

Systematic Literature Review and Model for Older Driver Safety

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Using the Precede-Proceed Model of Health Promotion (PPMHP) and an etiological systematic literature review, we examined the risk/protective factors of older driver safety in the United States. We described key features of this literature review and developed a structural model illustrating the prevalence of risk/protective factors in the health domain (63%) and in other PPMHP domains (environment 20%; behavior and lifestyle 10%; predisposing 1%; reinforcing 3%, enabling 2%; health education 2%). This model, a first step in synopsis and quantifying these risk/protective factors, informs rehabilitation professionals of their etiology and prevalence, affords opportunities for multidisciplinary research, and lays the foundation for intervention planning. **Key words:** *content analysis, etiology, mixed methods approach, older driver safety, Precede-Proceed Model of Health Promotion, structural model, systematic literature review*

BACKGROUND AND SIGNIFICANCE

Older driver safety

Older driver safety is a rapidly growing public health concern that holds numerous challenges for rehabilitation professional. Statistics show that there were 19.1 million licensed drivers aged 70 and older in the United States in 2001, that they have, based on miles

driven, higher rates of fatal crashes than any other group, except very young drivers, and that their numbers are increasing.¹ In 2001, nearly 7500 adults aged 65 and older died in motor vehicle crashes, and an estimated 259,500 suffered nonfatal injuries, with rates being twice as high for men as for women.^{2,3} In the near future, a larger proportion of this population will hold drivers' licenses, as the 65 and older age group is the fastest growing segment of the population. More than 40 million older adults will be licensed drivers by 2020,⁴ and these license holders are predicted to drive more miles than older drivers today.⁵ By 2030, people aged 65 and older are expected to represent 25% of the driving population and 25% of fatal crash involvement.⁶ Elderly drivers are clearly at an increased risk for motor vehicle crashes especially due to underlying medical conditions, medications, and functional impairments that are common to this group.⁷

The elderly drivers' declining abilities due to normal aging are not generally accommodated by the cars that they drive,⁸ their driving environments,⁹ or the social systems that should support them.¹⁰ It is often the

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The authors acknowledge the Centers for Disease Control and Prevention (CDC) for funding this research under Project # 1 K01 CE000497-01, and the National Older Driver Research and Training Center (NODRTC), University of Florida, Gainesville, Fla.

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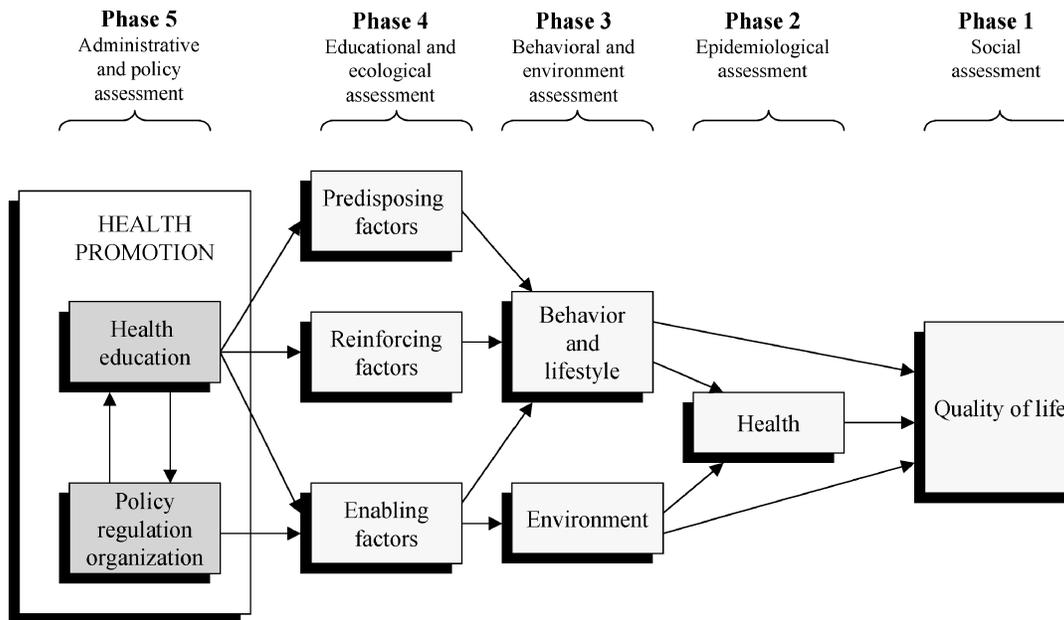


Figure 1. Precede phase of the Precede-Proceed Model of Health Promotion. Reprinted with permission from McGraw-Hill Companies.

case that their cars are too big, leading to poor or inadequate driver-vehicle fit.¹¹ Also, road signs often do not accommodate their visual challenges, such as increased sensitivity to glare, or high-contrast demand. Accompanied with declining cognition (eg, decreased attention, organization, and following of directions and judgment), quick maneuvers needed from sign observation and interpretation (such as lane changes) may potentially be problematic.⁹ Social systems to support the older driver are mainly lacking. As such, because of the dearth of referral and access to driver rehabilitation programs, older drivers may be required to stop driving prematurely.¹⁰ Driving cessation may be an option, but without adequate alternatives to driving, nondrivers are at risk of becoming homebound, isolated, and depressed.¹²

Older driver safety is a complex phenomenon that extends beyond the person level to multiple systems, including regulatory and policy-making systems, societal systems (for specific provisions of accommodations for older drivers), and healthcare systems. Unless we use an integrated approach, grounded

in a unifying socioecological model, we will not have taken the adequate steps to understand the interaction of the person, environment, and organizations' influence on safe driving. Continued neglect of these needs, accompanied with the "graying of America," could sharply increase the number of people killed in crashes, and leave many more injured and disabled.

Precede-Proceed Model of Health Promotion

The Precede-Proceed Model of Health Promotion (PPMHP),¹³ a socioecological planning model, has been applied, tested, studied, and verified in more than 900 published studies and thousands of unpublished projects in community, school, clinical, and workplace settings over the last decade.^{13,14} This model is multidimensional, founded in the social/behavioral sciences, and includes domains to recognize social, epidemiological, behavioral and environmental, educational and ecological, and administrative and policy factors (Fig 1). As such, it identifies multiple

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causations, which must be evaluated in order to assure appropriate intervention. The Precede phase of the model is a framework for systematically evaluating the social, health, behavioral and environmental, and educational aspects of the outcome—older driver safety.

Systematic literature review

Rehabilitation professionals, consumers, researchers, and policy makers are inundated with unmanageable amounts of information. As such, the need exists for literature to “efficiently integrate valid information and provide a basis for rational decision making.”¹⁵ Systematic literature reviews (SLRs) assemble, critically appraise, and synthesize the results of primary investigations addressing a topic of concern.¹⁶ These topics may address 1 of 5 areas: effectiveness of intervention; frequency rates; diagnostic tests; etiological or risk factor identification; and prediction or prognosis.¹⁷ Whatever the topic, systematic reviews contain a summary of all past research on an area of interest using a methodology that incorporates explicit methods to limit bias (systematic errors) and reduce chance effects, thus providing more reliable results upon which to draw conclusions and make decisions.¹⁸ The steps of the SLR guide the researcher through the process of systematically evaluating the existing literature in light of a predetermined research question.

Purpose statement

Observational studies have examined a plethora of associations between exposures and safe/unsafe outcomes in driving, yet no systematic review of the older driver safety literature has been conducted in the United States. The need for evidence to support clinical practice and policy development in the area of older driver safety has never been greater. We used the PPMHP as a guiding framework and the SLR method guidelines to synthesize the 1985–2005 older driver research literature (quantitative and qualitative, published and unpublished) to answer

the question: Within the framework of the PPMHP, what are the main risk and protective factors for older driver safety in the United States?

METHODS

Study protocol

The systematic review protocol ensures that the review is conducted with the same rigor expected from all other research.¹⁶ The protocol fulfills the same role as a research proposal in that each step in the review process is fully described. The protocol states the review question, how studies will be located, appraised, selected, analyzed, synthesized, and presented.^{16,19} The 7-step protocol for this study is discussed next.

In the *first step*, one formulates the problem, conceives, designs, and coordinates the review. To identify the risk and protective factors associated with older driver safety, our research question was etiological in nature. After searching the available sources to ascertain the work that has already been conducted in the area of older driver safety, we used the socioecological model, PPMHP, to conceptualize our research question.

The *second step* involves locating and selecting studies. On the basis of the research question, we performed a comprehensive, exhaustive search of the literature and included only primary studies. To ensure rigor and comprehensiveness in our search, we consulted with a university-based reference librarian and performed a careful selection of relevant reference databases and “fugitive” literature (literature not published). We developed a well-defined search strategy, and consulted with a database reference manager specialist to import the sources into an EndNote database.

During the *third step*, critically appraising studies, we trained 4 reviewers to complete a first screening of the title and abstract of each primary study. The reviewers developed and used explicit inclusion and exclusion criteria to determine which studies would remain for further systematic review. A reliability analysis, using a κ coefficient scale to measure

the level of agreement beyond chance, was employed.

The *fourth step*, systematically collecting the actual review data, involved developing and using a Web-based data capture tool to extract information from the primary sources. The same team of 4 reviewers was trained and reliability analyses were performed to measure consistency of their data extraction process.

On the basis of the *fifth step*, analyzing and presenting results, we used descriptive and content analysis to conduct a narrative meta-synthesis. In *step 6*, we interpreted the data on the basis of the main descriptors, risk factors associated with unsafe driving, and applicability of results to the PPMHP.

The final, *seventh step*, focuses on public presentation and report writing. We used editorial criteria to select information for publication and/or presentation, include procedures and results for the study to be reproducible, and discuss study limitations to enhance future research and enable other researchers to judge our process and findings of the systematic review.^{20,21}

Measurement

In this etiological study, we identified independent variables as any social, epidemiological, health, behavior, environment/vehicle, or organizational factors associated with safe/unsafe driving (outcome variable). Safe driving was conceptualized as physical and mental performance of the older driver, which equaled or exceeded the physical and mental demands of the driving activity. Operationally, we defined safe driving as the absence of any adverse driving outcomes. Unsafe driving was operationalized as driving events resulting in crashes, near crashes, minor accidents, injuries, or fatalities.

Inclusion/exclusion criteria

Specific inclusion criteria included published or unpublished primary quantitative or qualitative research studies that reported re-

sults in the English language; studies involving older drivers (60 years and older); mainly US studies published or conducted between January 1985 and April 2005; and that pertained to safe or unsafe driving. Studies that did not contain research results (eg, position papers), those investigating driving in a simulator, or those duplicating findings from primary studies were excluded.

Procedure for establishing rater reliability

We conducted interrater reliability (IRR) among the 4 raters, divided into 2 teams (team 1 and team 2), to ensure consistency in the use of inclusion/exclusion criteria. Using MAPLE Software Version 9.0,²² we assigned random numbers to each article. Each reviewer team screened 20 abstracts. Using a κ coefficient scale, we classified the level of agreement beyond chance.²³ The agreement ratings were none (0), slight (0–0.2), fair (0.2–0.4), moderate (0.4–0.6), substantial (0.6–0.8), and almost perfect (0.8–1.0). Team 1 achieved a κ coefficient of 1.0 while team 2 achieved a κ coefficient of 0.6. Disagreements from this screening were resolved through consensus meetings.¹⁹ Next, we established the IRR for reviewers' use of the inclusion/exclusion criteria, with κ coefficients ranging from 0.4 to 0.7. Full details of rater reliability are discussed elsewhere.²⁴

Literature search

Using guidelines suggested by Cooper and Hedges,¹⁶ we created a literature search strategy that included search terms and a list of databases. Search terms were "aged, old, older, senior, elder, driving, automobile driving, transportation, accident, crash, safety, and traffic safety"* and MeSH headings were (((("Aged"[MeSH] AND English[Lang]))) AND ((("Risk Factors"[MeSH])) AND

*Complete details of the search strategy are available from the corresponding author.

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((“Accidents, Traffic”[MeSH])) AND ((“Automobile Driving”[MeSH])).

To ensure comprehensive retrieval of relevant sources, we executed a multidatabase search. This included published reports, books, research reports, unpublished research, presentations, and dissertations. Databases available through the University of Florida Library (eg, Web of Science) provided access to literature in medicine, social science, biological science, and engineering. We also searched databases from federal and national transportation organizations, for example, Transportation Research Information Services (TRIS). Initial screening, for inclusion, was based on the source title and abstract.

Meeting the inclusion criteria, published sources were obtained in full text through online retrieval, library access, and intralibrary loan, while unpublished sources were obtained by contacting 87 researchers and experts in the driving field. The response rate for submitting unpublished studies was 10%, partly due to researchers' unfamiliarity with the SLR process. From the original 2509 abstracts reviewed, we included 864 sources in the full-text review, and from those we retrieved 780 full-text studies.

Data collection

We critically appraised data extraction tools developed by the McMaster University Occupational Therapy Evidence-Based Practice Research Group,²⁵ the Critical Appraisal Skills Programme,^{26,27} and the World Cancer Research Fund.²⁸ After identifying numerous strengths and limitations of these tools, we developed an objective and comprehensive quantitative and qualitative data extraction tool, SPIDER (Systematic Process for Investigating and Describing Evidence Based Research). Several versions of this tool were field tested, with reliability (test-retest and intrarater) completed,²⁴ and validity (content and construct) studies nearing completion. We converted the SPIDER tool into a Web-based product and used it to create a database

for all extracted information from the identified sources.

Methods for evaluating sources

On the basis of the inclusion and exclusion criteria, 4 reviewers examined the 780 full-text sources for an inclusion of 201 sources in the final SLR. The IRR was established for data extraction among the two teams of reviewers yielding κ coefficients ranging from 0.2 to 0.8 and from 0.4 to 1.0. Reviewers participated in consensus discussions to address disagreements and to come to a final decision for source inclusion or exclusion.

Statistical methods

Because of the heterogeneity of the study¹⁶ and to analyze the results, we used meta-synthesis approach.²⁹⁻³¹ We described key features (eg, areas of focus, research designs, or statistical methods) using summary statistics. We analyzed the *result sections* of the sources with a mixed method approach: meta-synthesis and content analysis. Results were classified into 2 categories according to whether or not results related factors to outcomes. Informed by the phases of the PPMHP, we developed a structural model to represent the percentages of risk and protective factors to safe/unsafe driving outcomes. For summary statistics, we used SAS Version 9.1.³² We used percentages and frequencies to describe the independent and dependent variables.

Mixed methods: Meta-synthesis and content analysis

From the Web-based data collection instrument, we created an MS-Excel spreadsheet containing all the *results*, arranged in line items, of the sources. Using a meta-synthesis and content analysis for developing and quantifying the coded information, we analyzed the results of these sources.^{29,33,34} We coded each text segment of the source's *result* section and used constant comparison to identify major themes across or within the specific context.³³⁻³⁵ We searched for words, terms,

Table 1. Focus of the systematic literature review ($N = 201$)*

Domain	Primary or secondary focus	Primary focus	Secondary focus
Social	40 (20)	15 (7.46)	25 (12.44)
Epidemiological	85 (42.29)	72 (35.82)	13 (6.47)
Health	128 (63.69)	102 (50.75)	26 (12.94)
Ecological	114 (60.20)	75 (37.31)	46 (22.89)
Behavioral	114 (56.62)	64 (31.84)	50 (24.88)

*Values given are number (percentage).

and semantic units of meaning. Once the basic unit of analysis was identified and coded, we sorted the units into main categories and into subcategories. This sorting was an iterative process in which we reassigned themes to different domains, relabeled, and collapsed categories and subcategories several times to make conceptual sense. We conducted this process according to the organizing framework of the study, the PPMHP, and taking into account the research context of each source.

To minimize researcher bias and to enhance the validity of the content, the same 4 reviewers performed the coding and devised the categories and subcategories. Each unit of analysis was assigned a domain label consistent with the domains of the PPMHP. For example, macular degeneration fell under the domain "health," under the main category "eye" and the subcategory "eye condition." Through out the analysis process, the reviewers worked with a coinvestigator trained in qualitative methods to increase the rigor, reliability, and validity of the process. All suggestions and recommendations in these consultation sessions were discussed within the context of the source data, consistent with the structure of the PPMHP, and then upon agreement of all parties incorporated into the final analysis. The detailed process description for the SLR is published in this issue of the journal.³⁶

Structural model

All labeled *results* data were imported and analyzed using SAS Version 9.1.³² To describe

the emerging structural model for older driver safety, we quantified the relationship of the independent variables to one another and to the outcome variable. We explained the relationship for directionality (independent variable to dependent variable) and quantified the relationship (n , %) of the risk or protective factors by domain, category, and subcategory to safe/unsafe driving (dependent variable).

RESULTS

Descriptive

From the 201 final primary sources, 181 (90%) were obtained from peer-reviewed journals, 1 from conference proceedings, 1 from the unpublished literature, 3 from dissertations, and 14 from national transportation-specific reports.

Table 1 presents the foci of the SLR. The domains were not mutually exclusive as one study fell in more than one domain. Sixty-four percent of sources had a primary and secondary focus on the health domain, 60% on the ecological domain, 57% on the behavioral domain, and 42% on the epidemiological domain. Only 20% of studies focused on the social (stakeholder and client perspectives) domain.

Table 2 presents the prevalence of research designs. While the lowest prevalence was evident among the experimental (12%), qualitative (4%), and ecologic (1%) designs, the cross-sectional (52%) and cohort (23%) designs yielded the highest prevalence. The designs were not mutually exclusive as sources often used more than one method.

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Table 2. Research designs used in the systematic literature review ($N = 201$)*

Design	
Randomized control trial	5 (2)
Community trial	2 (1)
Other experimental designs	21 (10)
Quasi experimental	12 (6)
Factorial design	2 (1)
Nonrandomized control trial	2 (1)
Uncontrolled trial	1 (0)
Time series with multiple measurements	4 (2)
Ecologic	1 (0)
Cohort	48 (23)
Prospective study	15 (7)
Concurrent retrospective and prospective study	4 (2)
Retrospective study	29 (14)
Case-control	19 (9)
Nested study	1 (0)
Cross-sectional	104 (52)
Case series, case report	5 (2)
Qualitative study	8 (4)
Other	28 (14)

*Values given are number (percentage).

Table 3 presents the statistical methods used in the sources. These were not mutually exclusive as many of the sources used more than one method. We observed the highest prevalence for the χ^2 test (26%), followed by the multiple logistic regression and logistic regression (23%), multiple regression (including regression, ANOVA, and ANCOVA) (21%), and t test/ Z test (20%). Correlations, estimation methods (confidence intervals), and nonparametric tests were used 13%, 11%, and 6% of the time, respectively. Prevalence for multivariate tests was 4%, and 1% each for structural equation models, discriminant analysis, factor analysis, and intraclass correlation coefficient methods.

Mixed method analysis

Table 4 presents the independent variables, or risk and protective factors by PPMHP domains, and the relationship (yes/no) of these factors to the outcome variable. These data

Table 3. Statistical methods ($N = 201$)*

Statistical method	
Summary statistics	16 (8)
Estimation—confidence intervals	22 (11)
χ^2 test	50 (26)
t Test/ Z test	38 (20)
Correlation (Pearson, Spearman, partial)	25 (13)
Nonparametric tests	11 (6)
Multiple regression, regression, ANCOVA, ANOVA	40 (21)
Multiple logistic regression, logistic regression	45 (23)
Poisson regression	6 (3)
MANOVA	2 (1)
Other multivariate	6 (3)
Structural equation models	1 (1)
Discriminant analysis	2 (1)
Factor analysis	2 (1)
Intraclass correlation	2 (1)
Bonferroni test	4 (2)

*Values given are number (percentage).

formed the bases for the structural model for older driver safety displayed in Figure 2. In this figure, we observe that the highest prevalence of significance among risk and protective factors and the outcome occurred in the health domain (63%). The environment domain had the second highest prevalence (20%), followed by the behavioral and lifestyle domain (10%). Variables from the predisposing, reinforcing, and enabling domains show weak representation (<1%, 2%, and 3%), and only 2% of health education variables showed significance to safe/unsafe driving.

Table 5 presents the format for reporting results. These were not mutually exclusive as sources often used various methods for reporting. Among all the sources, P values (53%), risk ratios (35%), estimation (24%), correlations (22%), regression coefficients (5%), and other formats (25%), summary statistics had the highest prevalence (measures of dispersion 70% and measures of central tendency 89%).

Table 6 presents the key words used by author(s) and reviewers. The highest prevalence (25%–39%) was found in the first category

Table 4. Significance of risk and protective factors to outcome variable ($N = 201$)*

PPMHP domain	Domain code	Relationship/ no significance	Relationship/ significance
Health education	7	1 (1.01)	9 (1.75)
Screening/assessment	71	1 (1.01)	8 (1.56)
Intervention	72	0 (0.00)	1 (0.19)
Counseling	73	0 (0.00)	0 (0.00)
Predisposing	4	1 (1.01)	3 (0.58)
Knowledge	41	1 (1.01)	1 (0.19)
Attitudes/beliefs/values	42	0 (0.00)	1 (0.19)
Perceptions	43	0 (0.00)	1 (0.19)
Reinforcing	5	21 (21.21)	17 (3.31)
Positive	51	0 (0.00)	1 (0.19)
Negative	52	21 (21.21)	16 (3.12)
Enabling	6	2 (2.02)	12 (2.34)
Resource availability/accessibility	61	0 (0.00)	0 (0.00)
Referrals	62	0 (0.00)	0 (0.00)
Rules/laws	63	2 (2.02)	8 (1.56)
Traffic engineering	64	0 (0.00)	4 (0.78)
Behavior and lifestyle	2	14 (14.14)	51 (9.94)
Safe driving behavior	21	0 (0.00)	17 (3.31)
Unsafe driving behavior	22	10 (10.10)	25 (4.87)
Driving status/history	23	2 (2.02)	7 (1.36)
Reduction (driving frequency)	24	0 (0.00)	1 (0.19)
Driving cessation	25	2 (2.02)	1 (0.19)
Resuming driving	26	0 (0.00)	0 (0.00)
Lifestyle	27	0 (0.00)	0 (0.00)
Environmental factors	3	8 (8.08)	100 (19.49)
Economic	31	0 (0.00)	1 (0.19)
Physical	32	8 (8.08)	85 (16.57)
Social	33	0 (0.00)	14 (2.73)
Services	34	0 (0.00)	0 (0.00)
Health	1	52 (52.53)	321 (62.57)
Body function and structure	9	52 (52.53)	313 (61.01)
Physical conditions	12	1 (1.01)	7 (1.36)
Eye	13	1 (1.01)	30 (5.85)
Heart	14	3 (3.03)	5 (0.97)
Systemic	15	1 (1.01)	1 (0.19)
Hearing	16	0 (0.00)	3 (0.58)
Neurological	17	6 (6.06)	27 (5.26)
Medication use	18	0 (0.00)	10 (1.95)
Exposure rates	19	14 (14.14)	64 (12.48)
Demographics	20	26 (26.26)	166 (32.36)
Activities	10	0 (0.00)	8 (1.56)
Participation	11	0 (0.00)	0 (0.00)
Cumulative total	...	99 (100.00)	513 (100.00)

*Values given are number (percentage).

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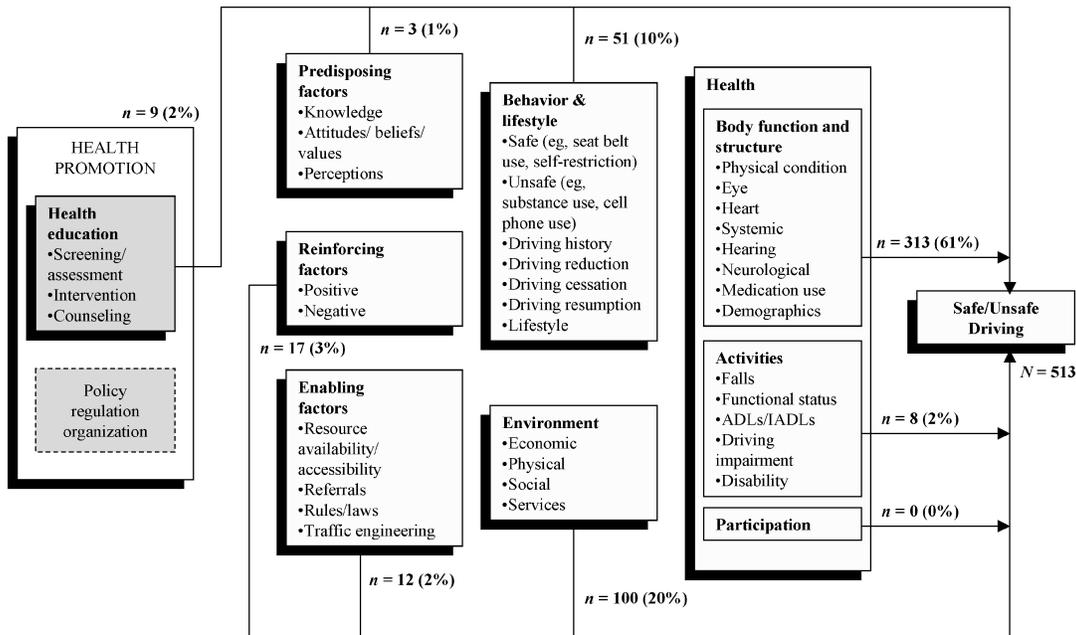


Figure 2. Structural model for older driver safety indicating significant relationships of risk and protective factors by Precede-Proceed Model of Health Promotion domains and categories to safe/unsafe driving rounded to the nearest percentage.

Table 5. Format for reporting results (N = 201)*

Format	
Measures of dispersion	135 (70)
Percentage	135 (70)
Measures of central tendency	171 (89)
Means	86 (44)
Medians	5 (3)
Standard deviations	33 (17)
Standard errors	4 (2)
Variances	1 (1)
Correlation	42 (22)
Estimation	46 (24)
Confidence intervals	46 (24)
Risk ratios	68 (35)
Odds ratios	47 (24)
Relative risks	21 (11)
P values	102 (53)
Regression coefficients	10 (5)
Other	48 (25)

*Values given are number (percentage).

of key words, mainly capturing the health, behavior, environment, and risk factors for older drivers. The prevalence for the second category ranged from 11% to 18%, describing the older driver group by gender, health, medical conditions, and impairment. Evaluations of driving performance, driving cessation, and self-regulation were also captured in this category. Key words in the third category had a prevalence that ranged from 1% to 9%. Not only are client/stakeholder perspectives in the lowest percentage range but prospective studies and prevention fall in this category as well.

DISCUSSION

This SLR synthesized the findings of the older driver safety literature from January 1985 to April 2005. We used a mixed methods approach to plan, describe, and analyze

Table 6. Key words ($N = 201$)*

% Category	Key word	Key words identified by authors and reviewers
≥25	Older driver	76 (39)
	Health	75 (38)
	Behavior	64 (33)
	Risk factors	61 (31)
	High risk	61 (31)
	Assessment	60 (31)
	Environment/ecology	55 (28)
10-24	Epidemiology	53 (27)
	Low risk	49 (25)
	Physical health	35 (18)
	Retrospective study	33 (17)
	Impairment	32 (17)
	Main medical conditions	31 (16)
	Cessation	30 (15)
	Female drivers	24 (14)
	Existing datasets	25 (13)
	Self-regulation	25 (13)
	Evaluation	24 (13)
≤9	Male drivers	24 (12)
	Fatality	21 (11)
	Prospective study	16 (9)
	Client perspective	14 (8)
	Mental health	14 (7)
	Decision making	13 (7)
	Stakeholders	13 (7)
	Prevention	11 (6)
	Medications	12 (6)
	Comorbidities	10 (5)
	Mortality or death	7 (4)
	Alternative transportation	7 (4)
	Family	6 (3)
	Outcome	6 (3)
	Participant perspective	5 (3)
	Activities of daily living	5 (3)
	Formal caregiver	4 (2)
Friends	4 (2)	
Informal caregiver	3 (2)	
Roles	3 (2)	
Morbidity	1 (1)	

*Values given are number (percentage). Key words were divided into percentage categories according to how often the key word was observed.

this SLR and to identify the main risk and protective factors associated with older driver safety.

The main findings revealed that most of the sources were observational in nature. Most research attention has been directed to the

health domain of the PPMHP, followed by the ecological and behavioral domains. Given the presence of health-related concerns in old age, this result was not especially surprising. However, this finding revealed that social factors (participant and stakeholder

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perspectives) are underexamined. Given that client and stakeholder perspectives are embedded in the social factors, necessary for intervention planning, this suggests a future area for research. According to a hierarchy for evidence-based practice,^{37,38} most evidences in this SLR are found from sources, observational in nature, placed lower in the hierarchy. This finding is not unexpected, considering that we performed an etiological SLR with many of risk factors stemming from observational designs. This explanation also helps us understand the low prevalence of randomized controlled trials. Surprisingly, qualitative studies, reflecting the participant and stakeholder perspectives, and community trials and ecological studies, reflecting effectiveness studies, are underrepresented. These findings are perhaps indicative of socioecological factors receiving less research attention than medically related factors, and thereby limiting the balance between biomedical and socioecological factors necessary to understand safe/unsafe driving.

The statistical methods used are consistent with the designs of the sources. For example, more than 80% of the designs were observational in nature, and we expected, as reported, a corresponding high prevalence of χ^2 tests, (multiple) logistic regression, (multiple) regression, and estimation methods. Likewise, the correlation, estimation, and risk ra-

tios adequately represented the observational designs used.

As evidenced by the key words and their prevalence ratings, it is clear that older drivers have been studied in the context of health, behavioral, and environmental factors. However, the client and stakeholder perspectives emerged at alarmingly low rates. Similarly, *prospective studies* and *prevention* have not received the research attention that the older driver field requires.

In this article, we presented, from the 201 analyzed sources, a structural model for older driver safety. This model, a first step in examining and synopsisizing the risk and protective factors for safe/unsafe driving in a systematic and integrated way, showed that most of these factors emerged from the health domain, and to a lesser extent, from the environmental domain of the PPMHP. To some extent, all other domains of the PPMHP captured risk and protective factors associated with safe/unsafe driving. The structural model quantified, and as such demonstrated the significance, of studying the factors for safe/unsafe driving in a systematic and integrated manner. This structural model informs rehabilitation professionals of the etiology and prevalence of risk and protective factors to safe/unsafe driving, affords opportunities for multidisciplinary research, and lays the foundation for comprehensive intervention planning.

REFERENCES

1. National Highway Traffic Safety Administration. *Traffic Safety Facts 2000. Older Population*. Washington, DC: National Highway Traffic Safety Administration; 2001.
2. Centers for Disease Control and Prevention. Older adult drivers. In: *Injury Fact Book 2001-2002*. 2004. Available at: http://www.cdc.gov/ncipc/factbook/18_Older_Adult_Drivers.htm. Accessed May 4, 2005.
3. Centers for Disease Control and Prevention. Preventing falls and motor vehicle-related injuries among older adults. 2004. Available at: <http://www.cdc.gov/programs/injury9.htm>. Accessed May 4, 2004.
4. Dellinger AM, Langlois JA, Li G. Fatal crashes among older drivers: decomposition of rates into contributing factors. *Am J Epidemiol*. 2002;155:234-241.
5. Eberhard J. Safe mobility for senior citizens. *IATSS Res*. 1996;20:29-37.
6. Insurance Institute for Highway Safety. Fatality facts, older people. Available at: http://www.highwaysafety.org/safety_facts/fatality_facts/older_people.htm. Accessed January 28, 2004.
7. McGwin G Jr, Sims RV, Pulley LV, et al. Relations among chronic medical conditions, medications, and automobile crashes in the elderly: a population-based case-control study. *Am J Epidemiol*. 2000;152:424-431.
8. Wang CC, Carr DB. Older driver safety: a report from the older drivers project. *J Am Geriatr Soc*. 2004;52:143-149.
9. Staplin L, Lococo K, Byington S, et al. *Highway Design Handbook for Older Drivers and Pedestrians*.

- Washington, DC: Federal Highway Administration; 2001.
10. Williams AF, Ferguson SA. Rationale for graduated licensing and the risks it should address. *Inj Prev*. 2002;8(suppl 2):9-14.
 11. The American Occupational Therapy Association, Inc. Tips for living: keeping older drivers safe. 2004. Available at: http://www.aota.org/featured/area6/do_cs/driver.pdf. Accessed December 22, 2005.
 12. Marotolli RA, Mendes de Leon CF, Glass TA, et al. Driving cessation and increased depressive symptoms: prospective evidence from the new haven EPESE. *J Am Geriatr Soc*. 1997;45:202-210.
 13. Green LW, Ottoson JM. *Community & Population Health*. 8th ed. Boston: McGraw Hill Higher Education; 1999.
 14. Green LW, Kreuter MW. *Health Promotion Planning*. 4th ed. Mountain View, Calif: Mayfield Publishing Company; 2005.
 15. Mulrow CD. Rationale for systematic reviews. *BMJ*. 1994;309:597-599.
 16. Cooper H, Hedges LV. Eds. *The Handbook of Research Synthesis*. New York: Russell Sage Foundation; 1994.
 17. National Health and Medical Research Council. How to review the evidence: systematic identification and review of the scientific literature. 1999. Available at: <http://www.nhmrc.gov.au/publications/synopses/cp65syn.htm>. Accessed January 5, 2005.
 18. Oxman AD, Guyatt GH. The science of reviewing research. *Ann N Y Acad Sci*. 1993;703:125-133.
 19. Pai M, McCulloch M, Gorman JD, et al. Clinical research methods: systematic reviews and meta-analyses: an illustrated, step-by-step guide. *Natl Med J India*. 2004;17(2):86-95.
 20. Classen S, Garvan C, Komaragiri V, et al. Systematic literature review and structural model for older driver safety. *Gerontologist*. 2005;45(special issue II):463-464.
 21. Winter S, Classen S, Garvan C, et al. Qualitative meta-synthesis of person and stakeholder perspective on safe driving and aging. *Gerontologist*. 2005;45(special issue II):464.
 22. Waterloo Maple Inc. *MAPLE Software* [computer software]. Version 10.0. Waterloo, Ontario, Canada: Waterloo Maple Inc; 2005.
 23. McGinn T, Wyer PC, Newman TB, et al. Tips for learners of evidence-based medicine, part 3: measures of observer variability (kappa statistic). *Can Med Assoc J*. 2004;171:1369-1373.
 24. Classen S, Sundaram S, Garvan CW, Awadzi K, Winter SM, Komaragiri V. Inter-rater reliability of a systematic literature review for older driver safety. In: *Proceedings of the International Conference on Aging, Disability and Independence*. February 1-5, 2006; St Petersburg, Fla. pp. 366-367.
 25. Law M, Stewart D, Letts L, et al. Critical review form for qualitative studies. Available at: <http://www.fhs.mcmaster.ca/rehab/ebp/pdf/qualreview.pdf>. Accessed March 17, 2005.
 26. Milton Keynes Primary Care Trust. Critical Appraisal Skills Programme—10 questions to help you make sense of qualitative research. 2002. Available at: <http://www.phru.nhs.uk/casp/qualitat.htm>. Accessed March 17, 2005.
 27. Milton Keynes Primary Care Trust. Critical Appraisal Skills Programme—12 questions to help you make sense of cohort studies. 2002. Available at: <http://www.phru.nhs.uk/casp/cohort%2012%20questions.pdf>. Accessed June 28, 2005.
 28. World Cancer Research Fund. Second expert report. Food, nutrition, physical activity and the prevention of cancer: a global perspective. Available at: http://www.wcrf.org/research/research_pdfs/slr_specification_manual%20.pdf. Accessed January 02, 2005.
 29. Dixon-Woods M, Agarwal S, Toung B, et al. *Integrative Approaches to Qualitative and Quantitative Evidence*. London: Health Development Agency; 2004.
 30. Creswell JW, Plano Clark VL, Guttman M, et al. Advanced mixed method research designs. In: Tashakkori A, Teddlie C, eds. *Handbook on Mixed Methods in the Behavioral and Social Sciences*. Thousand Oaks, Calif: Sage; 2003.
 31. Creswell JW, Fetters MD, Ivankova NV. Designing a mixed methods study in primary care. *Ann Fam Med*. 2004;2:7-12.
 32. SAS Institute Incorporated. *Statistical Analysis Software* [computer software]. Version 9.1. Cary, NC: SAS Institute Inc; 2005.
 33. Bryman A. *Social Research Methods*. Oxford: Oxford University Press; 2001.
 34. Silverman D. *Interpreting Qualitative Data: Methods for Analysing, Test, Talk and Interaction*. London: Sage; 2001.
 35. Strauss A, Corbin J. *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*. 2nd ed. Thousand Oaks, Calif: Sage Publications; 1998.
 36. Classen S, Lopez DS. Mixed-methods approach explaining process of an older driver safety systematic literature review. *Top Geriatr Rehabil*. 2006;22(2):99-112.
 37. Sackett DL, Straus SE, Richardson WS, et al. *Evidence-Based Medicine: How to Practice and Teach EBM*. London: Churchill Livingstone; 2000.
 38. Moore A, McQuay H, Gray JAM, eds. Evidence-based everything. *Bandolier*. 1995;1(12):1.