

Alcohol-Related Motor Vehicle Accident Fatality: Wisconsin Rural-Urban Trends and Observations

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ABSTRACT

Background: Wisconsin leads the nation in binge-drinking and alcohol consumption rates, creating substantial costs for taxpayers and contributing to countless alcohol-related comorbidities and numerous fatalities each year. This study was designed to assess the nature and extent of the alcohol problem in Wisconsin and compare alcohol- and non-alcohol-related motor vehicle accident (MVA) fatality rates between the subcultures of rural and urban counties and assess access to alcohol by examining Wisconsin liquor licensing.

Methods: County-level alcohol- and non-alcohol-related MVA fatality data from 1999 to 2006 were obtained from the Wisconsin Department of Transportation and the Wisconsin Interactive Statistics on Health (WISH) database; urban and rural counties were compared. Liquor license per capita rates were determined; rural and urban counties were compared. Additionally, trends in alcohol-related fatalities between 1999 and 2002 and between 2003 and 2006 were computed for all Wisconsin counties.

Results: Alcohol-related MVA fatalities were significantly higher in rural counties than non-alcohol-related MVA fatalities as compared to those in urban counties, with an Odds Ratio (OR) of 2.17 (95% Confidence Interval [CI], 2.00-2.35) and 1.68 (95% CI, 1.58-1.79), respectively. More importantly, significant interaction was found to be present between the 2 odds ratios ($P < 0.001$). When comparing these fatalities using county-level vehicle miles of travel (VMT) as a denominator, similar results were found; rural counties are still at significantly increased risk of MVA fatality in both alcohol- and non-alcohol-related MVAs compared to

urban, with an OR of 1.76 (95% CI, 1.62-1.91) 1.37 (95% CI, 1.28-1.45), respectively.

Conclusion: Evidence characterizing the rural alcohol subculture in Wisconsin's notorious consumption predicament is partially elucidated here, indicating the potential for rural counties to be a cost-effective target of intervention and policy.

INTRODUCTION

The pervasive and persistent drinking culture in Wisconsin has been documented for decades. Most recently, the state has earned the limelight by leading the nation in many aspects of alcohol consumption.¹ Between 2004 and 2005, Wisconsin led the nation in high school drinking (49%), underage drinking (39%), drinking among adults (68%), binge drinking among adults (22%), and chronic heavy drinking among adults (8%).¹ From 1996 to 2003, the per capita consumption of straight alcohol rose from 2.65 to 2.81 gallons per year.¹ The rate of alcohol-related motor vehicle accident (MVA) fatalities in Wisconsin is also much higher than national averages, with a rate of 6.7 MVA fatalities per 100,000 persons as compared to the national average of 5.7. Fatalities are most common among 16- to 34-year-olds.¹ The increase in alcohol-related MVA fatalities is not surprising given the circumstances surrounding consumption and recent reports about the state leading the country in self-reported drunk driving.² Roadway cleanup, years of potential life lost, and alcohol-related comorbidities present a tremendous cost to Wisconsin taxpayers and society as a whole each year.

Research in the fields of substance use and rural health are limited. However, there is some evidence to support the burden of alcohol consumption on rural localities. Atav and Spencer found that fewer youth in rural upstate New York have "never used alcohol" compared to urban and suburban peers, while more rural youth "frequently" use alcohol compared to peers.³ Another study found

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that despite drug prevalence and use being similar in urban and rural colonias in the Rio Grande Valley of Texas, binge drinking and alcohol dependence were statistically higher in rural areas ($P < 0.05$).⁴ Rural teenagers in Australia are plagued by a similar insidious drinking culture.⁵⁻⁶

Others suggest the greatest burden of alcohol abuse is in urban environments. In a 2002-2004 national survey on drug use and health, several authors found that although rural youth had increased rates of alcohol consumption compared to urban youth, rural adults consumed less alcohol than urban peers.⁷ Another national study found a higher prevalence of heavy drinking and binge drinking in metropolitan counties than in rural counties from 1995 to 2003, although all geographic areas in the study showed upward trends in these behaviors.⁸ A study conducted across several southern states also supports these findings, revealing that residents in rural communities were significantly more likely to be abstinent from drinking and less likely to be problem drinkers ($P < 0.001$).⁹

It is widely known that there is an inverse relationship between MVA fatalities and population density; consequently, these fatalities are more likely to occur in rural areas as opposed to urban environments. In fact, this implication is not limited to rural MVA fatalities but extends to all unintentional injuries.¹⁰⁻¹⁵ Increased rural prevalence of MVA fatalities may be due to numerous contributing factors including treacherous gravel roads, wildlife hazards, speeds of collision, driver behavior, vehicles driven, total miles traveled, delays in medical care, and variation in medical care.^{10-11,16-17} Borgianni et al found that MVA in Michigan were more likely to occur in rural geographic locales with an OR of 1.69 (95% CI, 1.3-2.1). When controlling for demographic (eg, sex, age) and crash characteristics, the OR was reduced to 1.56 (95% CI, 1.2-1.9). However, when continuing to control for the role of alcohol in the crash, the OR decreased to a non-significant ratio of 1.26 (95% CI, 0.6-2.4), suggesting alcohol's role in the etiology of rural collisions.¹⁸

Based on the literature, rural substance abuse appears to be regionally and culturally situated. Dew et al proposed that recent trends in rural substance abuse may be partially explained contextually through social and environmental factors involving rural communities.¹⁹ In a culture of omnipresent drinking, as is present in Wisconsin, it may be helpful to determine subcultures of increased risk to provide better information to public policymakers and to those in the field who target inter-

ventions. The purpose of this study is to examine the subculture of rural drinking in Wisconsin as it relates to access and MVA fatality.

METHODS

Alcohol-related MVA fatality data was obtained for each Wisconsin county from annual reports compiled by the Wisconsin Department of Transportation (DOT).²⁰⁻²¹ Two separate sets of denominators were obtained: (1) county population data from the Wisconsin Interactive Statistics on Health (WISH) database, and (2) county-level vehicle miles of travel (VMT) data from annual reports compiled by the Wisconsin DOT.¹⁶ The WISH database was also queried by county and applicable ICD-10 transportation mortality codes (V02 through V89.2) for total motor vehicle accident fatalities that occurred between 1999 and 2006.

The number of non-alcohol-related MVA fatalities was obtained by computing for each county the difference between total MVA fatalities and alcohol-related MVA fatalities from 1999 to 2006. These county-level data were categorized based on the National Center for Health Statistics (NCHS) 6-level urban-rural classification scheme: (1) Large Central Metro, (2) Large Fringe Metro, (3) Medium Metro, (4) Small Metro, (5) Micropolitan (non-metro), and (6) NonCore (non-metro). Metro codes (1-4) together created an "urban" county definition, while non-metro codes (5-6) served as a definition of "rural." Person-time rates, VMT rates, and ORs were calculated and statistically compared for these 2 subgroups of MVA fatality (ie, alcohol-related and non-alcohol-related) using the Breslow-Day test for homogeneity across urban and rural counties (OpenEpi v2.2.1).

Data were also obtained from a 2003 Wisconsin DOT report that indicated the total number of liquor licenses issued to each Wisconsin county for the sale of any type of alcohol, including production and retail.²² These criteria allow some Wisconsin businesses to hold more than 1 license. These data were then differentiated by their respective urban and rural definitions. Population denominators for 2003 were obtained from the WISH database.²⁰ ORs for the number of liquor licenses per capita were computed for urban and rural counties. ORs were recomputed for the number of liquor licenses per capita per 100 square miles for urban and rural counties to account for population density.

Four-year alcohol-related MVA fatality rates per 100,000 persons were calculated for each individual county at 2 separate time intervals: 1999-2002 and 2003-2006. Each county received a rank for both intervals in

order to track alcohol-related MVA fatality over the entire 8-year span. The 2 rates were analyzed with a 2-tailed, Mid-P Exact statistic.

RESULTS

There is a significant trend in MVA fatality rates as the Wisconsin countryside approaches rurality for both alcohol-related fatalities and total fatalities (Figure 1). Furthermore, MVA fatality rates per 100 million VMT show a similar trend (Figure 2). Consequently, both alcohol and non-alcohol fatality ratios demonstrate a trend toward rural fatality, though the odds of alcohol-related fatality in rural counties as compared to urban ones are significantly higher than the odds of non-alcohol-related MVA fatality across both sets of denominators (ie, person-years and total VMT) (Table 1). When a Breslow-Day statistic was calculated for homogeneity among the 2 ORs, it was found to be statistically significant in both sets, indicating a statistically significant interaction in regard to rurality and alcohol-related MVA fatality when accounting for both total person-years of observation and total VMT ($P < 0.001$). This is suggestive of an etiologic role played by alcohol in rural Wisconsin MVA fatalities.

When the number of liquor licenses per capita was compared for urban and rural counties, rural counties were found to have significantly more licenses per capita, OR=1.92 (95% CI, 1.86-1.98). When considering the geographic component (ie, population density) of urban and rural counties, the difference is more evident. For an average 100 square mile area, rural counties have 4.47 times more liquor licenses per capita than urban counties (Table 2). When a geographic region approaches rurality, there is a notable trend of fewer people per liquor license (Figure 3).

The most notable counties with an increased trend in alcohol-related MVA fatality are Milwaukee, Winnebago, Washburn, Marquette, and Green Lake ($P \leq 0.05$). Conversely, Oneida County is the only county to have a statistically significant decrease in alcohol-related fatalities between the 2 time intervals (Table 3). Oneida County also made the largest improvement in alcohol-related MVA fatality county rank, going from 51 to 3.

DISCUSSION

The increase in the number of liquor licenses per capita in Wisconsin is suggestive of increased rural access to alcohol and provides a starting point for policy change and regulation. However, further research is necessary to explicate the intricate nuances among Wisconsin drinking subcultures. This may pose powerful policy

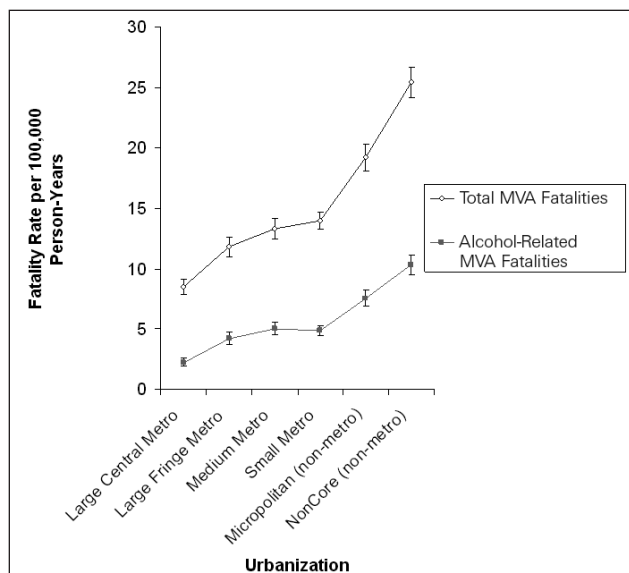


Figure 1. Wisconsin burden of motor vehicle accident (MVA) fatalities by urbanization, 1999-2006.

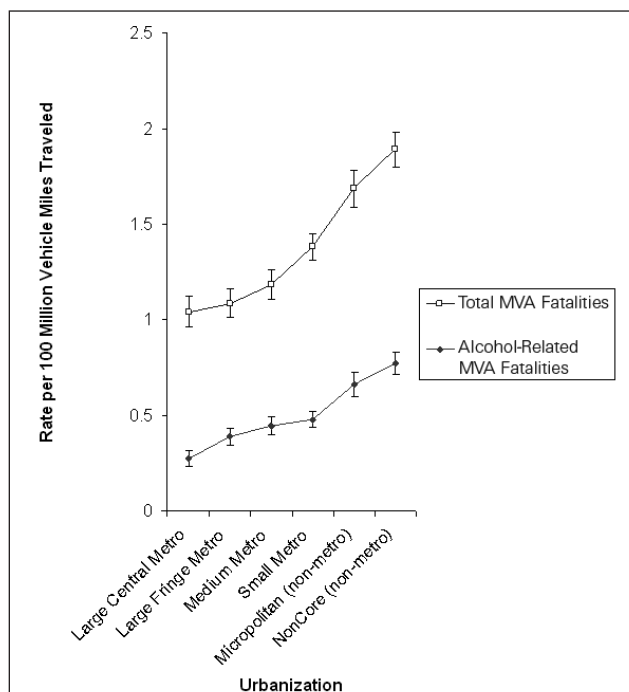


Figure 2. Wisconsin motor vehicle accident (MVA) fatalities by urbanization and rate per 100 million vehicle miles traveled, 1999-2006.

and intervention strategies to implement the most cost-effective intervention in mitigating 1 of Wisconsin's most notorious and dangerous attributes.

In 2004, the federal government recognized the treachery and problematic nature of MVA fatalities on rural roadways in the United States. They identified 4 primary contributors to the rural disparity: human

Table 1. Odds Ratio of Motor Vehicle Crash Fatality Risk 1999-2006 for Wisconsin Counties (Urban vs Rural)

	Fatality Rate per 100,000 Persons Odds Ratio (95% CI)		Fatality Rate per 100 Million VMT Odds Ratio (95% CI)	
	Urban	Rural	Urban	Rural
Non-Alcohol-Related Motor Vehicle Fatalities	1.00	1.68 (1.58, 1.79) ^a	1.00	1.37 (1.28, 1.45) ^b
Alcohol-Related Motor Vehicle Fatalities	1.00	2.17 (2.00, 2.35) ^a	1.00	1.76 (1.62, 1.91) ^b

^a Breslow-Day Test for Homogeneity $P < 0.001$

^b Breslow-Day Test for Homogeneity $P < 0.001$

Abbreviation: CI, confidence interval.

Table 2. Wisconsin Rural and Urban Differences in Liquor Licenses per Capita

	Relative Ratio (95% CI)	
	Urban	Rural
Liquor License per Capita	1.00	1.92 (1.86, 1.98)
Liquor License per Capita per 100 Square Miles	1.00	4.47 (4.34, 4.62)

Abbreviation: CI, confidence interval.

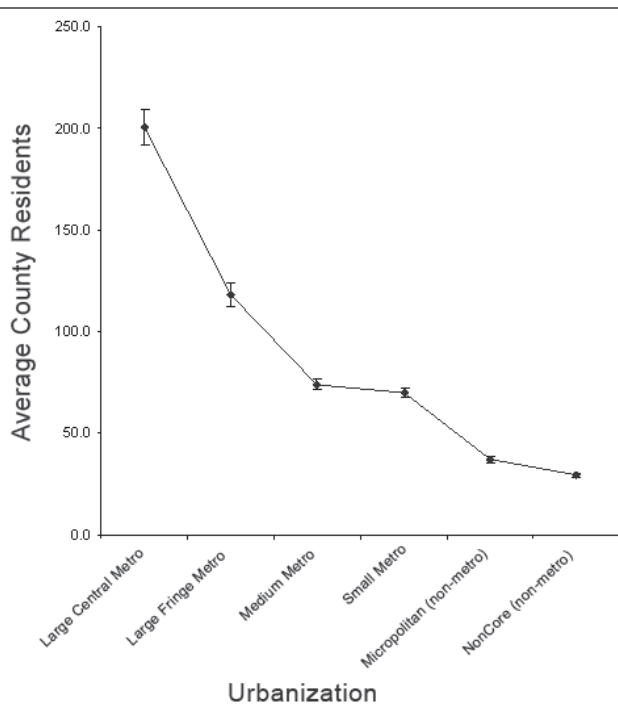


Figure 1. Average Wisconsin county residents per liquor license, per 100 square miles by urbanization (2003).

behavior, roadway environment, vehicles, and the degree of care individuals receive after a crash. Among human behaviors, safety belt use, distraction, speed, drowsiness, and alcohol were listed as formidable contributors.¹¹ By comparing rural alcohol-related fatalities to rural non-alcohol-related fatalities across both sets of denominators, a natural control for these additional non-alcohol confounders (eg, differences in mileage, treachery of gravel roadways, travel speed, wildlife) is employed.

Improvements in seatbelt laws and more ad campaigns against drunk driving have recently been implemented in Wisconsin. However, the sentencing guidelines still vary substantially for repeat driving under the influence (DUI) and driving while intoxicated (DWI) offenses across the 10 judicial districts. Overarching state guidelines, depending on the particular circumstances, offer marginal penalties for the first several offenses.²³ The mandatory use of ignition interlock devices for repeat offenders have been proven to be useful in mitigating and altering repeat offenders' driving behavior.²⁴ State and federal funding could be provided to ensure this option is implemented.¹¹

Muelleman et al found that after controlling for injury severity, residents of rural Nebraska counties still experience nearly twice the risk of dying in a motor vehicle crash than residents of urban counties, suggesting regional variation in medical care and services.¹⁷ It is therefore essential to continue to improve, support, and expand rural critical access hospitals and emergency medical services in order to provide quality care to underserved rural areas of Wisconsin.

Larger distances of travel in rural communities and the lack of public and/or other pay-for-service transportation make the Road Crew a unique and specific solution to this rural Wisconsin alcohol and MVA fatality interaction problem. This program, which is funded by the National Highway Traffic Safety Administration (NHTSA), uses social marketing to provide rural participants a safe and effective alternative to driving under the influence.²⁵⁻²⁶ Additionally, the program has been estimated to reduce drunk driving crashes by 17% in the Wisconsin rural communities that have adopted it.²⁵

Limitations to this study include defining "urban" versus "rural."²⁷⁻²⁸ For example, due to the solitary city of Superior, a county like Douglas gets classified as Medium Metro, when the vast majority of the geographical area constituting Douglas County is arguably very rural. This particular scenario will tend to have a washing-out effect on the significance of the increased

Table 3. Alcohol-Related Motor Vehicle Crash Fatalities, 1999-2002 and 2003-2006 (Urban and Rural Counties)

	1999-2002	2003-2006	Relative Change in Rate (%)	P Value		1999-2002	2003-2006	Relative Change in Rate (%)	P Value
	Fatalities (County Rank) ^a	Fatalities (County Rank) ^a				Fatalities (County Rank) ^a	Fatalities (County Rank) ^a		
Urban Counties					Rural Counties (continued)				
Washington	27 (22)	18 (5)	-37.2	0.13	Rusk	5 (42)	4 (26)	-20.3	≥0.50
Douglas	14 (42)	10 (19)	-29.7	0.40	Dodge	24 (34)	20 (19)	-18.9	0.49
Saint Croix	20 (40)	19 (22)	-19.0	≥0.50	Door	9 (42)	8 (28)	-14.7	≥0.50
Fond du Lac	24 (25)	20 (15)	-18.3	≥0.50	Marinette	30 (66)	26 (63)	-14.4	≥0.50
Waukesha	35 (7)	35 (2)	-3.9	≥0.50	Adams	15 (67)	14 (66)	-13.7	≥0.50
Ozaukee	7 (5)	7 (1)	-3.5	≥0.50	Burnett	13 (68)	12 (67)	-13.4	≥0.50
Calumet	8 (19)	9 (15)	3.6	≥0.50	Taylor	8 (52)	7 (40)	-13.1	≥0.50
Racine	34 (17)	36 (14)	3.7	≥0.50	Juneau	15 (64)	14 (60)	-13.0	≥0.50
Brown	34 (14)	39 (9)	8.5	≥0.50	Langlade	9 (55)	8 (48)	-12.6	≥0.50
Pierce	10 (31)	12 (32)	11.6	≥0.50	Clark	14 (54)	13 (49)	-9.2	≥0.50
Outagamie	26 (16)	31(13)	12.1	≥0.50	Jefferson	25 (46)	24(31)	-8.5	≥0.50
Sheboygan	15 (10)	18 (7)	15.0	≥0.50	Sauk	15 (31)	15 (24)	-5.8	≥0.50
Dane	61 (12)	77 (10)	15.8	0.32	Dunn	13 (42)	13 (32)	-4.7	≥0.50
Rock	45 (38)	55 (40)	16.0	0.39	Vernon	10 (48)	10 (38)	-3.8	≥0.50
Kenosha	41 (33)	52 (36)	16.5	0.39	Bayfield	4 (29)	4 (24)	-2.9	≥0.50
Iowa	7 (39)	10 (51)	27.4	≥0.50	Florence	6 (70)	6 (72)	-1.0	≥0.50
Marathon	26 (20)	38 (29)	29.7	0.17	Lafayette	7 (55)	7 (53)	-0.6	≥0.50
Oconto	19 (60)	29 (68)	30.4	0.22	Wood	11 (13)	12 (7)	8.5	≥0.50
Chippewa	13 (23)	21 (40)	33.7	0.25	Walworth	29 (40)	35 (43)	11.7	≥0.50
Milwaukee	65 (3)	104 (4)	38.2	0.002	Buffalo	6 (55)	7 (59)	13.5	≥0.50
Eau Claire	10 (8)	17 (12)	39.7	0.21	Grant	18(50)	21 (51)	13.7	≥0.50
Columbia	11 (21)	20 (45)	42.3	0.14	Lincoln	8 (31)	10 (36)	18.1	≥0.50
La Crosse	8 (4)	16 (5)	49.0	0.12	Polk	12 (35)	16 (44)	18.9	≥0.50
Winnebago	13 (5)	28 (11)	52.3	0.02	Monroe	12 (35)	17 (50)	26.0	0.43
Kewaunee	3 (14)	9 (54)	65.6	0.10	Waushara	6 (27)	9 (45)	28.2	≥0.50
Rural Counties					Waupaca	15 (35)	23 (54)	33.0	0.23
Oneida	14 (51)	4 (3)	-72.3	0.02	Ashland	6 (48)	10 (64)	40.2	0.33
Menominee	9 (72)	3 (65)	-66.3	0.10	Manitowoc	11 (10)	19 (19)	42.1	0.15
Shawano	23 (62)	13 (34)	-45.2	0.08	Jackson	5 (27)	9 (57)	42.4	0.33
Green	19 (61)	11 (34)	-45.0	0.11	Barron	8 (17)	16 (38)	48.3	0.13
Iron	7 (69)	4 (62)	-43.8	0.37	Price	2 (9)	4 (22)	50.6	0.45
Forest	5 (58)	3 (30)	-41.6	0.49	Crawford	4(23)	10 (61)	59.5	0.12
Pepin	3 (53)	2 (27)	-35.4	≥0.50	Washburn	4 (26)	13 (69)	67.5	0.04
Vilas	14 (65)	10 (56)	-32.7	0.34	Marquette	5 (47)	17 (71)	70.0	0.01
Sawyer	21 (71)	15 (70)	-32.2	0.25	Richland	1 (2)	4 (18)	74.7	0.22
Portage	18(29)	14 (17)	-23.3	0.46	Green Lake	1 (1)	7 (45)	85.7	0.04
Trempealeau	16(63)	13 (58)	-21.0	≥0.50					

^a Alcohol-related motor vehicle fatality rankings and percent changes are based on county's crude fatality rate.

rural MVA fatality. Furthermore, due to the limitations in the definition of “rural,” it is important to distinguish between a rural community and a rural county. While this study makes a generalization about rural counties, the limitation in definition decreases the generalizability to individual rural communities, which are certainly found in most “urban” Wisconsin counties.

The denominator selection is another limitation of this study. The denominator person-years of county observation was used because it is consistent, accurate,

and easily obtained. The denominator of county-level VMT was used in an attempt to better estimate the actual denominator of persons at risk of dying in an alcohol-related fatality. Both of these point estimates constitute a conservative estimate, as the persons who consume alcohol and drive regularly will clearly be a smaller denominator. Other potential denominators (eg, reported DUI) are difficult to obtain and are often based on estimates done through self-reported surveys. Furthermore, it is complicated to discern how many

individuals are at risk for an alcohol-related fatality and how often they are at risk, as the frequency may vary substantially for any given individual over time.

Acknowledgments: I would like to thank Byron Crouse, MD, Patrick Remington, MD, and Michael M. Miller, MD, for providing feedback and insight into my manuscript. I would also like to thank the Wisconsin Office of Rural Health (www.worh.org) for providing additional resources, mentorship, and guidance.

Funding/Support: None declared.

Financial Disclosures: None declared.

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Wisconsin Medical Journal

The mission of the *Wisconsin Medical Journal* is to provide a vehicle for professional communication and continuing education of Wisconsin physicians.

The *Wisconsin Medical Journal* (ISSN 1098-1861) is the official publication of the Wisconsin Medical Society and is devoted to the interests of the medical profession and health care in Wisconsin. The managing editor is responsible for overseeing the production, business operation and contents of *Wisconsin Medical Journal*. The editorial board, chaired by the medical editor, solicits and peer reviews all scientific articles; it does not screen public health, socioeconomic or organizational articles. Although letters to the editor are reviewed by the medical editor, all signed expressions of opinion belong to the author(s) for which neither the *Wisconsin Medical Journal* nor the Society take responsibility. The *Wisconsin Medical Journal* is indexed in Index Medicus, Hospital Literature Index and Cambridge Scientific Abstracts.

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