.doi.org/10.1002/sim.3697 [Epub 2009/09/17. PubMed PMID: 19757444; PubMed Central PMCID: PMC3472075].
38. D'Agostino RB. Propensity score methods for bias reduction in the comparison of a treatment to a non-randomized control group. Stat Med 1998;17:2265-81. http://dx.doi.org/10.1002/(sici)1097-0258(19981015)17:19<2265::aid-sim918>3.0.co;2-b.
39. Freedman DA, Berk RA. Weighting regressions by propensity scores. Eval Rev 2008;32:392-409. http://dx.doi.org/10.1177/0193841X08317586 [Epub 2008/07/02. PubMed PMID: 18591709].
40. Rosenbaum PR, Rubin DB. The central role of the propensity score in observational studies for causal effects. Biometrika 1983;70:41-55. http://dx.doi.org/10.1093/biomet/70.1.41.
41. Shadish WR, Steiner PM. A primer on propensity score analysis. Newborn Infant Nurs Rev 2010;10:19-26. http://dx.doi.org/10.1053/j.nainr.2009.12.010.
42. Whedon JM, Davis MA. Medicare part B claims for chiropractic spinal manipulation, 1998 to 2004. J Manipulative Physiol Ther 2010;33:558-61. http://dx.doi.org/10.1016/j.jmpt.2010.09.004 [Epub 2010/11/03. PubMed PMID: 21036277; PubMed Central PMCID: PMC2998184].
43. Whedon JM, Song Y. Geographic variations in availability and use of chiropractic under Medicare. J Manipulative Physiol Ther 2012;35:101-9. http://dx.doi.org/10.1016/j.jmpt.2011.12.004 [Epub 2012/01/20. PubMed PMID: 22257945; PubMed Central PMCID: PMC3278567].
44. Whedon JM, Song Y, Davis MA, Lurie JD. Use of chiropractic spinal manipulation in older adults is strongly correlated with supply. Spine 2012. http://dx.doi.org/10.1097/BRS.0b013e31825762b7 [Epub 2012/04/11. PubMed PMID: 22487711].
45. Weeks WB, Whedon JM, Toler A, Goertz CM. Medicare's demonstration of expanded coverage for chiropractic services: limitations of the demonstration and an alternative direct cost estimate. J Manipulative Physiol Ther 2013;36:468-81. http://dx.doi.org/10.1016/j.jmpt.2013.07.003 [PubMed PMID: 23993755].
46. Hosmer D, Lemeshow S. New York: Wiley; 1989.
47. Sharma R, Haas M, Stano M. Patient attitudes, insurance, and other determinants of self-referral to medical and chiropractic physicians. Am J Public Health 2003;93:2111-7 [Epub 2003/12/04. PubMed PMID: 14652343; PubMed Central PMCID: PMC1448161].
48. Shekelle PG, Markovich M, Louie R. Comparing the costs between provider types of episodes of back pain care. Spine 1995;20:221-6 [discussion 7. PubMed PMID: 7716629].
49. Shekelle PG, Markovich M, Louie R. Factors associated with choosing a chiropractor for episodes of back pain care. Med Care 1995;33:842-50 [PubMed PMID: 7637405].

Appendix. Supplementary Tables

Supplementary Table 1. *International Classification of Diseases, Ninth Edition, Clinical Modification, Diagnosis Codes Used to Identify Back Conditions for Which Chiropractic or Medical Care May Be Received*

Category	Description
Dorsopathies—spondylosis and allied disorders	
721.2	Thoracic spondylosis without myelopathy
721.3	Lumbosacral spondylosis without myelopathy
721.4	Thoracic or lumbar spondylosis with myelopathy
721.5	Kissing spine; Baastrup's syndrome
721.6	Ankylosing vertebral hyperostosis
721.7	Traumatic spondylopathy; Kümmell's disease or spondylitis
721.8	Other allied disorders of spine
721.9	Spondylosis of unspecified site
Dorsopathies—intervertebral disk disorders	
722.1	Displacement of thoracic or lumbar intervertebral disk without myelopathy
722.2	Displacement of intervertebral disk, site unspecified, without myelopathy
722.5	Degeneration of thoracic or lumbar intervertebral disk
722.6	Degeneration of intervertebral disk, site unspecified
722.7	Intervertebral disk disorder with myelopathy
722.8	Postlaminectomy syndrome
722.9	Other and unspecified disk disorder; calcification of intervertebral cartilage or disk discitis
Dorsopathies—other and unspecified disorders of back	
724	Other and unspecified disorders of back
Osteopathies, chondropathies, and acquired musculoskeletal deformities	
738.4	Acquired spondylolisthesis
738.5	Other acquired deformity of back or spine
Osteopathies, chondropathies, and acquired musculoskeletal deformities, nonspecific—nonallopathic lesions not elsewhere classified	
739.2	Thoracic region
739.3	Lumbar region
739.4	Sacral region
Dislocation—other, multiple, and ill-defined dislocations	
839.2	Thoracic and lumbar vertebra, closed
839.3	Thoracic and lumbar vertebra, open
839.4	Other vertebra, closed
Sprains and strains of joints and adjacent muscles—sacroiliac region	
846	Sprains and strains of sacroiliac region
Sprains and strains of joints and adjacent muscles—other and unspecified parts of back	
847.1	Thoracic
847.2	Lumbar
847.3	Sacrum
847.4	Coccyx

Supplementary Table 2. *Comparison of Group Mean Values Before and After Propensity Score Adjustment*

	Unadjusted Mean Values			Propensity Score Adjusted Mean Values		
	Persons With Chiropractic Episodes (n = 174)	Persons With Medical-Care-Only Episodes (n = 883)	*P* [a]	Persons With Chiropractic Episodes (n = 174)	Persons With Medical-Only Episodes (n = 883)	*P* [a]
Age	81.0	81.8	.06	82.0	81.7	.55
Male	0.45 [c]	0.30	.001	0.30	0.33	.56
Race						
White	0.96 [c]	0.87	.0004	0.87	0.89	.58
African American	0.01 [c]	0.08	.002	0.08	0.07	.52
Hispanic	0.02	0.04	.16	0.05	0.04	.64
Married	0.55 [c]	0.43	.002	0.44	0.45	.79
Education						
Grade school	0.17	0.22	.13	0.18	0.21	.39
Some high school	0.12	0.16	.12	0.13	0.16	.19
High school	0.39 [d]	0.32	.05	0.39	0.32	.09
Some college	0.32	0.30	.58	0.30	0.30	.97
Income quintile						
First (lowest)	0.05 [c]	0.12	.003	0.09	0.11	.53
Second	0.18 [d]	0.26	.02	0.28	0.25	.36
Third	0.13	0.12	.52	0.16	0.12	.23
Fourth	0.22	0.19	.28	0.16	0.19	.32
Fifth (highest)	0.41 [c]	0.31	.008	0.31	0.33	.55
More than 1 insurance policy	0.04	0.04	.84	0.03	0.04	.55
Working	0.07	0.06	.43	0.05	0.06	.61
Health status in 1995						
≥3 comorbid conditions	0.34	0.39	.19	0.36	0.38	.53
Angina	0.06	0.11	.07	0.09	0.10	.73
Arthritis	0.58 [d]	0.67	.02	0.62	0.66	.36
Cancer	0.18	0.17	.77	0.15	0.17	.50
Diabetes	0.12	0.12	.90	0.11	0.12	.53
Heart attack	0.03	0.04	.53	0.03	0.04	.72
Hip fracture	0.02	0.03	.69	0.02	0.02	.75
Hypertension	0.53	0.55	.55	0.53	0.55	.69
Lung disease	0.12	0.09	.19	0.10	0.10	.95
Psychological problems	0.08	0.12	.06	0.13	0.12	.73
Stroke	0.13	0.14	.81	0.12	0.14	.48
Prior fall	0.32	0.40	.07	0.38	0.39	.89
ADL limitations	0.27 [e]	0.64	<.0001	0.48	0.57	.22
IADL limitations	0.28 [e]	0.60	<.0001	0.50	0.54	.67
LBF limitations	0.99 [e]	1.48	<.0001	1.46	1.40	.60
Self-rated health good or better	0.71 [c]	0.59	.002	0.60	0.62	.61
Depressive symptoms [b]	1.42 [d]	1.76	.03	1.92	1.70	.18
Good vision	0.46	0.44	.74	0.41	0.45	.37
Good hearing	0.45	0.46	.69	0.44	0.46	.66
Pain	0.25 [c]	0.38	.0004	0.39	0.36	.36
Lifestyle factors in 1995						
Vigorous activity	0.40 [e]	0.27	.0001	0.31	0.29	.66
Overweight/obese	0.59 [c]	0.47	.003	0.51	0.49	.65
Former smoker	0.50	0.44	.12	0.41	0.45	.34
Current smoker	0.04	0.05	.49	0.06	0.05	.50
Drink >1 alcoholic drink per day	0.32 [c]	0.20	.0003	0.21	0.22	.75
Health services use						
Prior hospitalization	0.30 [d]	0.38	.04	0.34	0.37	.53
Prior back condition episode	0.18	0.13	.11	0.13	0.14	.67
Respondent status						
Self-respondent at survey 1 and survey 2	0.88 [d]	0.82	.04	0.87	0.83	.14
Self-respondent at survey 1, proxy at survey 2	0.06	0.08	.22	0.06	0.08	.36

(*continued on next page*)

Supplementary Table 2. (*continued*)

	Unadjusted Mean Values			Propensity Score Adjusted Mean Values		
	Persons With Chiropractic Episodes (n = 174)	Persons With Medical-Care-Only Episodes (n = 883)	*P* [a]	Persons With Chiropractic Episodes (n = 174)	Persons With Medical-Only Episodes (n = 883)	*P* [a]
Proxy at survey 1, self-respondent at survey 2	0.03	0.02	.22	0.04 [d]	0.02	.03
Proxy at survey 1, proxy at survey 2	0.03 [d]	0.08	.02	0.03 [d]	0.08	.02

ADL, activities of daily living; *IADL*, instrumental activities of daily living; *LBF*, lower body function.

[a] χ^2 Test of proportions used for categorical variables, *t* tests used for continuous.

[b] Depressive symptoms count was asked only of self-respondents (n = 951).

[c] Statistical significance at < 0.01.

[d] Indicates statistical significance at < 0.05.

[e] Indicates statistical significance at < 0.0001.