

# The Longitudinal Research on Aging Drivers (LongROAD) Study: Understanding the Design and Methods

In 2015, 40 million licensed drivers age 65 years and older represented 18% of the total licensed driver population in the United States (FHWA, 2016). The number of older drivers has increased by 50% since 1999 and is projected to continue increasing (FHWA, 2014). Although driving allows older adults to meet their mobility needs and to stay independent, a number of age-related functional impairments, medical conditions and medication side effects can compromise driving abilities (Eby et al., 2009). To understand and meet the safe mobility needs of older adult drivers, the AAA Foundation for Traffic Safety (AAAFTS) launched the Longitudinal Research on Aging Drivers study (LongROAD) with the following goals:

- Better understand the major protective and risk factors of safe driving in older adults
- Assess the effects of medical conditions and medications on driving behavior and safety
- Investigate the mechanisms through which older adults self-regulate their driving behaviors to cope with functional declines as they age
- Determine the extent, use and effects of new vehicle technology and aftermarket vehicle adaptations among older drivers
- Identify the determinants and health consequences of driving cessation during the process of aging

## METHODS

The LongROAD study is a multisite prospective cohort study designed to collect data on the medical, behavioral, environmental and vehicle technological factors influencing older adults' driving. Active older drivers ages 65 to 79 years were identified by screening electronic medical records of health systems or primary care clinics affiliated with the five study sites (Cooperstown, New York; Baltimore, Maryland; Denver, Colorado; San Diego, California; and Ann Arbor, Michigan). Study sites mailed recruitment letters to all potentially eligible participants identified through the screening process and then contacted them by telephone. Each site aimed to enroll 600 participants distributed across three age groups (65-69, 70-74 and 75-79) and between sexes.

### Design: What was the study's strategy for addressing the project's aims?

The project was designed for an initial five-year period. Eligible and consented participants were assessed at the baseline interview and then annually thereafter (Figure 1). Starting with the baseline visit and continuing every other

year during the follow-up, participants are required to complete an in-person visit at the study site. In alternate years, beginning with the first year following the baseline visit, participants receive an abbreviated telephone interview.

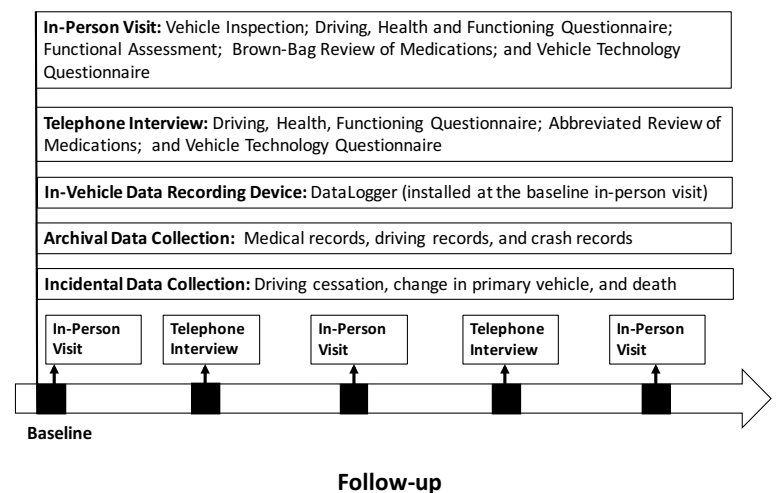


Figure 1. Data collection timeline for LongROAD study

**Study Measures: What kind of information is being collected?**

***In-Person Visit and Telephone Follow-Up Interviews***

In-person visits last approximately three hours and include several questionnaire administrations, a number of functional assessments, review of medications and a vehicle inspection. Telephone interviews last about one hour and only include questionnaire administration.

**Vehicle inspection.** A vehicle inspection was conducted on each participant’s vehicle at baseline and is repeated every other year or when the participant changes his or her primary vehicle. The vehicle inspection collects data on the condition and maintenance of the vehicle and the presence of in-vehicle technologies and aftermarket adaptations.

**Driving, health and functioning questionnaire.** At baseline, and annually during in-person and telephone interviews, research staff administer a questionnaire to obtain data on participants’ driving, health and functioning. Specific data from these questionnaires include: demographics; cognitive, mental and physical health; driving behaviors; health behaviors; healthcare utilization and health conditions.

**Functional assessment.** Functional assessments measure participants’ cognitive, motor, and perceptual levels of functioning. These batteries of measurement were selected based on sound psychometrics properties and their use in other driving/older adult longitudinal studies (e.g., the Health and Retirement Study, the National Health and Aging Trends Study and the Women’s Health and Aging Study) to facilitate comparisons. Each participant was assessed in person at baseline and is assessed every other year thereafter.

**“Brown-bag review” of medications.** Data on medications and supplements currently taken by each study participant are collected using a “brown-bag review” method at the in-person assessment and annually thereafter. While scheduling the in-person assessment, research staff ask participants to bring all current medications (both prescribed and over the counter) and supplements with them for review.

**Vehicle technology questionnaire.** To assess the experiences participants have had with advanced vehicle technologies and aftermarket vehicle adaptations in their own vehicles, the vehicle technology questionnaire was administered to participants at baseline and is repeated

annually when there has been a change in primary vehicle or when a new aftermarket adaptation or modification has been made. For 15 in-vehicle technologies (listed in Table 1), the questionnaire addresses presence, use and perceptions of safety where appropriate.

The questionnaire also addresses the presence of aftermarket vehicle adaptations. The questionnaire explores the presence of various possible vehicle adaptations listed in Table 1. For each adaptation, the questionnaire asks with whom the participant worked to determine that the adaptation was appropriate, whether a professional made the adaptation, and how the participant learned to use the adaptation.

**Table 1. List of in-vehicle technologies and in-vehicle adaptations asked on the Vehicle Technology Questionnaire**

In-Vehicle Technology	In-Vehicle Adaptations
Navigation assistance	Cushions for comfort
Backup assist/taid	Custom armrests
High intensity discharge headlights	Safety belt extensions
Directional control headlights	Driver side airbag deactivation
Adaptive cruise control	Upper body support
Night vision enhancement	Steering knob
Forward collision warning	Spin pin
Blind spot warning	Palm grip
Lane departure warning	Tri-pin
Rearview camera	Steering splint
Drowsy driver alert	Amputee ring
Electronic stability control	Left foot throttle
Assistive parking	Gas pedal block
Voice control	Pedal extensions
Integrated Bluetooth cellular phone	Hand controls
Automatic emergency response	Adapted dashboard controls
In-vehicle concierge	Aftermarket push button ignition
	Convex/multifaceted mirrors

***In-vehicle Data Recording Device***

At the baseline in-person visit, the participant’s primary vehicle was equipped with an in-vehicle data recording device (called the DataLogger). This device collects objective driving behavior data, including: days driving, trips, miles, miles and minutes per trip, trip chains, miles and minutes per chain, number and percentage of trips at night and day (including peak hours of 7-9 a.m. and

4-6 p.m.), number and percentage of trips on high-speed roads, number and percentage of trips made less than 15 miles from home and over 25 miles from home, number of left and right turns, right to left turn ratio and number of high deceleration and speeding events.

### **Archival and Incidental Data**

**Medical records.** At baseline, research staff reviewed the medical record of each participant for up to five years prior to the baseline assessment date. During follow-up, the medical record for the previous 12 months is reviewed annually. Data collected from each participant's medical record include clinical diagnoses, surgical procedures and healthcare utilization in the previous year, including the numbers of hospital admissions and visits to primary care providers, specialists and emergency departments affiliated with the health system.

**Driving records.** At baseline, up to the previous five years of driving record data were collected. During follow-up, driving record data are collected annually for the previous 12 months. Driving record data collected include driver license status, administrative actions, convicted moving violations and driving-related criminal offenses.

**Crash records.** Crash data are based on police reports and generally cover all crashes involving injury or death of any person or property damage in excess of \$1,000. Driving records indicate the occurrence of crashes, as well as driving-related convictions. At baseline, crash data were collected for up to the past five years. During follow-up, crash data are collected annually for the previous year. In addition to demographic and study information, crash-, vehicle- and person-level data are collected for each crash.

**Driving cessation questionnaire and mortality data.** It is anticipated that during follow-up, some participants will cease driving permanently. Therefore, a driving cessation questionnaire was designed to collect information about the general circumstances surrounding the decision to stop driving, specific reasons for stopping driving, means of meeting mobility needs following driving cessation and psychosocial factors associated with no longer driving. The questionnaire is administered by telephone one to three months after a participant has permanently stopped driving.

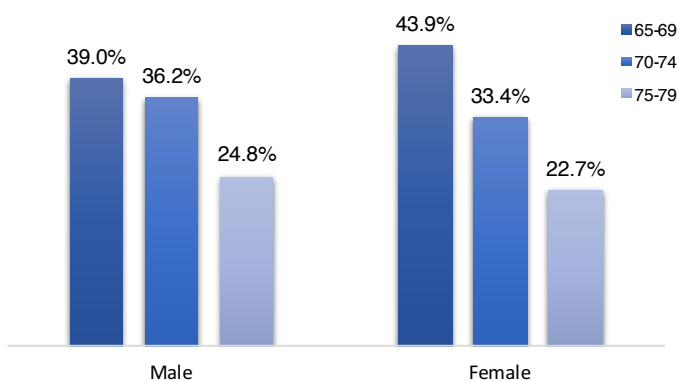
During the follow-up period, it is anticipated that some participants will die. In these cases, data are collected,

where possible, about the date and cause of death. These data are acquired through examination of the medical record, discussion with family members and/or review of the death certificate.

## **RESULTS**

### **Participants: Who is participating in the study?**

Recruitment and enrollment were completed between July 2015 and March 2017. A total of 2,990 participants were enrolled in the LongROAD study. Of those recruited, 53% were female. Of all the participants, 41.6% were aged 65-69, 34.7% aged 70-74 and 23.7% aged 75-79 (see Figure 2).



**Figure 2. Recruited LongROAD participants: age distribution by gender (males = 1,404, females = 1,586)**

To date (Oct. 19, 2017), first-year anniversary telephone interviews have been completed with 77% (2,317) of the participants, and second-year anniversary in-person visits have been conducted with 305 participants.

### **LongROAD Participants Compared with General Older Drivers: Do the LongROAD participants resemble older drivers on U.S. roads?**

The baseline data from the LongROAD study has been compared with the data from the American Driving Survey (ADS) Aging Cohort Study (Triplett, 2016) to evaluate the similarities of LongROAD participants to a nationally representative sample of drivers. The similarities on two data sets were assessed based on raw percentage differences (i.e., LongROAD - Aging) as well as relative differences (i.e., (LongROAD - Aging)/Aging) through driving characteristics and behaviors. Table 2 shows results on driving characteristics summarizing that LongROAD participants drove more miles, drove more often and took longer trips than did older drivers from

the Aging Cohort Study. In addition, a larger proportion of LongROAD participants had 2006 or newer model year vehicles. Interestingly, a smaller proportion of LongROAD participants reported having vehicle safety features present in their vehicles than those of the Aging Cohort Study. However, the estimates on the Aging Cohort Study are highly likely to be over-reported given that vehicle safety features listed in Table 1 are usually present in high-end vehicles.

Table 3 presents comparisons on driving behaviors summarizing that there were no significant discrepancies found between LongROAD and Aging Cohort Study participants in most activities and avoidance behaviors. The only exception is responses to the question, “Do you avoid driving in bad weather at night?” where 62% of LongROAD participants admitted this behavior, whereas only 18% of participants in the Aging Cohort Study reported this. The overall results from these comparisons conclude that avoidance behaviors were similar across two studies, and differences, if any, could be caused by different survey methods (i.e., in-person vs. phone interview).

## DISCUSSION

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The LongROAD study is the first multisite longitudinal cohort study in the United States that delves into the dynamic changes in driving safety as drivers become older. LongROAD participants were sampled from university-affiliated medical centers; therefore, the data does not necessarily represent the nation’s older drivers in terms of demographic characteristics. LongROAD participants tend to have higher education, income and overall better health. However, comparing LongROAD participants with the ADS Aging Cohort (nationally representative sample of older drivers) shows the two samples are similar with respect to driving behaviors and attitudes.

By collecting multiple sources of information—including GPS information, vehicle information, medication use, functional assessments and archival and incidental data such as medical records, driving records and crash records— this study can explore in great detail the risk factors and changes that happen over time in older adults with regard to driving behaviors, patterns and safety. Furthermore, we anticipate that outcomes from the study can contribute to finding efficient and effective ways to prolong mobility, independence and well-being of older adults.

Table 2. Comparisons in driving characteristics between LongROAD and ADS Aging Cohort Study by age group

	ALL Drivers 65-79				Drivers 65-74				Drivers 75-79			
	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A
<b>Total</b>	<b>2990</b>	<b>805</b>			<b>2280</b>	<b>598</b>			<b>710</b>	<b>207</b>		
<b>Estimated Miles Driven per Week</b>												
Less than 50 miles	26%	39%	-13%	-33%	25%	36%	-11%	-31%	27%	49%	-22%	-45%
50-99 miles	23%	28%	-5%	-18%	23%	29%	-6%	-21%	26%	26%	0%	0%
100 or more miles	51%	32%	19%	59%	52%	35%	17%	49%	47%	25%	22%	88%
<b>Estimated Length of Most Trips (back and forth)</b>												
Less than 1 mile	1%	2%	-1%	-50%	1%	3%	-2%	-62%	2%	2%	0%	0%
1-5 miles	20%	38%	-18%	-47%	19%	27%	-8%	-28%	21%	38%	-17%	-45%
6-10 miles	30%	22%	8%	36%	30%	30%	0%	0%	30%	22%	8%	36%
11-15 miles	18%	15%	3%	20%	18%	17%	1%	5%	20%	15%	5%	33%
More than 15 miles	31%	23%	8%	35%	32%	24%	8%	36%	27%	23%	4%	17%
<b>On Average, Number of Days Driven per Week</b>												
1-2 days	6%	11%	-5%	-46%	6%	10%	-4%	-38%	6%	15%	-9%	-60%
3-5 days	35%	40%	-5%	-13%	34%	39%	-5%	-12%	36%	44%	-8%	-18%
6-7 days	59%	49%	10%	20%	59%	52%	7%	14%	58%	41%	17%	41%
<b>Model Year of Vehicle</b>												
2005 or older	33%	47%	-14%	-30%	35%	39%	-4%	-9%	29%	41%	-12%	-29%
2006 or newer	67%	53%	14%	26%	65%	61%	4%	6%	71%	59%	12%	20%
<b>Safety Features of Vehicle (model year 2006 or newer)</b>												
Navigation System	28%	32%	-4%	-13%	28%	33%	-5%	-16%	27%	30%	-3%	-10%
Backing Aid System	40%	41%	-1%	-2%	41%	44%	-3%	-7%	38%	32%	6%	19%
Adaptive, or Active Headlights	4%	17%	-13%	-76%	4%	18%	-14%	-77%	4%	16%	-12%	-75%
Adaptive Cruise Control	6%	52%	-46%	-88%	6%	53%	-47%	-89%	6%	50%	-44%	-88%
Forward Collision Warning System	7%	11%	-4%	-33%	7%	13%	-6%	-48%	6%	5%	1%	20%
Blind Spot Warning System	10%	13%	-3%	-21%	10%	15%	-5%	-32%	11%	8%	3%	38%
Lane Departure Warning System	6%	10%	-4%	-40%	6%	11%	-5%	-43%	5%	6%	-1%	-14%
Assistive Parking System	1%	7%	-6%	-85%	1%	7%	-6%	-86%	1%	7%	-6%	-86%

Yellow cells indicate that LongROAD estimates are substantially smaller than ADS Aging Cohort counterparts based on both criteria (i.e., raw percentage and relative differences). Green cells indicate that LongROAD estimates are substantially larger than ADS Aging Cohort counterparts based on both criteria (i.e., raw percentage and relative differences).

Table 3. Comparisons in driving activities and characteristics between LongROAD and ADS Aging Cohort Study by age group

	ALL Drivers 65-79				Drivers 65-74				Drivers 75-79			
	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A	LongROAD (L)	Aging Driver (A)	Difference (L-A)	Rel Diff (L-A)/A
<b>Total</b>	<b>2990</b>	<b>805</b>			<b>2280</b>	<b>598</b>			<b>710</b>	<b>207</b>		
<b>Reasons for Moving</b>												
Moved to a new location in the past year	4%	4%	0%	5%	4%	4%	0%	-9%	4%	3%	1%	38%
Moved to be closer to place you normally drive	11%	18%	-7%	-39%	12%	19%	-7%	-38%	7%	14%	-7%	-50%
Moved for more options for getting around	6%	15%	-9%	-60%	6%	19%	-13%	-68%	4%	0%	4%	--
Moved for any other driving related reason	4%	9%	-5%	-56%	3%	8%	-5%	-61%	7%	14%	-7%	-50%
<b>Reasons for Buying New Car</b>												
Bought a different car in the past year	16%	13%	3%	23%	16%	15%	1%	5%	14%	9%	5%	59%
Bought car because not comfortable driving previous car	12%	21%	-9%	-43%	11%	23%	-12%	-51%	16%	11%	5%	45%
Bought car because not feeling safe driving previous car	12%	15%	-3%	-20%	12%	17%	-5%	-29%	13%	6%	7%	117%
Bought car for other driving related reason	22%	14%	8%	57%	23%	16%	7%	46%	20%	6%	14%	233%
<b>Reason for New Regular Exercise Routine</b>												
Began a new exercise routine in the past year	26%	28%	-2%	-8%	26%	27%	-1%	-4%	26%	32%	-6%	-19%
Began new routine to lose weight	50%	48%	2%	4%	53%	47%	6%	13%	39%	49%	-10%	-20%
Began new routine to improve physical fitness	84%	95%	-11%	-12%	82%	93%	-11%	-12%	89%	99%	-10%	-10%
Began new routine to improve overall health	90%	99%	-9%	-9%	89%	99%	-10%	-10%	93%	100%	-7%	-7%
New routine was related to driving	17%	4%	13%	325%	16%	3%	14%	540%	20%	9%	11%	122%
<b>Avoidance Behaviors</b>												
Do you avoid driving at night	37%	42%	-5%	-12%	36%	41%	-5%	-11%	41%	44%	-3%	-7%
Do you avoid left turns where there is no left turn arrow	14%	20%	-6%	-30%	12%	20%	-8%	-39%	17%	21%	-4%	-19%
Do you avoid driving in bad weather	53%	54%	-1%	-2%	52%	54%	-2%	-3%	54%	54%	0%	0%
Do you avoid driving in bad weather at night	62%	18%	44%	250%	61%	18%	43%	247%	66%	19%	47%	247%
Do you avoid driving on busy roads	23%	21%	2%	10%	23%	23%	0%	2%	24%	18%	6%	33%
Do you avoid driving to unfamiliar places	17%	21%	-4%	-19%	16%	20%	-4%	-20%	20%	25%	-5%	-20%
Do you avoid driving in rush hour traffic	56%	51%	5%	10%	56%	52%	5%	9%	57%	51%	6%	12%
Do you avoid driving on freeways	11%	13%	-2%	-15%	11%	13%	-2%	-15%	11%	13%	-2%	-15%

Yellow cells indicate that LongROAD estimates are substantially smaller than ADS Aging Cohort counterparts based on both criteria (i.e., raw percentage and relative differences). Green cells indicate that LongROAD estimates are substantially larger than ADS Aging Cohort counterparts based on both criteria (i.e., raw percentage and relative differences).

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## ABOUT THE AAA FOUNDATION FOR TRAFFIC SAFETY

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