

# Health conditions, health symptoms and driving difficulties in older adults

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## Abstract

**Objectives:** previous research has indicated that age-related medical or health conditions can affect driving performance in older adults but little, if any, research has examined the mechanisms through which health conditions affect driving difficulties in older adults.

**Design:** cross-sectional, correlational study.

**Setting:** random sample from the community. We examined the nature of the relations among health conditions, health-related symptoms, physical fitness levels and specific types of self-reported driving difficulties in a random sample of older adults.

**Participants:** three hundred eighteen adults 60 years of age or older.

**Intervention:** None.

**Measurements:** general health, health-related symptoms, driving-related difficulties and physical activity.

**Results:** our findings support the position that health-related symptoms are more clearly associated with driving difficulties than are health conditions, and mediate the relations between health conditions and driving difficulties. Health-related symptoms involving the spine and lower body appeared to be particularly relevant to difficulties with driving experienced in those body areas (i.e. spine and lower body).

**Conclusion:** these findings are encouraging, in that the most frequently reported symptoms are in areas highly amenable to modification and, in that most of our respondents indicated a willingness to engage in exercise if an association between fitness and driving was demonstrated.

**Keywords:** driving, symptoms, physical activity, exercise programmes, spine, elderly

## Introduction

In response to the ageing of the population, the maintenance of mobility among older adults is a growing area of concern. Transportation mobility is an important source of independence for older adults. Driving is the most common form of transportation used by older adults in North America [1], and restrictions on driving may seriously limit access to goods and services, social networks and medical care [2, 3].

Health problems and lack of confidence have been cited as important factors associated with cessation of driving in older adults [4–7]. The mechanisms through

which health conditions may affect driving behaviours, however, are not clear. Only in specific instances does the mere presence of the health condition necessarily prompt immediate cessation of driving (e.g. uncontrolled epilepsy, or other acute neurological conditions). More often the physician is left to ponder the degree to which the symptoms associated with the identified health condition may adversely affect driving. Little, if any, research with older drivers has gone beyond the identification of the association between health conditions (or illnesses) and driving (e.g. accident rates, cessation of driving). Understanding the manner in

which health conditions relate to driving difficulties may prove useful for identifying strategies to promote continued mobility in older adults.

It has also been observed that older adults who are physically active perform better on psychomotor tests and that psychomotor functions are relevant to driving [8]. Moreover, preliminary research suggests that specific fitness and psychomotor training programmes may be effective means of assessing and enhancing many of the psychomotor skills required by the older driver [2]. However, before initiating a physical fitness intervention programme targeting specific psychomotor skills, it is important to understand how health conditions and fitness levels relate to health-related symptoms and specific types of driving difficulties.

The present study examined the nature of the relations among health conditions, health-related symptoms, physical fitness levels and specific types of driving difficulties in a sample of older drivers. It was anticipated that different health conditions would be associated with similar health-related symptoms (e.g. pain) and that these health-related symptoms would be more closely related to driving difficulties than the health conditions. If this is the case, it may be possible to identify those health symptoms that are particularly relevant to driving difficulties. It was also anticipated that a test of mediation would show that health symptoms mediate the relations between health conditions and driving-related difficulties. Finally, we anticipated that older drivers who sustained physically active lifestyles would experience fewer driving difficulties. Since activity level is potentially modifiable, participants were asked if they would take part in a free fitness programme if it were shown that more physically active seniors have less difficulty driving a vehicle.

## Method

### Participants

A random sample of 318 people aged 60 years and over, living in the Capital Regional District of Victoria, British Columbia, Canada, were identified through random digit dialing protocols and completed a 20-min survey over the telephone. Individuals from this broad range of ages were included to ensure that we obtained participants with varying levels of driving difficulties and health conditions. All research procedures followed the guidelines of the *Canadian Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans* and were approved by the University of Victoria Human Research Ethics Board. Participants were informed that, by answering the interview questions, they were consenting to take part in the study. Only those participants who were actively driving ( $n = 239$ ) and were unlikely to be experiencing significant cognitive impairment (i.e. obtained scores greater than 3/6 on the Wechsler Memory Scale Information–WMSI subtest) were selected (total  $n = 227$ ). Of these drivers, 225 held valid driver's licenses. The WMSI subtest was used to screen for cognitive impairment because it is easily administered over the telephone and extensive data was available on older Canadians for comparison purposes

[9]. This sample ranged in age 60–92 years with a mean of 70.4 (SD = 7.4). Approximately two-thirds of the sample (i.e. 62.6%) was female. Approximately two-thirds of the sample had attained at least a high school education (60%).

### Measures

Our telephone survey included an assessment of demographic characteristics (e.g. age), health conditions, health-related symptoms, driving difficulties, and physical activity levels.

#### Health

Participants rated their general health on two items from the Short-Form 36 [10] using a 5-point scale. First, they rated their health, in general (1 = very good, to 5 = very poor). Then they rated their general health in relation to their health 1 year prior (1 = much better, to 5 = much worse). In addition, participants reported whether they had received a diagnosis of a health condition within each of the following eight areas: musculoskeletal disorders; cardiovascular or pulmonary conditions; neurological conditions; endocrine disorders; visual impairments; sleeping disorders; psychological disorders; other major health condition. Within each of these areas, participants were provided with examples and descriptions of possible types of conditions and given the opportunity to seek clarification about these conditions from the interviewer. These groups of conditions were selected to reflect the major conditions typically associated with driving difficulties [11, 12].

#### Health-related symptoms

Participants reported whether they were currently experiencing various health-related symptoms 'at all' (score = 1) or 'not at all' (score = 0) (see Appendix 1, available online at <http://ageing.oxfordjournals.org>). The presence or absence of these symptoms was then combined (i.e. summed) to reflect single measures within each body area defined as: lower body (maximum score = 4), spine (maximum score = 6), visual system (maximum score = 2), central nervous system (CNS; maximum score = 5) and upper body (maximum score = 4). The resulting composite scores for the health symptoms within each body area were relevant to, and allowed for, comparisons with either the health conditions listed above or driving-related difficulties listed below.

#### Driving-related difficulties

Participants reported the amount of difficulty experienced performing each of the following driving-related behaviours on a 4-point scale (0 = no difficulty; 1 = some difficulty; 2 = a lot of difficulty; and 3 = completely unable): shoulder checking, grasping/turning the steering wheel, applying the brake/gas/clutch, fastening a seat belt, bending to get

through a vehicle door, stepping up to get in or out of a vehicle, stepping down to get in or out of a vehicle, swinging legs in or out of a vehicle, using door locks, using door handles, opening or closing the vehicle door from inside or outside the vehicle, using dashboard controls, reading dashboard instruments, and whether or not they had any difficulty with corrected daytime or nighttime vision. These driving tasks were selected because they have previously been identified as being important to driving independence and mobility for older people [13]. To facilitate comparisons with the health symptoms (above), these difficulties were then combined (i.e. summed) within body area defined as: lower body (maximum score = 12), spine (maximum score = 9), visual system (maximum score = 9), and upper body (maximum score = 15) (see Appendix 2, available online at <http://ageing.oxfordjournals.org>).

### Physical activity

A measure of the frequency of physical activity was calculated based on a staging strategy developed by Reed, Velicer, Prochaska, Rossi and Marcus [14] and adapted by Rhodes, Plotnikoff, and Spence [15] for the Canadian population. Participants described their physical activity level over the preceding 6 months as regular (i.e. 4 or more times per week on average), occasional (i.e. 2–3 times/week on average) or sporadic (i.e. less than twice per week). Physical activity was defined as activities performed at least at a moderate intensity, accumulating at least 30 min each time. This definition of physical activity reflected Health Canada's position for recommended weekly activity among older adults [16]. The single item measure of physical activity participation has been validated in prior phone surveys [17].

### Data analysis

Frequencies were calculated to determine the health conditions, health symptoms and driving difficulties most prevalent in the sample. Ordinary least squares regression analyses were used to test the relations between health conditions and health symptoms, health conditions and driving difficulties, health symptoms and driving difficulties, and physical activity and driving difficulties. To test whether health-related symptoms mediated the relations between health conditions and driving difficulties, a hierarchical ordinary least squares regression analysis was conducted using those driving difficulties which were inter-correlated with specific health symptoms and health conditions [18].

## Results

### Description of sample

The frequency with which participants reported health conditions was as follows: cardiovascular/pulmonary, 32.2%; musculoskeletal, 31.3%; visual, 19.4%; endocrine, 17.6%; problems with sleep or conditions that affect arousal, 9.7%; neurological, 4.8%; and psychological conditions, 2.6%.

The frequency with which the participants reported the presence of at least some health-related symptoms in the designated body areas was as follows: spine, 41.8%; lower body, 29.84%; upper body, 27.6%; central nervous system, 25.8%; and vision, 17.3%. Of note, three of the four individual items reported by 18% ( $n = 40$ ) of the sample or more were related to the spine (limited strength or movement in torso,  $n = 42$ ; stiffness in neck,  $n = 54$ , and stiffness in spine,  $n = 49$ ) and one was related to the lower body (limited strength or movement in legs,  $n = 54$ ).

The most frequently reported driving difficulties involved vision (30.8%), the spine (22%) and the lower body (21.1%). Driving difficulties related to the upper body were rarely reported (4%). The only individual item reported by 18% ( $n = 40$ ) or more of the sample group was difficulty with corrected nighttime vision.

Sixty-five per cent of the sample group reported meeting Health Canada's recommended activity level for older adults. This is above the average for British Columbia (i.e. 54%) [19], but is to be expected since Victoria is the city with the highest physical activity levels in the province [20]. Of note, 74% indicated that they would be interested in taking part in a free fitness programme designed to improving in-car strength and flexibility.

### Health conditions related to health symptoms

For each group of health symptoms, the health conditions were entered into a multiple regression in a single step (see Table 1). Health symptoms affecting the lower body were significantly associated with musculoskeletal, neurological and sleeping-related health conditions. Health symptoms affecting both the upper body and spine were also significantly associated with musculoskeletal and sleeping-related health conditions. Health symptoms affecting the central nervous system were significantly associated with neurological and sleeping-related health conditions.

### Health conditions related to driving difficulties

For each group of driving-related behaviours, the health conditions were entered into a multiple regression in a single step (see Table 2). Only health conditions falling within the musculoskeletal and neurological areas were significantly related to lower body driving difficulties. Only health conditions falling within the musculoskeletal area were significantly associated with driving difficulties involving the spine.

### Health symptoms related to driving difficulties

For each set of driving-related behaviours, the health symptoms groupings were entered into a multiple regression in two steps. In the first step, the body locations thought to be most closely associated with driving behaviour were entered. All remaining health symptom body locations were entered in the second step (see Table 3). In all cases except upper body driving difficulties, the body location of driving difficulties was significantly related to health symptoms experienced in those or closely related body locations (entered as the

**Table 1.** Hierarchical regression of health conditions on health symptoms (Standardised  $\beta$ )

Health conditions	Health symptoms				
	Lower body $\beta$	Upper body $\beta$	Spine $\beta$	CNS $\beta$	Vision $\beta$
Musculoskeletal	-0.388 <sup>a</sup>	-0.291 <sup>a</sup>	-0.394 <sup>a</sup>	-0.014	0.030
Cardio/pulmonary	-0.056	0.014	-0.066	0.015	-0.099
Neurological	-0.226 <sup>a</sup>	0.010	0.044	-0.197 <sup>a</sup>	0.069
Endocrine	-0.014	0.099	-0.099	-0.035	-0.038
Visual	-0.037	-0.085	-0.027	-0.001	-0.076
Sleeping disorders	-0.177 <sup>a</sup>	-0.204 <sup>a</sup>	-0.183 <sup>a</sup>	-0.217 <sup>a</sup>	-0.088
Psychological disorders	-0.076	-0.063	-0.028	-0.151	0.071
$R$	0.551	0.424	0.476	0.380	0.179
$R^2$	0.303	0.180	0.227	0.144	0.032
$\Delta R^2$	0.303 <sup>a</sup>	0.180 <sup>a</sup>	0.227 <sup>a</sup>	0.144 <sup>a</sup>	0.032

<sup>a</sup>  $p < 0.001$ **Table 2.** Hierarchical regression of health conditions on driving behaviours (Standardised  $\beta$ )

Health conditions	Block	Driving behaviours						
		Lower body $\beta$	Block	Upper body $\beta$	Block	Vision $\beta$	Block	Spine $\beta$
Musculoskeletal	1	-0.243 <sup>a</sup>	1	-0.067	1	.128	1	0.183 <sup>a</sup>
Cardiovascular/ Pulmonary	1	-0.048 <sup>a</sup>	1	0.042	1	-0.032	1	-0.084
Neurological	1	-0.287 <sup>a</sup>	1	-0.009	1	-0.009	1	-0.140
Endocrine	1	0.017	1	-0.002	1	-0.013	1	-0.074
Visual	1	-0.079	1	-0.082	1	-0.072	1	-0.045
Sleeping disorders	1	-0.034	1	-0.059	1	-0.056	1	-0.059
Psychological disorders	1	-0.128	1	-0.163	1	-0.066	1	0.012
$R$		0.447 <sup>a</sup>		0.229		0.165		0.290
$R^2$		0.200		0.053		0.027		0.084
$\Delta R^2$		0.200 <sup>a</sup>		0.053		0.027		0.084 <sup>a</sup>

<sup>a</sup>  $P < 0.001$ .

first block). Health symptoms related to CNS functions also contributed significantly to driving difficulties experienced in the lower body and spine and were the only symptoms related to upper body driving difficulties.

### Tests of health symptoms as a mediator of health condition-driving difficulty relations

Based on prior analyses, two driving-related difficulties were inter-correlated with specific health symptoms and health conditions. First, spine-related driving difficulties, spine-related health symptoms, and musculoskeletal health conditions were inter-correlated. To test whether spine-related health symptoms mediated the relations between the musculoskeletal health conditions and spine-related driving difficulty (DV), musculoskeletal health conditions (IV<sub>1</sub>) were entered in step one ( $F_{1,222} = 11.38, P < 0.01; R^2 = 0.05$ ) of the regression equation. In step two, spine-related health symptoms (IV<sub>2</sub>) showed a significant contribution to the equation ( $\Delta F_{1,221} = 16.63, P < 0.01; \Delta R^2 = 0.07$ ). Furthermore, the musculoskeletal variable was reduced in the regression equation from a significant  $\beta$  of  $-0.22$  ( $P < 0.01$ ) to a non-significant  $\beta$  of  $-0.10$  ( $P > 0.05$ ) supporting complete mediation [18].

Lower body driving difficulties, spine, lower body, and CNS-related health symptoms, and musculoskeletal and neurological health conditions were also inter-correlated.

Thus, musculoskeletal and neurological health conditions were entered in step one ( $F_{2,220} = 22.96, P < 0.01; R^2 = 0.17$ ). In step two, spine, lower body, and CNS-related health symptoms made significant additional contributions ( $\Delta F_{3,217} = 11.12, P < 0.01; \Delta R^2 = 0.11$ ). Due to these contributions, the musculoskeletal variable was reduced in the regression equation from a significant  $\beta$  of  $-0.26$  ( $P < 0.01$ ) to a non-significant  $\beta$  of  $-0.09$  ( $P > 0.05$ ) supporting complete mediation. In contrast, the neurological variable was not reduced in the regression equation to a non-significant  $\beta$  ( $P > 0.05$ ; from  $\beta = -0.30$  to  $\beta = -0.22$ ).

### Physical activity related to driving difficulties

A single multiple regression analysis (one step) was used to examine the relations between self-reported physical activity and driving-related difficulties. Physical activity only showed a strong relation to driving difficulties involving the spine ( $\beta = -0.22, P < 0.05$ ). All other driving difficulties were non-significant. This indicated that those persons who are not physically active report more difficulties with driving tasks related to the spine.

### Discussion

These results suggest that health symptoms are more strongly related to driving difficulties than are health conditions. This has implications for the identification of drivers who may be



**Table 3.** Hierarchical regression of health symptoms on driving behaviours (Standardised  $\beta$ )

Health symptoms	Block	Driving behaviours						
		Lower body $\beta$	Block	Upper body $\beta$	Block	Vision $\beta$	Block	Spine $\beta$
Spine	1	0.180 <sup>a</sup>	2	−0.068	2	−0.078	1	0.253 <sup>a</sup>
Lower	1	0.276 <sup>a</sup>	2	0.048	2	0.024	1	0.158
Upper	2	−0.001	1	0.127	2	0.101	1	−0.082
Vision	2	−0.062	2	0.119	1	0.435 <sup>a</sup>	2	0.092
CNS	2	0.226 <sup>a</sup>	2	0.243 <sup>a</sup>	2	0.133	1	0.244 <sup>a</sup>
<i>R</i>		0.491 <sup>a</sup>		0.324		0.477 <sup>a</sup>		0.469 <sup>a</sup>
<i>R</i> <sup>2</sup>		0.241		0.105		0.227		0.220 <sup>a</sup>
$\Delta R^2$		0.049 <sup>a</sup>		0.084 <sup>a</sup>		0.030		0.008

<sup>a</sup>  $P < 0.001$ .

experiencing problems with the physical activities involved in driving. Traditionally, both in clinical practice and research, the emphasis has been on examining the association between health conditions and driving [21]. Moreover, driving ability, in these contexts, has often been defined by crash rates or an overall driving ability score [22]. Our findings suggest that it may be more fruitful to examine for specific health symptoms, and relate these to specific forms of driving difficulties.

Of interest, the most frequently reported health-related symptoms were related to spine (42%) and lower body (29%) functions and these, in turn, were significantly correlated with a number of driving difficulties involving the spine and lower body. Our mediation analyses support the contention that health-related symptoms (spine, and/or lower body, CNS) mediate the relations between health conditions and driving difficulties (spine and lower body related) for musculoskeletal health conditions. Of all the physiological systems that affect driving abilities, the spine and lower body may be the most modifiable. Our observed association between current fitness levels and driving difficulties related to the spine support this contention.

Although it has been suggested that well designed exercise programmes may be instrumental in enhancing older driver performance [23], the specific loci of the mechanisms through which exercise may affect driving has remained unclear. Our findings, taken in conjunction with those of Ostrow, Shaffron and McPherson [2], suggest that physical activity involving spinal flexibility may prove useful for enhancing specific aspects of driving performance such as turning to check for traffic or operating a seat belt.

It is encouraging that the most frequently reported symptoms were in areas highly amenable to modification and that most of our respondents indicated that an association between fitness and driving would be viewed as motivation to engage in exercise. Physical activity levels of older adults are generally the lowest amongst the population [19] and motivation towards exercise adherence is difficult to maintain [24]. Driving is an activity highly valued by older adults [25] and particularly important to their independence and well-being [2, 3]. As such, our findings reveal that the maintenance of driving ability may play an important and currently untapped role as a motivational incentive for regular exercise.

## Conclusion

Our findings support the position that health-related symptoms are more clearly associated with driving difficulties than health conditions, and mediate the relations between health conditions and driving difficulties. Health-related symptoms involving the spine and lower body appeared to be particularly relevant to difficulties with driving experienced in those body areas (i.e. spine and lower body). Activity level also showed a strong association with driving difficulties involving the spine. These findings are encouraging since the most frequently reported symptoms are in areas highly amenable to modification and most of our respondents indicated a willingness to engage in exercise if an association between fitness and driving was demonstrated. Additional research is needed to articulate how specific activities involving the spine and lower body relate to specific types of driving difficulties, and how improvement in function may best be realised.

## Key points

- Health-related symptoms, rather than health conditions, are more clearly associated with driving difficulties
- Health-related symptoms experienced in the body areas involving the spine and lower body appear to be particularly relevant to difficulties with driving
- Activity level also showed a strong association to driving difficulties involving the spine
- Seventy four per cent of participants indicated that they would be interested in taking part in a fitness programme geared to improving in-car strength and flexibility

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The study concept and design, acquisition of subjects and/or data, analysis and interpretation of data were performed by the two corresponding authors. Preparation of the manuscript was performed by all authors.

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## Conflicts of Interest

There are no conflicts of interest.

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