

Driving Cessation and Increased Depressive Symptoms

David R. Ragland,¹ William A. Satariano,² and Kara E. MacLeod¹

¹University of California Traffic Safety Center and

²School of Public Health, University of California at Berkeley.

Background. To understand the consequences of driving cessation in older adults, the authors evaluated depression in former drivers compared with active drivers.

Methods. Depression (as assessed using the Center for Epidemiological Studies Depression Scale), driving status, sociodemographic factors, health status, and cognitive function were evaluated for a cohort of 1953 residents of Sonoma County, California, aged 55 years and older, as part of a community-based study of aging and physical performance. The authors reinterviewed 1772 participants who were active drivers at baseline 3 years later.

Results. At baseline, former drivers reported higher levels of depression than did active drivers even after the authors controlled for age, sex, education, health, and marital status. In a longitudinal analysis, drivers who stopped driving during the 3-year interval (i.e., former drivers) reported higher levels of depressive symptoms than did those who remained active drivers, after the authors controlled for changes in health status and cognitive function. Increased depression for former drivers was substantially higher in men than in women.

Conclusions. With increasing age, many older adults reduce and then stop driving. Increased depression may be among the consequences associated with driving reduction or cessation.

As they age, older persons typically decrease and eventually stop driving. In the next few decades, millions of older adults will stop driving, most after a lifetime of depending on driving for independence and mobility. It is crucial to determine whether adverse consequences follow such a change in these older adults. A small but increasing literature suggests that driving cessation affects activity levels and well-being. Outcomes associated with driving cessation include reduced independence, reduced access to essential services, impaired ability to maintain a household or to conduct other essential activities, and reduced community activity and social integration (1–6). Driving cessation has been shown to influence personal identity and life satisfaction. Previous research indicates that driving shapes internal (e.g., self, family) and external (e.g., community, society, world) role perceptions (7–9). Studies have also indicated that older persons who drive tend to have higher levels of life satisfaction compared with those who do not drive (5,8,10).

Because driving in the United States is so integral to independence and mobility, it would not be surprising also to find psychological reactions to driving cessation. Two articles have focused on depression associated with driving cessation (11,12). In a cohort study of 1316 men and women in New Haven, Connecticut, aged 65 years and older, Marottoli and colleagues (11) found that during a 6-year interval, persons who stopped driving experienced increased depressive symptoms, even when changes in demographics and psychosocial and medical factors were considered. In a cohort study of 4102 men and women older than 70 years, Fonda and colleagues (12) found that during a 2-year period, persons who stopped driving were 1.44 times more likely to experience increased depressive symptoms compared with those who continued to drive.

Although previous research effectively indicated the relationship of depressive symptoms and driving status among the populations examined, it is important to determine whether similar findings are supported in other populations. In this study, we evaluated the association between depressive symptoms and driving status in a different community

setting and among an expanded cohort. Study participants for this investigation were adults aged 55 years or older residing in Sonoma, California.

METHODS

At baseline, we compared depression measures between current drivers and former drivers. Three years later, we compared depression measures between those who continued to drive and those who stopped driving during the follow-up period.

Participants

As part of the Study of Physical Performance and Age-Related Changes in Sonomans (SPPARCS), participants were adults aged 55 years and older who lived in the city and environs of Sonoma County, California. This community-based, longitudinal study evaluated age-related changes in physical activity and function (13–15). A community-based census identified 3057 age-eligible persons, of whom 2092 (68.4%) were enrolled and interviewed for the study between May 1993 and December 1994 (13).

Compared with the 1990 U.S. census for adults in Sonoma aged 55 years and older, the sample slightly overrepresented adults ages 65–73 years (41.3% vs 38.8%) and underrepresented adults aged 85 years and older (7.3% vs 8.7%). The sample was also somewhat more affluent and educated. The modal income category (\$25,000–\$49,000) of the sample was the same as California in general, and the sample had household annual incomes that were very similar to the state population. However, the sample underrepresented households with incomes of less than \$10,000.

We analyzed baseline data for participants ($n = 1953$) and follow-up participants ($n = 1772$) for this report. Both baseline and 3-year follow-up interviews included data on depressive symptoms, driving status, health status, and cognitive function. Among all participants at baseline, we designed the analysis to compare depression measures be-

Table 1. Driving Status at Baseline and 3-Year Follow-Up for Adults Aged 55 or Older Among Sonoma County Residents (SPPARCS)

Status	Baseline	Follow-Up*
Current drivers	1772	1419
Former drivers	135	42
Never drivers	46	NA
Lost to follow-up	NA	311
Total	1953	1772

Notes: *Follow-up included only current drivers at the baseline ($n = 1772$).

SPPARCS = Study of Physical Performance and Age-Related Changes in Sonomans; NA = not applicable.

tween current drivers and former drivers. We designed the analysis of data for drivers over time to compare depression measures between those who continued to drive and those who stopped driving during the follow-up period.

Cross-sectional analyses were restricted to participants who had baseline data for driving status, depressive symptoms, and relevant control variables ($n = 1953$). Prospective analyses were restricted to 1772 current drivers at baseline who also had follow-up data on driving status, depressive symptoms, and relevant control variables.

Health Status

We assessed participants' health status at each wave using participant-reported physician-diagnosed conditions, including asthma, bronchitis, emphysema, cancer, atherosclerotic heart disease, cerebrovascular disease, cirrhosis-hepatitis, kidney disease, Parkinson's disease, and diabetes.

Cognitive Function

Cognitive function was assessed by a modified Mini-Mental State Examination. Based on responses during interviews, we selected a subset of six items to provide the most sensitive measure of cognitive function for this sample. The six items included questions and tasks that at least 10% of the subjects had answered or performed incorrectly. The values were grouped into the lowest quartile (scores 0–14) and upper three quartiles (scores 15–18).

Depression Status

The Center for Epidemiological Studies Depression Scale (CES-D) (16) was administered at baseline and at follow-up interviews. The CES-D is a depression instrument in which respondents report the occurrences of feelings, behavior, or both on 20 items. The score is the sum of the 20 weighted items. A score of 16 or more is considered currently depressed. Based on these scores, we evaluated a dichotomous depression variable (i.e., depressed $16 \leq$ vs not depressed < 16) and a continuous variable.

Driving Status

Driving status was determined from both self-reported driver license history and driving behavior. Current drivers were defined as driving with a valid driver's license. Former drivers were defined as previously holding a valid driver's license but not currently driving. Never drivers were those who had never held a valid driver's license.

Analyses

For the cross-sectional analysis of baseline data, we performed linear regression analyses to compare depression

scores for current drivers versus former drivers and current drivers versus never drivers. The analyses controlled for age, sex, marital status, health status, and cognitive status.

For the longitudinal analysis, we conducted a linear regression to evaluate the relationship between the follow-up depression scores and a dichotomous driving-status variable (i.e., current drivers, designated as those who remained current drivers during the entire follow-up period, and former drivers designated as those who stopped driving during that interval). The analysis controlled for age, sex, baseline health and cognitive status, and changes in health and cognitive status between the baseline and follow-up examinations.

RESULTS

Driver Status at Baseline and Follow-Up

Of 1953 participants interviewed at the baseline (Table 1), 1772 were current drivers, 135 were former drivers, and 46 were never drivers. Of the 1772 current drivers at baseline, 311 (17.5%) were lost to follow-up. Of the remaining 1419, 97% remained current drivers at the follow-up, whereas 3% had stopped driving (i.e., become former drivers).

Baseline Cross-Sectional Results

In a bivariate analysis (Table 2), rates of depressed status were higher in former drivers (20.7%) and never drivers (15.2%) than in current drivers (8.3%). Similarly, the mean depression scores were higher in former drivers (9.0) and never drivers (10.1) than in current drivers (6.1).

Driving status was also associated with specific socio-demographic characteristics (Table 2). Compared with current drivers, former drivers were generally older, had fewer years of education and were more likely to be women, to have poorer health, and to be widowed. Never drivers had a similar profile.

In the multivariate analysis, baseline driving status maintained its strong association with depression scores after we controlled for other factors related to driving status (Table 3). The regression coefficient comparing depression scores of former drivers and current drivers was 1.67 ($p < .005$); that is, on average, former drivers had depression scores that were 1.67 times higher than the scores of current drivers. The coefficient comparing never drivers to current drivers was 1.69 ($p < .05$). In the multivariate regression model, the depression score was associated with (older) age, (male) sex, marital status (divorced/separated or widowed), and poor health status at baseline. We repeated the multivariate analyses for women and men separately (Figure 1). The difference between current drivers and former drivers was slightly higher for men, but this difference was not significant ($p = .68$).

Longitudinal Results

The multivariate analyses of follow-up data included only current drivers at baseline and compared the depression scores of 42 participants who became former drivers with the 1419 participants who continued to drive. The depression scores were higher in former drivers (9.7) than in current drivers (5.7) ($p < .001$). Former drivers had an

Table 2. Baseline Sociodemographic, Depression, and Health Status Variables by Baseline Driving Status for Adults Aged 55 or Older Among Sonoma County Residents (SPPARCS)

Baseline Characteristics	Driving Status at Baseline			<i>p</i> Value
	Current Driver (<i>N</i> = 1772)	Former Driver (<i>N</i> = 135)	Never Driver (<i>N</i> = 46)	
Current depressed status (CES-D) Score of 16+				
Yes	8.3%	20.7%	15.2%	
No	91.7%	79.3%	84.8%	<.001
Mean depression scores	6.1	9.0%	10.0%	<.001
Age				
55–64	29.9%	4.4%	8.7%	
65–74	45.1%	21.5%	28.3%	
75–84	22.6%	52.6%	43.5%	
85+	2.4%	21.5%	19.6%	<.001
Education level, y				
0–11	7.5%	20.0%	45.7%	
12	23.9%	23.7%	28.3%	
13+	68.6%	56.3%	26.1%	<.001
Sex				
Female	57.8%	67.4%	91.3%	
Male	42.2%	32.6%	8.7%	<.001
Marital status				
Married	64.7%	49.6%	43.5%	
Divorced/separated	12.3%	8.9%	8.7%	
Widowed	19.2%	34.8%	34.8%	
Never married	3.8%	6.7%	13.0%	<.001
Health status				
Good	55.2%	38.5%	52.2%	
Poor	44.8%	61.5%	47.8%	<.001

Note: SPPARCS = Study of Physical Performance and Age-Related Changes in Sonomans; CES-D = Center for Epidemiological Studies Depression scale.

increase in average depression score of 3.71, whereas current drivers had virtually no change ($p < .001$).

Former drivers were generally older than current drivers ($p < .001$) and were more likely to have had a change toward poorer health status and to be widowed. There were no differences by sex or education.

In the multivariate analyses, the increased depression scores in former drivers remained higher than in current drivers. The regression coefficient for former drivers was 3.12; that is, the average depression score increased 3.12 for former drivers compared with current drivers. We found no differences in cognitive function, as assessed using the modified Mini-Mental State Examination, in the follow-up multiple regression, and thus we did not include it in this model.

Age was related to change in depression, with those ages 65–74 years and 75–84 years showing increased depression compared with those aged 55–64 years. Women had increased depression compared with men ($p < .02$). Change in health status, cognitive function at baseline, and change in cognitive function were each related to increased depression.

We repeated the multivariate analysis for women and men separately. Among former drivers, Figure 1 (bottom panel) shows increased depression scores over time for both

Table 3. Baseline Multiple Regression Results for Depression Scores in Relation to Driving Status and Selected Control Variables (SPPARCS)

Parameter	<i>N</i>	Coefficient	<i>SE</i>	<i>p</i> Value
Driving status				
Current driver	1772	Referent	—	—
Former driver	135	1.67	0.63	<.01
Never driven	46	1.69	0.98	.09
Sociodemographic factors				
Age, y				
55–64	539	Referent	—	—
65–74	841	0.13	0.35	.71
75–84	492	0.84	0.43	.04
85+	81	0.04	0.84	.96
Sex				
Male	796	Referent	—	—
Female	1157	1.17	0.31	<.001
Marital status				
Married	1234	Referent	—	—
Divorced/separated	233	1.86	0.47	<.001
Widowed	404	1.35	0.40	<.001
Never married	82	0.61	0.72	.71
Educational level, y				
0–11	181	1.92	0.54	<.001
12	468	0.91	0.34	<.01
13+	1304	Referent	—	—
Health status				
Good	1054	Referent	—	—
Poor	899	1.18	0.29	<.001
Cognitive status				
Baseline Mini-Mental				
State Examination	1953	–0.41	0.07	<.001

Notes: Use of antidepressants was initially selected for controlling but showed little or no difference.

SPPARCS = Study of Physical Performance and Age-Related Changes in Sonomans; *SE* = Standard error.

women and men, with greater increases among men. In contrast, current drivers who continued to drive had very little change in depression scores over time for either men or women. The different pattern for men versus women was significant ($p < .01$).

DISCUSSION

As expected, current drivers at baseline who stopped driving during the 3-year follow-up interval (i.e., former drivers) reported higher levels of depressive symptoms than did those who remained current drivers, even when changes in health status and cognitive function were considered. These findings are consistent with previous studies showing an association between driving cessation and depressive symptoms (11,12).

An association between driving cessation and depression could operate through several mechanisms: Driving cessation could contribute to depressive symptoms through a loss of independence and mobility; depressive symptoms may accelerate the process of driving cessation; or a change in some third variable(s) (e.g., a particular health condition) could affect depression and driving cessation. It should be noted, of course, that this is the problem of interpretation

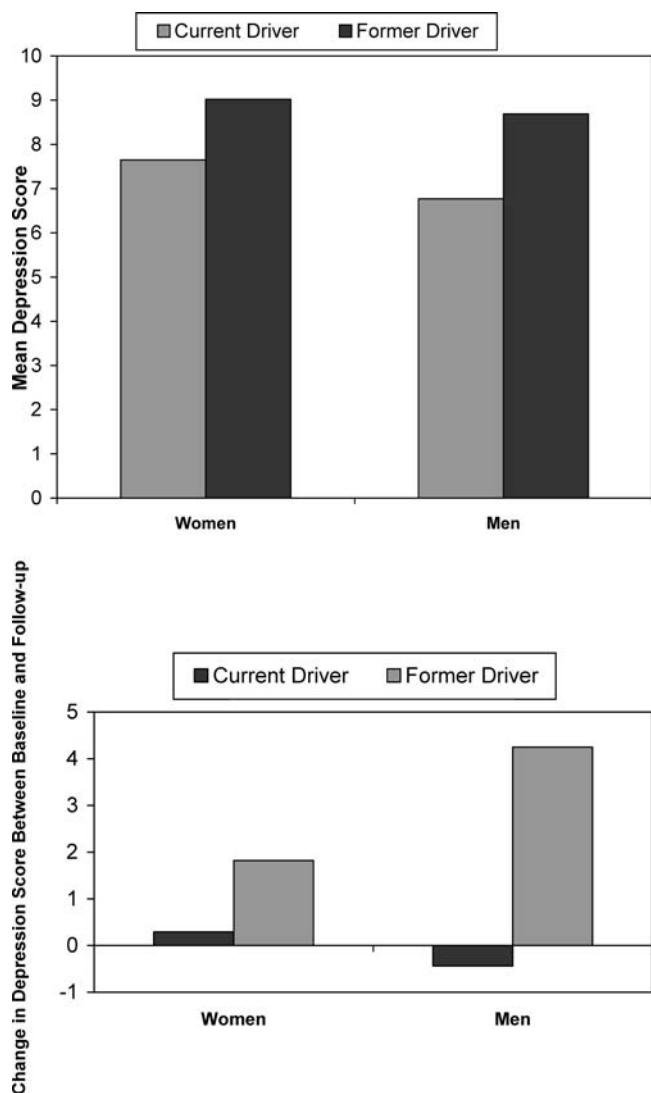


Figure 1. **Top:** The results of a multivariate regression for depression score and driving status by sex. Depression was measured using the Center for Epidemiological Studies Depression Scale (CES-D), and scores could range from 0 to 60. The difference between current drivers and former drivers was slightly higher for men, but this difference was not significant ($p = .68$). The mean CES-D score was 7.65 for female current drivers and 6.77 for male current drivers. The mean CES-D score was 9.02 for female former drivers and 8.69 for male former drivers. **Bottom:** The change in depression scores over time by driving status at follow-up and by sex. The results of a multivariate analysis of depression scores of 42 participants who became former drivers and 1419 participants who remained current drivers are compared by sex. Depression was measured using the CES-D, and scores could range from 0 to 60. Among former drivers, depression scores increased over time for both women and men, with greater increases among men. In contrast, current drivers who continued to drive had very little change in depression scores over time for either men or women. The different pattern for men versus women was significant ($p < .01$). The change in CES-D score was 0.29 for female current drivers and -0.44 for male current drivers. The change in CES-D score was 1.82 for female former drivers and 4.25 for male former drivers.

with all studies that show the relationship between driving cessation and other variables. It is essential to distinguish between the effects of changes in driving itself and the effects of other variables that are related to changes in driving (10).

Table 4. Baseline Depression Score, Sociodemographic and Health Status Indicators by Driving Status at Follow-Up for Adults Aged 55 and Older Among Sonoma County Residents (SPPARCS)

Baseline Characteristics	Driving Status at Follow-Up		<i>p</i> Value
	Current (<i>N</i> = 1419), %	Former (<i>N</i> = 42), %	
Current depression status			
Yes	5.7	9.7	
No			<.001
Change in current depression score	0.1	3.71	<.001
Age, y			
55–64	32.6	4.8	
65–74	46.4	35.7	
75–84	19.5	40.5	
85+	1.5	19.1	<.001
Sex			
Female	57.1	66.7	
Male	42.9	33.3	.22
Educational level, y			
0–11	7.0	7.1	
12	23.1	23.8	
13+	69.9	69.1	.99
Marital status			
Married	67.0	52.4	
Divorced/separated	11.7	9.5	
Widowed	17.9	35.7	
Never married	3.5	2.4	<.05
Health condition			
Good health—no change	51.2	26.2	
Poor health—change from good	6.6	7.1	
Poor health—no change	42.1	66.7	<.01

Note: SPPARCS = Study of Physical Performance and Age-Related Changes in Sonomans.

In the current analyses, we found evidence that the association between driving cessation and depression is due to the effect of driving cessation on depression. First, we conducted a prospective analysis to determine whether baseline depression was associated with subsequent driving cessation, which it was not. This finding appears to contradict the alternative explanation that depression has an important effect on driving cessation. Second, in the longitudinal analysis, we controlled for several variables that may affect both driving cessation and depression, specifically health status and cognitive status. Neither of these variables decreased the association between driving cessation and depression. This finding contradicts the alternative explanation that some third variable affects both depression and driving cessation. To the extent that we controlled for change in health status between the baseline and follow-up interviews, we reduced the possibility that our findings resulted from changes in general health status that affect both driving and depression.

Implications for Research

Future research on driving among elderly adults should include additional population studies on the magnitude and age distribution of those who have reduced or stopped driving; studies of patterns of driving cessation and the decision process to voluntarily stop driving (17–19); and the

Table 5. Multiple Regression of Follow-up Driving Status, Sociodemographic Characteristics, and Changes in Health Status Against Follow-up Depression Scores

Variable	N	Coefficient	SE*	p Value
Driving status				
Current driver	1419	Referent	—	—
Former driver	42	3.12	0.82	<.001
Sociodemographic factors				
Age, y				
55–64	465	Referent	—	—
65–74	673	0.71	0.31	.02
75–84	294	1.71	0.39	<.001
85+	29	0.32	1.00	.74
Sex				
Male	—	Referent	—	—
Female	—	0.57	0.27	.04
Health status				
Good health—no change	626	Referent	—	—
Poor health—change from good	97	0.43	0.55	0.43
Poor health—no change	738	0.94	0.28	<.0001
Educational level, y				
0–11	102	0.94	0.28	<.0001
12	339	0.43	0.55	.43
13+	1020	Referent	—	—

Note: SE = standard error.

practical economic, social, psychological, and physical consequences of driving reduction or cessation. Because many existing studies have been correlational, the causal directions between driving and health status require refinement. Some studies are more likely to present a causal reference. For example, if we had a frequent assessment of depression and the extent of driving behavior, we could more likely make a causal attribution than if the assessment was less frequent along this time line. Also needed are studies of mitigating factors of the driving-depression association (e.g., the presence of a spouse).

Implications for Policy

Programs are needed to help older adults (and their families and caregivers) who experience age-related health and functional decline and decide to stop driving make the transition between driving and not driving. As noted in many studies, research is needed in precessation planning and educational techniques that would identify, create, and test strategies to help drivers cope before, during, and after driving cessation (3,11,12,19). Based on the results we presented here, such research should include assessments of whether such programs reduce the likelihood of depression among older drivers going through this process. To our knowledge, programs to facilitate the process of driving cessation have not included depression as a programmatic outcome, even though current programs exist that are designed to prevent and treat depression in older populations (20). In addition, many of the studies reviewed reinforced the importance of continuing to develop a range of transportation alternatives for a variety of elderly transportation needs. Burkhardt and colleagues (3) and Marottoli and colleagues (11) suggested that, along with developing more alternatives, current operating transportation systems need to be reassessed to determine whether they are effectively meeting the full transportation needs of the communities they serve.

ACKNOWLEDGMENTS

Supported by Contract Agreement DTNH22-00-H-05249 from the National Highway Traffic Safety Administration and grant RO1 AG09389 from the National Institute on Aging.

This research was presented at the Transportation Research Board annual meeting in a session entitled “Costs of Older Adult Mobility,” January 13, 2003.

Address correspondence to David R. Ragland, PhD, MPH, University of California Traffic Safety Center, University of California at Berkeley, 140 Warren Hall, Berkeley, CA 94720-7360. E-mail: david@uclink4.berkeley.edu

REFERENCES

1. Marottoli RA. The physician's role in the assessment of older drivers. *Am Fam Physician*. 2000;61:39–42.
2. Mollenkopf H, Marcellini F, Ruoppila I. Outdoor mobility and social relationships of elderly people. *Arch Gerontol Geriatr*. 1997;24:295–310.
3. Burkhardt J, Berger AM, Creedon M, Gavock AT. *Mobility and Independence: Changes and Challenges for Older Drivers*. Bethesda, MD: Econometrics; 1998.
4. Cutler SJ. The effects of transportation and distance on voluntary association participation among the aged. *Int J Aging Hum Dev*. 1974;5:81–94.
5. Cutler SJ. Transportation and changes in life satisfaction. *Gerontologist*. 1975;15:155–159.
6. Harrison A, Ragland DR. *Consequences of Driving Reduction or Cessation for Older Adults*. Berkeley, CA: University of California Berkeley Traffic Safety Center; October 1, 2002. Working paper UCB-TSC-RR-2002-03.
7. Berger, JT, Rosner F. Ethical challenges posed by dementia and driving. *J Clin Ethics*. 2000;11:304–308.
8. Burkhardt JE. Mobility changes: their nature, effects, and meaning for elders who reduce or cease driving, 1999. *Transportation Research Record*; 1999:11–18.
9. Eisenhandler SA. The asphalt Identikit: old age and the driver's license. *Int J Aging Hum Dev*. 1990;30:1–14.
10. Carp FM. *Significance of Mobility for the Well-being of the Elderly*. Washington, DC: Transportation Research Board National Research Council; 1988.
11. Marottoli RA, Mendes de Leon CF, Glass TA, et al. Driving cessation and increased depressive symptoms: prospective evidence from the New Haven EPESE. Established Populations for Epidemiologic Studies of the Elderly. [Comment in: *ACP J Club*. 1997;127:44]. *J Am Geriatr Soc*. 1997;45:202–206.
12. Fonda SJ, Wallace RB, Herzog AR. Changes in driving patterns and worsening depressive symptoms among older adults. *J Gerontol B Psychol Sci Soc Sci*. 2001;56:S343–S351.
13. Satariano WA, Smith J, Swanson A, Tager IB. A census-based design for the recruitment of a community sample of older adults: efficacy and costs. *Ann Epidemiol*. 1998;8:278–282.
14. Satariano WA, Haight TJ, Tager IB. Reasons given by older people for limitation or avoidance of leisure time physical activity. *J Am Geriatr Soc*. 2000;48:505–512.
15. Tager IB, Hollenberg M, Satariano WA. Association between self-reported leisure-time physical activity and measures of cardiorespiratory fitness in an elderly population. *Am J Epidemiol*. 1998;147:921–931.
16. Dellinger A, Sehgal M, Sleet DA, Barrett-Connor E. Driving cessation: what older drivers tell us. *J Am Geriatr Soc*. 2001;49:431–435.
17. Persson D. The elderly driver: deciding when to stop. *Gerontologist*. 1993;33:88–91.
18. Kostyniuk LP, Shope JT, Molnar LJ, University of Michigan, Transportation Research Institute, General Motors Corporation. *Reduction and Cessation of Driving Among Older Drivers in Michigan*. Ann Arbor MI: University of Michigan Transportation Research Institute; 2000
19. Blazer DG. Depression in late life: review and commentary. *J Gerontol Biol Sci Med Sci*. 2003;58A:249–265.

Received April 21, 2003

Accepted September 15, 2003

Decision Editor: John E. Morley, MB, BCH