

# **ADOLESCENT PREDICTORS OF TRAFFIC CRASH PATTERNS FROM LICENSURE INTO EARLY YOUNG ADULTHOOD**

C. Raymond Bingham, Jean T. Shope  
University of Michigan Transportation Research Institute  
Ann Arbor, MI

## **ABSTRACT**

This paper examines differences in the adolescent psychosocial and problem behavior characteristics of individuals who have stable-low, increasing, stable-high and decreasing frequencies of motor vehicle crashes from licensure into early young adulthood. Problem Behavior Theory was used as the guiding theoretical framework. Study data were collected when the participants were in 10<sup>th</sup> and 12<sup>th</sup> grades, and during a young adulthood follow-up telephone survey conducted five to six years later (n = 1,936). For men, stable high crash rates were associated with less parental monitoring and more substance use, and a stable low crash rates were associated with better marks in school. For women, stable high crash rates were associated with poorer marks in school and more substance use, and patterns of both decreasing and stable high crash rates were associated with less parental monitoring and less parental orientation. It is concluded that patterns of motor vehicle crashes are associated with adolescent psychosocial and problem behavior characteristics. Interventions targeting these factors may have broad positive effects on problem behaviors, including problem driving and motor vehicle crashes. In addition, the results of this study may be useful in designing traffic safety policies that target individuals whose psychosocial characteristics indicate that they are at high risk of being involved in a crash.

In recent years public awareness of the risk of injury experienced by young drivers has steadily increased, becoming common public knowledge. Nevertheless, motor vehicle crashes (crashes) remain the leading cause of death among teen novice drivers (i.e., 16-19 years of age) (National Highway Traffic Safety Administration [NHTSA], 2003). Various factors contribute to teens' crash risk, and understanding them is key to the development of behavioral and policy interventions to reduce the rate of teen crash deaths. Increased public awareness of teen crash risk has led to the development of

various programs, and the establishment of laws, such as Graduated Driver Licensing (GDL) (Shope, Molnar, 2003), that reduce the risk of teens being injured or killed in a crash. Nevertheless, increased public awareness of teen crashes has not led to a full appreciation or understanding of why teen drivers are at high risk, the implications of teen driving risk for individual teens, or for the need to develop and refine policies so that they reduce teen driving risk sufficiently.

Teen driving is a source of considerable social concern for teens' health and safety. Driving risks faced by teens are dissimilar from other threats to teens' health, such as alcohol misuse, unprotected sex, and illicit drug use. Unlike other health threats, driving is highly valued by US society. It is viewed as a "right" and not a privilege, and for teens, "becoming a driver" is a notable developmental, social, and personal transition, and rite of passage on the road to adulthood (Arnett, 2002). As a result, US society often responds ambivalently to teen driving risk. For example, in spite of GDL, licensing laws in many states place minimal restrictions on teens' driving (Insurance Institute for Highway Safety, 2005), even though empirical evidence suggests broader driving restrictions would further increase teens' safety (Chen, Baker, Braver, Li, 2000; Cvijanovich, Cook, Mann, Dean, 2001; Doherty, Andrey, MacGregor, 1998).

Parents' perception of and reactions to teen crash risk are also mixed. Parents believe their teenaged children are generally responsible, and, therefore, will avoid the behaviors that the parents believe to be the primary causes of teen crashes and resulting injuries. However, many parents do not fully appreciate the risks that teens experience in typical driving conditions. Parents of teen drivers generally recognize exceptional driving behaviors such as teen drinking and driving, as extremely risky, but fail to appreciate the considerable risks associated with common situations, such as driving with teen passengers, without safety belts, in bad weather, on the weekend, or in rain at night (Simons-Morton, Hartos, 2003). Such misperceptions on the part of parents are understandable in that certain driving conditions are risky for them, but not for adults.

Inexperience and immaturity both contribute to high crash rates involving teen drivers. Driving safety changes rapidly as novice drivers gain experience and skill (Mayhew, Simpson, Pak, 2003). However, driving skill may be less important to driving risk than judgment (Vernick et al., 1999), which develops more slowly with extensive driving experience, and critical brain maturation (Giedd, Blumenthal, Jeffries, et al., 1999; Yurgelun-Todd, 2002). Anatomical and physiological characteristics of the adolescent brain contribute to poor judgment, impulsiveness and elevated emotionality; hence, substantial time is required before judgment clearly impacts driving safety.

While relatively little research has examined the association between psychosocial factors and driving outcomes, available research shows clear associations between teen driving outcomes and psychosocial development (Bingham, Shope, 2004a, 2004b). Problem Behavior Theory (PBT) provides a framework for examining links between psychosocial characteristics and risky driving. PBT classifies behavior as conventional (i.e., socially *prescribed/ encouraged*) or problem behavior (i.e., socially *proscribed/ prohibited* behavior), and recognizes that problem behaviors tend to co-occur within individuals, resulting in a “problem behavior syndrome.” PBT recognizes four systems of variables. Three of these systems, the *perceived environment system*, *personality system*, and *behavior system* generated hypotheses for this study. Substance use and problem driving are included in the behavior system. The *perceived environment and personality systems* provide motivation for involvement in, or avoidance of problem behaviors, including risky driving (Beirness, Simpson, 1988; Jessor, Jessor, 1977; Donovan, 1993; Jessor, 1987; Shope, Bingham, 2002). The social-environmental system is the fourth, and includes broad background variables that are not included in this study.

Although not embedded within PBT, sex consistently moderates psychosocial characteristics and problem behaviors, including risky driving. Sex differences have been demonstrated in the associations between parental monitoring (Copeland, Shope, Waller, 1996), substance use (Shope, Waller, Lang, 1996; Shope, Waller, Raghunathan, et al., 2001a), drinking-driving, and riding with a drinking driver (MacKinnon, Pentz, Broder, et al., 1994). For this reason, sex was included as a main effect and as a moderator in the models tested for this study.

The objective of this study was to identify psychosocial characteristics of teens that predict their crashes in the first few years of independent driving.

## METHODS

**SAMPLE** - This study used existing data that were collected when the participants were in 10<sup>th</sup> (average age = 15.7 years) and 12<sup>th</sup> grades, and during a young adulthood follow-up telephone survey (average age 23.8 years) at which point they had been licensed to drive for an average of 8.06 years (SD = 1.1 years, range = 2 to 12). High school assessments were conducted in the fall of 1988 and 1989 (10<sup>th</sup> grade) and the spring of 1991 and 1992 (12<sup>th</sup> grade) as part of a school-based substance abuse prevention evaluation study called the Alcohol Misuse Prevention Study (AMPS; Shope, Copeland, Maharg, et al., 1996).

**SURVEYS** - From 1984 through 1992, six school districts in southeastern Michigan participated in AMPS. Data collection began when the participants were in the 5<sup>th</sup> and 6<sup>th</sup> grade, and continued through 12th grade (for effectiveness of AMPS see Shope, Dielman, Butchart, et al., 1996a; Shope et al., 1992). The 10th and 12th grade surveys measured demographic characteristics, substance use behavior, perceptions of parental attitudes and behavior, and other psychosocial and behavioral variables.

The sample for this study was a longitudinal subset of the AMPS sample, and included only participants who had a Michigan driver license (so that official driving records could be obtained), a young adult telephone interview, and at least one high school survey (n = 1,936). Participants in this study were 47.6% male, 85.3% white, 1.9% Black, 0.5% American Indian, 2.7% Asian, and 9.6% from other races. The University of Michigan Institutional Review Board approved the data collection procedures for this study, and all participants provided informed consent.

**STATE DRIVER RECORDS** - Driver history records were obtained annually from the Michigan Department of State (DoS), and included administrative data describing all officially reported motor vehicle crashes occurring in Michigan that involved study subjects. Record updates were obtained from the DoS annually and merged with those existing records, providing a continuous (i.e., day-by-day) record of the subjects' driver histories from original licensure to the time of the young adult survey.

**SURVEY MEASURES** - Measures representing overall high school levels were calculated by averaging scores across surveys administered in the spring of the participants' 10th and 12th grade years. This method of data reduction simplified the analyses and allowed the inclusion of participants who were missing one of the two high school surveys (i.e., data from the single time-point were used in lieu of an average over two time-points).

Parental behavioral monitoring and parental permissiveness were used as separate indicators of the adolescent perceived environment system. Parental behavioral monitoring (McAlister, 1983) was measured by four items. This measure has adequate internal consistency ( $\alpha = .63$ ) (Cattell, 1982) and has been used successfully in past research predicting adolescent and young adult outcomes (Bingham, Shope, 2004a; 2004b).

Parental permissiveness was constructed by summing the scores of four items (White, Johnson, Horwitz, 1986). This scale has been found in past research to be predictive of adolescent and young adult behavioral outcomes (Bingham, Shope, 2004a, 2004b), and has adequate internal consistency ( $\alpha = .54$ ) (Cattell, 1982).

The personality system was assessed using three measures of participants' connectedness with family and school, and individual acceptance of deviant behavior. Parent-orientedness was measured by three items summed so that a higher score represented greater parent-orientedness ( $\alpha = .72$ ). A single item asked adolescents to report their typical grades in school on a scale ranging from 1 = mostly F's to 9 = mostly A's. Finally, tolerance of deviance was assessed by a modified five-item version of the measure developed by Rachal and associates (1975). The items were summed so that higher scores represented greater tolerance of deviance ( $\alpha = .80$ ).

Substance use was the adolescent problem behavior of primary interest in this study, and included cigarette use, alcohol misuse, and marijuana use. Cigarette use and marijuana use were each measured by three separate items that assessed the frequency of use during the previous 12 months. Alcohol misuse during the previous 12 months was assessed by a 10-item scale that measured overindulgence in alcohol (i.e., drink more than planned, sick after drinking, and get drunk), trouble resulting from alcohol use (i.e., trouble in school, with friends, parents and police), and alcohol use leading to complaints from others (i.e., same and opposite sex friends, and dating partners) ( $\alpha = .82$ ) (Shope, Copeland, Dielman, 1994). Higher summed scores reflected greater alcohol misuse.

The three substance use measures were aggregated into a single measure of substance use. A hierarchical coding method was used in which cigarette smoking was coded 0 for no smoking and 1 for any smoking, alcohol misuse was coded 0 for no misuse and 2 for any misuse, and marijuana was coded 0 for no use and 4 for any use. This method scored the use of illicit drugs (marijuana) higher than alcohol misuse, and alcohol misuse higher than cigarette smoking (see Bingham & Shope, 2004a for a similar ordering and theoretical rationale). The coding yielded a total score that identified unique combinations of substance use that rank in order of their relative seriousness: 0 = no substance use, 1 = cigarette smoking only, 2 = alcohol misuse only, 3 = cigarette smoking and alcohol misuse, 4 = marijuana use only, 5 = cigarette smoking and marijuana use, 6 = alcohol misuse and marijuana use, and 7 = cigarette smoking, alcohol misuse, and marijuana use.

Self-reports of behaviors that are socially proscribed or frankly illegal are often suspected of lacking validity. However, there is substantial published evidence supporting the validity of self-report of illegal behaviors, including substance use, when confidentiality is assured as it was in this research (Babor, Del Boca, 1992; Babor, Steinberg, Anton, Del Boca, 2000; Chaikelson, Arbuckle, Lapidus, 1994; Darke, Heather, Hall, et al., 1991; Williams, Toomey, McGovern, 1995).

**DRIVER HISTORY MEASURES** - Motor vehicle crash patterns were based on driver history records spanning the interval from initial driver licensure (mean age at licensure: women =  $16.25 \pm 0.44$ , men =  $16.14 \pm 0.52$ , range of 15 to 17 years of age) through the beginning of the telephone follow-up interviews (i.e., September 1999) (mean age, women =  $23.86 \pm 0.70$ ; men =  $24.01 \pm 0.73$ ). This interval was divided into teen (age < 20) and young adult (age  $\geq$  20) segments. Crashes were summed within the two segments, providing each subject's total crashes from licensure to age 20, and from age 20 to the telephone survey.

Crash patterns were defined using all crashes (not only at-fault) by first dividing the sample into low and high crash rate groups based on the median number of crashes within sex. For both sexes the median number of crashes was 0, so that the groups that were formed were no crashes versus any crashes. The number of crashes ranged from zero to seven (zero to five for women and zero to seven for men) in the teen segment, and zero to six (zero to five for women and zero to six for men) in the young adult segment. The high and low groups were used to classify participants based on their crash patterns. The first "Stable Low," included drivers with no crash rates in either segment. The second group was called "Increasing" and included drivers who had no crash in the first segment and at least one in the second. The third group had at least one crash in both segments and was called "Stable High," and the fourth group, called "Decreasing," had at least one crash in the first segment and no crash in the second.

**CONTROLLING FOR DRIVING EXPOSURE** - Age at licensure and the total number of miles driven in the 12 months prior to the young adult survey were used to adjust the model for driving exposure. Age at licensure was obtained from the driver history records. Only participants who had received their license prior to age 19 (96% of the sample) were included in these analyses to ensure that all participants had at least one year as licensed drivers in the first segment. Age at licensure adjusted the models for variation in maturity at licensure (i.e., age of licensure), experience (i.e., total length of time as a licensed driver), and exposure to the potential of being in a traffic crash.

The total miles driven in prior the 12 months was measured in the young adult telephone follow-up, and is the only variable from the young adult follow-up that was included in this study. This measure adjusted the models for variation in total amount of driving near the end of the study interval. Its inclusion in the models adjusted the estimates for variation due to the amount of driving in the second interval.

## RESULTS

Four hundred thirty-one men (46%) experienced at least one crash in the first segment, 437 (47%) in the second segment, and 652 (70%) over both segments. For women, the numbers of crashes were 408 (40%), 401 (39%), and 647 (63%) in the first and second segments, and overall.

Participants with different crash patterns were compared using analysis of variance with the psychosocial measures (i.e. parental monitoring and permissiveness, parent orientation, tolerance of deviance, marks in school), substance use, and control measures (i.e., miles driven in the previous 12 months, age at licensure) as dependent variables (see Table 1). Following these initial analyses, the models with the psychosocial and substance use variables as dependent measures were tested again while controlling for total miles driven in the prior 12 months and age at licensure. Interactions of crash group and sex were tested, but none were significant; hence the results for men and women are presented separately.

With the exception of number of miles driven in the prior 12 months, differences tended to occur between those groups with low initial crash rates (i.e., stable low and increasing) and those with high initial crash rates (i.e., stable high and decreasing). Men and women in the increasing and stable high groups reported driving more miles in the prior 12 months as young adults than those in the stable low and decreasing groups. Also, men and women in the stable low and increasing crash groups tended to get licensed at a later age, reported greater parental awareness of their activities, had better marks in school, and had less substance use in adolescence than the stable high and decreasing groups. Women, but not men, in the stable low and increasing groups were more parent-oriented and were less tolerant of deviance as adolescents. Parental permissiveness was not associated with crash group for either sex.

Group differences in tolerance of deviance for women became non-significant when the model was controlled for license age and miles driven in the prior 12 months. No other changes were observed when these variables were entered as control variables in the models testing group differences in the psychosocial variables and substance use.

In a follow-up analysis, participants were given a score of 1 if they had initial high crash levels (i.e., stable high and decreasing combined) and 0 if they had initial low crash levels (i.e., stable low and increasing combined). Logistic regression with backward elimination was then used to build multivariate models predicting initial high versus low crash levels using the same dependent variables included in the analysis of variance models. The multivariate models were estimated separately for men and women.

For men, as substance use and lower marks in school increased, the odds of having initial high crash rates increased (Wald  $\chi^2$  (2) = 15.01,  $p < .001$ ). When this model was adjusted for license age and total miles driven in the year prior to the young adult survey, substance use (Wald  $\chi^2$  (1) = 5.73,  $p = .017$ ; o.r. = 1.06), marks in school (Wald  $\chi^2$  (1) = 6.54,  $p = .011$ ; o.r. = 0.879), and license age (Wald  $\chi^2$  (1) = 9.07,  $p = .03$ ; o.r. = 0.652) remained in the model (Wald  $\chi^2$  (3) = 23.73,  $p < .001$ ). Once again, as substance use increased and marks in school and license age decreased, the odds of being in the initial high group increased.

For women, less parent orientation predicted increased odds of having an initial high crash rate (Wald  $\chi^2$  (1) = 24.32,  $p < .001$ ). When this model was adjusted for total miles driven in the prior year and age at licensure, less parent orientation (Wald  $\chi^2$  (1) = 24.02,  $p < .001$ ; o.r. = 0.792) and younger age at licensure (Wald  $\chi^2$  (1) = 9.68,  $p = .002$ ; o.r. = 0.587) predicted increased odds of having initial high crash rates (Wald  $\chi^2$  (2) = 33.93,  $p < .001$ ).

## DISCUSSION

The purpose of this research was to examine the association between adolescent psychosocial characteristics and problem behavior, and crash outcomes from licensure to approximately age 24 years. Prior research has shown that problem driving behavior is related to psychosocial characteristics and other problem behaviors in a manner consistent with Problem Behavior Theory (Donovan, 1993; Shope, Bingham, 2002). Trajectories of psychosocial development from adolescence to young adulthood are also related to driving outcomes (Bingham, Shope, 2004a, 2004b), and recent research has predicted driving offense patterns from adolescent psychosocial development (Bingham, Shope, submitted). These preliminary studies have led naturally to the question of a systematic association between psychosocial and behavioral factors and teen crashes.

Motor vehicle crashes are relatively rare events, making it difficult to identify predictors. Although they occur infrequently, and many are minor, crashes can result in serious outcomes, and are the leading cause of death among teens and children. Because of their potentially serious nature, and our overwhelming reliance on motor vehicles for transportation, the identification of risk factors and the development of interventions to prevent crashes are of great importance. The results of this research identify systematic patterns of association between psychosocial developmental and problem behavior characteristics of teens, and patterns of crash occurrence in the early years of driving. Furthermore, the pattern of associations observed in this study is consistent with the conceptual framework outlined by Problem Behavior Theory, and shows that factors that

commonly predict involvement in problem behaviors, such as substance use and socially proscribed behavior, also predict crashes.

The ability to predict motor vehicle crashes using psychosocial characteristics and problem behavior is important in continued efforts to improve the driving safety of teens. Individual-level characteristics such as those identified in this study provide a broader characterization of teens who are the most likely to experience a crash in the early years of driving. In addition, this study shows how patterns of change in crash risk are related to these same individual characteristics. These associations of crash occurrence with psychosocial and problem behavior variables, in combination with Problem Behavior Theory (PBT) provide insight into the developmental mechanisms relating to crash risk. In turn, these results suggest public health and developmental intervention approaches, which have successfully targeted other problem behaviors, that might be used in to reduce crash injuries to teens.

Using PBT as a theoretical guide, information from this study can benefit interventions in two general ways. First, individual characteristics that are associated with particular patterns of crash risk can be identified and addressed by behavioral programs. Interventions that are designed to change these key behaviors may reduce the risk for crash. Second, the information from this research and from PBT can assist planners to design interventions that are suitable and attractive to at-risk individuals. This suitability enhances the intervention's chances of success by facilitating engagement and retention of the individual in the intervention.

Key aspects identified in this study that might be targeted by interventions to reduce the crash risk of young drivers include connections with conventional social institutions and individuals representing these institutions, and parenting strategies. Teens who had better marks in school, felt a stronger orientation toward family, and whose attitudes toward deviance were in line with the values of conventional society had better crash outcomes than those whose behavior was not in line with social standards. These patterns included both patterns of sustained lower crash risk during the teens and early 20's, as well as initially high rates that are followed by declines during early young adulthood.

Social Control Theory (Hirschi, 1969) posited that teens who have positive affiliations with conventional social institutions, such as family, religion, and school, and relationships with the people representing them, had more to lose and less to gain by behaving in a manner that was contrary to societal mores. This hypothesis is consistent with PBT, and is supported by the current research. In terms of interventions, this association suggests that interventions that foster the development of positive relationships between teens

and conventional social institutions may have the effect of reducing crash risk.

Parental awareness of their children's activities can arise due to the child's willing disclosure of information to their parents, but also through effective parental monitoring of children's activities. Parental awareness of children's activities has been repeatedly shown to predict positive developmental outcomes of children, and this research indicates that crash risk may also be reduced through parents' use of effective methods of supervision to increase their awareness and influence over their teenage children's activities. Indeed, interventions aimed at encouraging parents to restrict their teenage children's driving early in their driving careers, and that provide parents with structured direction in providing appropriate monitoring and supervision of their teenaged children's driving are effective in reducing teens' crash risk (Simons-Morton, Hartos, 2003; Hartos, Eitel, Haynie, 2000). Future interventions should follow suit. Many parents would provide better supervision of their teenagers' driving if they had the tools to do so. Development of interventions that provide practical tools for this purpose should be pursued.

What cannot be concluded from this research is that adolescent psychosocial characteristics cause crash risk. It is impossible from this study to determine whether psychosocial characteristics and problem behavior are part of the cause, or whether, as with other teen behaviors (e.g. sexual behavior, see Bingham, Crockett, 1996), these factors are part of a syndrome or pattern of associated behaviors, attitudes and consequences that are all part of a teen's developmental trajectory.

In either case, whether psychosocial characteristics and problem behaviors are part of a syndrome that includes elevated crash risk, or whether they combine with other factors to contribute to crash risk, effective interventions are important, and have the potential to reduce a teen's risk of negative outcomes, including a motor vehicle crash.

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Table 1. Crash group means, standard deviations, and differences by sex.

Variables	(1) Stable Low	(2) Increasing	(3) Stable High	(4) Decreasing	F	p
<b>Men (n = 929)</b>						
Total Miles	1.53 <sup>2,3</sup> (±1.31)	1.79 <sup>1</sup> (±1.33)	1.96 <sup>4</sup> (±1.52)	1.67 <sup>3</sup> (±1.43)	3.97	.008
License Age	16.13 <sup>2</sup> (±.44)	16.25 <sup>1,3,4</sup> (±.60)	16.09 <sup>2</sup> (±.55)	16.07 <sup>2</sup> (±.48)	5.19	.002
Parental Monitoring	9.38 <sup>3</sup> (±2.21)	9.47 <sup>3</sup> (±2.08)	8.77 <sup>1,2,4</sup> (±2.40)	9.37 <sup>3</sup> (±2.21)	4.57	.004
Parental Permissiveness	8.70 (±1.59)	8.40 (±1.78)	8.72 (±1.61)	8.69 (±1.83)	1.78	.149
Parent Orientation	5.05 (±1.35)	4.99 (±1.34)	4.77 (±1.33)	5.01 (±1.31)	1.96	.118
Tolerance of Deviance	2.31 (±.65)	2.28 (±.70)	2.36 (±.66)	2.35 (±.72)	.71	.543
Marks in School	7.29 <sup>2,3,4</sup> (±1.41)	6.75 <sup>1</sup> (±1.44)	6.67 <sup>1</sup> (±1.50)	6.92 <sup>1</sup> (±1.44)	8.69	<.001
Substance Use	2.01 <sup>3</sup> (±2.50)	2.33 <sup>3</sup> (±2.61)	3.04 <sup>1,2,4</sup> (±2.79)	2.41 (±2.64)	6.09	<.001
<b>Women (n = 1007)</b>						
Total Miles	1.19 <sup>2,3</sup> (±.85)	1.45 <sup>1</sup> (±1.08)	1.48 <sup>1</sup> (±1.07)	1.31 (±1.33)	4.24	.006

License Age	16.25 <sup>2</sup> (±.44)	16.35 <sup>1,3,4</sup> (±.53)	16.19 <sup>2</sup> (±.35)	16.21 <sup>2</sup> (±.41)	6.13	<.001
Parental Monitoring	9.97 <sup>3,4</sup> (±2.03)	10.02 <sup>3,4</sup> (±1.96)	9.58 <sup>1,2</sup> (±2.18)	9.40 <sup>1,2</sup> (±2.28)	5.34	.001
Parental Permissiveness	8.73 (±1.70)	8.67 (±1.74)	8.70 (±1.74)	8.84 (±1.60)	.49	.688
Parent Orientation	5.18 <sup>3,4</sup> (±1.38)	5.15 <sup>3</sup> (±1.48)	4.49 <sup>1,2,4</sup> (±1.36)	4.90 <sup>1,3</sup> (±1.40)	10.27	<.001
Tolerance of Deviance	2.26 <sup>3</sup> (±.60)	2.27 <sup>3</sup> (±.59)	2.42 <sup>1,2</sup> (±.63)	2.36 (±.62)	3.24	.022
Marks in School	7.33 <sup>3</sup> (±1.27)	7.22 <sup>3</sup> (±1.27)	6.93 <sup>1,2,4</sup> (±1.29)	7.25 <sup>3</sup> (±1.29)	3.72	.011
Substance Use	2.42 <sup>3</sup> (±2.68)	2.60 <sup>3</sup> (±2.70)	3.43 <sup>1,2,4</sup> (±2.73)	2.85 <sup>3</sup> (±2.72)	5.45	.001

Note, groups are numbered from one to four (see top row of table). Superscripts denote groups that differ significantly.