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Does economic vulnerability moderate the association between transportation mode and social activity restrictions in later life?

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ABSTRACT
Transportation is critical to older adults' ability to participate in social activities in their community. We examined the association between modes of transportation and restrictions in social activity (*i.e.* visiting with others, religious attendance, clubs and organised activities, and going out for enjoyment), with particular attention to the moderating effects of economic vulnerability. We used logistic regression to analyse data from 7,197 community-dwelling older adults from the 2011 wave of the National Health and Aging Trends Study, a representative sample of adults aged 65 and over in the United States of America. Economic vulnerability moderated the association between transportation mode and social activity restrictions. Findings suggest that even when economically vulnerable older adults have access to driving, walking or public transit, they may be at a higher risk for social exclusion than their counterparts with more financial resources.

KEY WORDS – social exclusion, mobility, disparities, social participation.

Introduction

Participating in social activities, such as interacting with friends and family, attending religious services, belonging to clubs and other organisations, or going out for enjoyment, benefits older adults' physical health, mental well-being and survival (Adams, Leibbrandt and Moon 2011; Chatters *et al.* 2008; Glass *et al.* 2006; James *et al.* 2011; Thomas 2012). Inadequate transportation, however, reduces older adults' ability to engage in social activities outside the home (Cvitkovich and Wister 2001; Marottoli *et al.* 2000;

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Mezuk and Rebok 2008). For example, in the United States of America (USA), older adults who do not drive make fewer trips for religious, social or community activities compared to their driving counterparts (US Government Accountability Office 2004). Prior research has demonstrated that compared to those with greater financial resources, older adults who are economically vulnerable are more likely to stop driving and subsequently rely on a less-independent mode of transportation (*i.e.* receiving rides from family and friends) (Choi and Mezuk 2013; Choi *et al.* 2012). In addition, research with adults at younger ages indicates that the economically vulnerable are at a higher risk for cutting back or foregoing social activities (Agrawal *et al.* 2011). Together, these findings suggest that economically vulnerable older adults may cut back on their trips to participate in social activities regardless of their access to transportation options. To our knowledge, however, there is limited research on the ways limited financial resources may affect older adults' use of transportation options, even when those options are available to them. Such understanding is critical to develop and implement interventions that promote social participation and reduce social exclusion among economically vulnerable older adults. To address this gap in the literature, using a nationally representative data-set from the USA we examined the association between modes of transportation and social activity restrictions, with particular attention to the moderating effects of economic vulnerability on this relationship.

Background and literature review

Modes of transportation and participation in social activities

The decline in social activity participation in later life that has been documented by research (*e.g.* Cornwell, Laumann and Schumm 2008) is attributed to a variety of factors, including changes in health and functioning and shrinking social networks. Modes of transportation also play an important role, given that many social activities occur out in the community.

It is likely that different modes of transportation are differentially associated with participation in social activities among older adults. Non-drivers are more likely to experience transportation challenges compared to their driving counterparts (Weeks *et al.* 2015), indicating that driving facilitates social participation. A recent review of 50 peer-reviewed articles reported having a car or driver's licence is a key contributor to older adults' social participation (Levasseur *et al.* 2015). In the USA, driving is the preferred mode of transportation for older adults (Burkhardt *et al.* 2002; Rudman *et al.* 2006) because it is not only convenient and flexible, but also fosters a sense of freedom and identity (Glasgow and Blakely

2000). Older adults report that driving has numerous advantages, including the ability to reach a wide variety of destinations, protection from inclement weather, faster travel times, provision of door-to-door travel and not having to depend on others (Burkhardt *et al.* 2002).

In contrast, other modes of transportation may create barriers to social activity participation. Relying on rides provided by family, friends or other helpers – the second most common mode of transportation for older Americans (Ritter, Straight and Evans 2002) – presents several barriers to participation in activities. Older adults who use this mode express dissatisfaction with travelling at the convenience of the driver, and can experience feelings of obligation (Burkhardt *et al.* 2002) and dependency (Ritter, Straight and Evans 2002). In addition, older adults who receive rides from others travel less than those who use other forms of transportation (Burkhardt 2000).

Walking and using public transit offer alternative modes of transportation to car travel, but there are challenges to their use for older adults living in the USA. While older adults who walk have higher levels of social participation and greater access to goods and services compared to those who do not (Berke *et al.* 2007; Dahan-Oliel *et al.* 2010), very few American older adults use this mode of transportation. The 2009 National Household Travel Survey reported that 6 per cent of adults age 65 and older walked at least 30 minutes per day (Pucher *et al.* 2011). Walking for transportation is related to one's neighbourhood environment, particularly the extent to which it is mixed land use (*i.e.* including both commercial and residential areas) and walkable (*i.e.* offering well-maintained sidewalks, connected streets and short blocks) (Sallis and Kerr 2006). Many neighbourhoods in the USA are designed for vehicles rather than pedestrian traffic, particularly those located in suburban and rural areas (Choi, Adams and Kahana 2012; Lynott *et al.* 2009). Similar to walking, the ability to use public transit depends in part on the neighbourhood environment, and many suburban and rural communities lack public transportation services. An estimated one-third of older adults do not have public transit in their communities (Rosenbloom and Herbel 2009), and those that do may not have service to destinations for social activities. Data from the 2009 National Household Travel Survey indicated that older adults took approximately 2 per cent of all trips using public transportation (Lynott and Figueirido 2011). Older adults note numerous other barriers to public transit use, including long travel times, limited weekend services, unreliable arrival times, and difficulties with obtaining and understanding transit information (Burkhardt *et al.* 2002). Older adults also view public transit as unsafe, unresponsive and inconvenient (Adler and Rottunda 2006; Burkhardt *et al.* 2002).

Not only may modes of transportation such as driving, getting rides from others, walking or taking public transit have differential effects on social participation overall, they may also have differential effects depending on the *type* of social activity. One study of older adults in the United Kingdom, for example, found that different modes of transportation accounted for a different percentage of trips depending on their purpose (Davis *et al.* 2011). Driving one's own car, for example, was the most common mode of transportation for social visits and entertainment, while walking or travelling by bicycle was the most common mode to attend religious services. The majority of prior studies of social participation, however, typically use a composite measure or scale that includes a variety of activities (*e.g.* Dahan-Oliel *et al.* 2010; Desrosiers *et al.* 2009; Hand *et al.* 2012; Perkins *et al.* 2008; Richard *et al.* 2013). Questions therefore remain regarding the transportation-related factors that may create barriers to different types of social participation.

Social exclusion among economically vulnerable older adults

Social exclusion occurs when groups are unable to engage in the 'normal activities of citizens in that society' (Burchardt, Le Grand and Piachaud 1999: 229), such as paid work, the consumption of goods and services, and participation in community life (Schonfelder and Axhausen 2003). Social exclusion calls attention to the ways that those with limited financial resources often experience multiple deprivations. For example, inequities in areas such as health care, housing, zoning, education and social capital place the economically vulnerable at an even greater disadvantage (Marsh and Mullins 1998). More recently, scholars have explored the role of transportation in social exclusion, particularly as social networks become more geographically disperse and social participation often depends on a high level of community mobility (Cass, Shove and Urry 2005). The existing literature indicates that across age groups, those with limited financial resources experience significant disadvantage in their access to transportation options. Indeed, low-income individuals of all ages are less likely to use *any* modes of transportation compared to those with higher incomes (Blumenberg and Pierce 2013).

As noted by Scharlach and Lehning (2013), older adults in the USA are at risk of social exclusion because of ageist norms, retirement from the workforce, loss of social roles, declines in physical and cognitive functioning, and a social and physical infrastructure that prioritises the needs of those who are younger and able-bodied. Furthermore, the limited mobility options available to older adults can constrict the geographic distribution of the places to which they regularly travel, known as their 'activity space' or 'life

space' (Choi *et al.* 2015; Schonfelder and Axhausen 2003), thereby making it difficult to participate in social activities in the community. In the gerontology literature, self-regulation typically describes the efforts of older adults with health impairments to remain drivers as long as possible by avoiding highways, driving during the day, staying off the road during rush hour and travelling on familiar routes (*e.g.* Adler and Rottunda 2006). Vision and cognitive impairments, for example, make it difficult for older adults to drive (Brenner, Homaifer and Schultheis 2008; Dellinger *et al.* 2001). Cars also require significant expenditures to purchase, maintain and repair (Clifton 2004), suggesting the potential for self-regulation due to limited finances. Together these findings suggest that economically vulnerable older adults are at an increased risk for social exclusion due to restricted mobility options compared to those with more financial resources. To our knowledge, however, there has been limited research regarding the extent to which economic vulnerability can exacerbate social exclusion by not only restricting older adults' access to different modes of transportation, but also limiting their use even when they are available.

Purpose of the study

This study uses cross-sectional data from a representative sample of community-dwelling older adults living in the USA to examine the relationship between modes of transportation and social activity restrictions, with particular attention to potential disadvantage among those who are economically vulnerable compared to those with more financial resources. Specifically, the first purpose of this study is to examine the association between four modes of transportation (*i.e.* driving, relying on rides from others, walking and using public transit) and four social activities (*i.e.* interacting with friends and family, attending religious services, belonging to clubs and other organisations, or going out for enjoyment). Based on prior work suggesting that, particularly in the USA, as a more independent mode of travel driving is more facilitative of social activity participation than other transportation modes, we hypothesise that driving will be associated with lower odds of social activity restrictions (Hypothesis 1), while other modes of transportation will be associated with higher odds of social activity restrictions (Hypothesis 2). Based on the prior work on social exclusion cited above, the second purpose of this study is to assess whether economically vulnerable older adults experience disadvantages in social activity participation even when they drive a car. We therefore also hypothesise that economic vulnerability will be associated with a reduction in the positive association between driving and social activity participation (Hypothesis 3).

Design and methods

Data and sample

We used data from the 2011 wave of the National Health and Aging Trends Study (NHATS), a representative sample of Medicare beneficiaries ages 65 or older in the USA that aims to: (a) examine disability trends and dynamics in late life, and (b) understand how late life changes affect social and economic circumstances (Kasper and Freedman 2012). Using the Medicare enrolment database as the sampling frame, the NHATS employed a stratified three-stage sample design to ensure sufficient participation by age and race/ethnicity, over-sampling those aged 90 or older and African Americans (Montaquila *et al.* 2012*a*). A total of 8,245 older adults participated in 2011, for a response rate of 71 per cent. The data-set includes analytic weights to adjust for over-sampling and non-response. We excluded those living in a residential care setting or nursing home (N = 1,048), for a final selected sample of 7,197 older adults.

Measures

Social activity restrictions. We constructed measures to indicate whether respondents reported a restriction in four social activities: (a) visiting with friends and family; (b) attending religious services; (c) participating in clubs, classes or other organised activities; and (d) going out for enjoyment (*e.g.* for dinner, a movie, gambling, seeing a play, *etc.*). NHATS is one of the few national studies of health and ageing in the USA that assesses not only social activity restrictions but also whether the activities are valued by the respondent (Freedman *et al.* 2011). To create each variable, we used responses from two questions. For example: 'In the last month, did your health or functioning ever keep you from attending religious services' (0 = no, 1 = yes) and 'How important is it to you to attend religious services?' (0 = not so important, 1 = somewhat important, 2 = very important). We coded respondents who answered yes to the first question and either somewhat important or very important to the second question as having a restriction in each activity.

Modes of transportation. We included four dichotomous measures to indicate whether the respondent reported using a specific mode of transportation in the past month: driving, rides from others, walking or public transportation (0 = no, 1 = yes). These measures were not mutually exclusive so respondents could have used multiple modes of transportation.

Economic vulnerability. We used the receipt of Medicaid, a public health insurance programme for low-income Americans, as an indicator for

economic vulnerability (0 = no, 1 = yes). While there are some variations in eligibility requirements among states, Medicaid is only available to older adults with low incomes (*i.e.* at most 133% of the US federal poverty level) and few financial assets.

Socio-demographic and health characteristics. We adjusted for socio-demographic, health and neighbourhood characteristics that the empirical literature suggests is associated with social activity restrictions. Based on research demonstrating that those 85 or older have lower levels of participation compared to other age groups (Desrosiers *et al.* 2009), we measured age as a dichotomous variable (0 = under 85 years, 1 = 85 or older). We included gender (0 = male, 1 = female) because women often participate more in activities than men (Dahan-Oliel *et al.* 2010). Prior research has documented racial and ethnic differences in activities (Bird *et al.* 2009), so we compared non-Hispanic White (reference group), non-Hispanic African American, Latino/Hispanic of any race and other. Extant research indicates older adults who are married tend to have higher levels of social participation than those who are not, so we included marital status (0 = not married, 1 = married) (Dahan-Oliel *et al.* 2010). Furthermore, we adjusted for education (0 = less than high school diploma, 1 = high school diploma or higher) because those with more education are more likely to participate in social activities (Dahan-Oliel *et al.* 2010).

Poor health or functioning may prevent older adults from engaging in social activities (Levasseur, Desrosiers and Whiteneck 2010; Perkins *et al.* 2008). We included four indicators of physical health. First, we created a count variable to measure whether a respondent reported difficulty performing six activities of daily living (ADL): eating, bathing, toileting, dressing, getting around the house, and getting in and out of bed (range 0–6). Second, we created a count variable of self-reported diagnosed conditions as follows: heart attack, heart disease, high blood pressure, arthritis, osteoporosis, diabetes, lung disease, stroke, dementia or cancer (range 0–10). We also included two dichotomous measures of whether a respondent reported an overnight hospital stay or a fall within the last year (0 = no, 1 = yes). Prior research indicates that depressive symptoms contribute to social activity restrictions among older adults (Benyamini and Lomranz 2004). The NHATS measures depressive and anxiety symptoms using the Patient Health Questionnaire-4 (PHQ-4), which assesses how often (0 = not at all, 1 = several days, 2 = more than half the days, 3 = nearly every day) a respondent had little interest, felt down, felt nervous or had been unable to stop worrying over the last month. Summed scores range from 0 to 12, where a higher score indicates a greater level of depression and anxiety. Internal consistency reliability was $\alpha = 0.75$.

Finally, we included a measure of neighbourhood problems because prior research suggests those living in neighbourhoods with fewer problems report higher satisfaction with their social participation (Hand *et al.* 2012). Based on interviewer observations of each NHATS respondent's neighbourhood, we created a count variable ranging from 0 to 4, where a higher score indicated more neighbourhood problems (*i.e.* presence of litter, graffiti, vacant houses and/or foreclosure signs). Internal consistency reliability was $\alpha = 0.72$.

Data analysis plan

We conducted logistic regression analyses to examine the relationship between modes of transportation and restriction in each of the social activities using Stata 12. We addressed missing data through multiple imputation using multivariate normal regression (Acock 2012). Missing data were low, with each item missing less than 2 per cent. We also tested for multicollinearity of all variables using the variance inflation factor. We employed weighted methods to provide more accurate estimation by adjusting for over-sampling and non-response. NHATS technical papers provide more details on the study design and weighting (Montaquila *et al.* 2012*a*, 2012*b*). For each logistic regression model, we adjusted for socio-demographic, health and neighbourhood characteristics. In addition, we created four interaction terms between the modes of transportation and economic vulnerability to examine whether this variable moderates the relationship between transportation and social activity restrictions. Finally, we conducted *post hoc* analyses to examine the relationship between economic vulnerability and social activities.

Results

Table 1 presents descriptive statistics for our selected sample of community-dwelling NHATS participants. Approximately 15 per cent of respondents were economically vulnerable. Among the total sample, a minority had restrictions in any of the four activities in the past month, with religious attendance the most frequently reported. Driving was the most common mode of transportation, used by nearly three-quarters of respondents in the past month. Public transit was the least common, used by less than 10 per cent of respondents. As shown in Table 1, the demographic characteristics of this sample align closely with those reported for the general population of Americans aged 65 or older (*e.g.* Ortman, Velkoff and Howard 2014), with the exception of a higher percentage of African American respondents due to over-sampling. Respondents reported few ADL limitations or symptoms of depression and anxiety, and interviewers noted few

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TABLE 1. *Characteristics of selected sample from the National Health and Aging Trends Study*

Characteristic	Total	Economically vulnerable	Higher resourced
Social activity restriction (%):			
Family/friend visits	7·7	13·3	6.6
Religious services	13.1	23.2	11.3
Clubs/classes/organised activities	6.1	7·9	5·7
Going out for enjoyment	7·5	12.3	6.7
Mode of transportation (%):			
Drive	73·4	43.1	77.6
Rides from others	50.3	66.2	47·5
Walk	48.7	49.3	48.6
Public transit	8.8	17.1	7·4
Age 85 or older (%)	19.0	21.9	18.5
Female (%)	57·4	64.8	56.0
Race/ethnicity (%):			
White	68.5	31.2	75.3
African American	22.3	45.8	18.0
Latino/Hispanic any race	6.2	15.7	4·5
Other	2.6	7·3	2.1
Married (%)	49.8	24.2	54·5
High school graduate (%)	72.9	38.7	79.1
Mean number of ADL limitations (range 0–6)	0.8	1.4	0.7
Mean number of diagnosed conditions (range 0–9)	2.6	3.0	2.5
Hospital stay in past year (%)	22.8	29.2	21.6
Fall in past year (%)	31.0	35·4	30.2
Mean PHQ-4 score (range 0–12)	2.0	3.0	1.8
Mean number of neighbourhood problems (range 0–4)	0.3	0.6	0.2
N	7,197	1,080	6,117

Notes: The table presents unweighted data prior to multiple imputation. ADL: activities of daily living. PHQ-4: Patient Health Questionnaire-4.
Significance level: All bivariate comparisons between economically vulnerable and higher resourced respondents were significant at $p < 0.01$ except 'Walk'.

neighbourhood problems. Respondents averaged more than two diagnosed health conditions, nearly one-quarter had a hospital admission in the past year and nearly one-third had fallen in the past year.

As shown in Table 1, a significantly higher percentage of economically vulnerable older adults reported social activity restrictions. Older adults with few financial resources were less likely to drive and more likely to receive rides from others or use public transit; there were no significant differences in walking. Economically vulnerable respondents were also more likely to be women, African American and/or Hispanic/Latino, unmarried, and have less than a high school education. They also had significantly worse health indicators and were more likely to live in neighbourhoods with observed problems.

Table 2 presents the results of the logistic regression analyses examining the direct effects of modes of transportation on social activity restrictions. Contrary to our first hypothesis, driving was not significantly associated with social activity restrictions. However, walking was associated with significantly lower odds of restrictions in visiting family and friends (odds ratio (OR) = 0.71), attending religious services (OR = 0.71) or going out for enjoyment (OR = 0.75). Results indicated partial support for our second hypothesis, as receiving rides from family and friends was significantly associated with greater odds of restrictions in all four types of social activity (OR = 1.96 for family/friend visits; OR = 1.71 for religious services; OR = 1.67 for clubs and organised activities; OR = 2.02 for going out for enjoyment). Public transit use had no direct effects on social activity restrictions.

Also shown in Table 2, a number of other socio-demographic and health covariates had significant associations with social activity restrictions in this sample. Respondents aged 85 or older had significantly lower odds of reporting restrictions in visiting with family and friends, but greater odds of restrictions in religious attendance. Women had higher odds of restrictions in attending religious services or participating in clubs. African Americans had significantly higher odds of restrictions in religious attendance, while high school graduates had significantly lower odds of reporting a restriction in this activity. High school graduates had greater odds of not participating in clubs and other organised activities. Indicators of poor physical health, including number of ADL limitations, number of diagnosed conditions, hospitalisation in the past year and the PHQ-4 indicator of poor mental health, consistently increased the odds of social activity restrictions. In addition, respondents who fell in the past year had significantly greater odds of restrictions in attending religious services. Neighbourhood problems were significantly associated with restrictions in visiting with family and friends and going out for enjoyment.

Table 3 shows the results of the logistic regression models testing our third hypothesis. The interaction term between driving and economic vulnerability was significantly associated with restrictions in attending religious services and going out for enjoyment. While driving a car was associated with lower odds of restrictions in both activities, economically vulnerable respondents who drove were more likely to report a restriction compared to those with more financial resources. For example, *post hoc* analyses indicated that among respondents who drove, nearly 16 per cent of the economically vulnerable reported a restriction in attending religious services compared to only 6 per cent of those with more financial resources. Similarly, the interaction between walking and economic vulnerability was significantly related to a restriction in participating in clubs and organised activities, and the

TABLE 2. *Logistic regression on social activity restrictions for selected sample from the National Health and Aging Trends Study*

Characteristic	Family/friend visits		Religious services		Clubs/classes/ organised activities		Going out for enjoyment	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Mode of transportation:								
Drive	0.91	0.67, 1.23	0.82	0.64, 1.04	0.93	0.67, 1.29	0.86	0.64, 1.15
Rides from others	1.96***	1.44, 2.67	1.71***	1.33, 2.20	1.67**	1.20, 2.32	2.02***	1.47, 2.76
Walk	0.71**	0.56, 0.90	0.71**	0.59, 0.87	0.87	0.66, 1.15	0.75*	0.59, 0.97
Public transit	0.90	0.55, 1.46	0.72	0.48, 1.07	0.75	0.51, 1.42	0.80	0.52, 1.23
Economic vulnerability (Medicaid)	0.92	0.58, 1.45	1.07	0.80, 1.42	0.75	0.49, 1.15	1.04	0.74, 1.45
Age 85 or older	0.72*	0.52, 0.99	1.51**	1.17, 1.95	0.98	0.73, 1.32	1.03	0.83, 1.29
Female	1.26	0.95, 1.66	1.89***	1.52, 2.35	1.34*	1.05, 1.72	1.12	0.89, 1.40
Race/Ethnicity (Ref. White):								
African American	0.91	0.67, 1.24	1.31**	1.08, 1.59	1.03	0.77, 1.39	0.82	0.59, 1.14
Latino/Hispanic any race	1.11	0.61, 2.02	1.18	0.80, 1.74	1.33	0.41, 1.89	1.04	0.67, 1.61
Other	1.28	0.66, 2.49	0.90	0.50, 1.62	0.88	0.91, 1.51	0.84	0.43, 1.64
Married	0.97	0.73, 1.30	1.20	0.95, 1.52	1.17	0.91, 1.51	0.94	0.77, 1.16
High school graduate	0.82	0.62, 1.08	0.76*	0.58, 0.98	1.45*	1.07, 1.94	1.50**	1.20, 1.88
ADL limitations (range 0–6)	1.46***	1.35, 1.58	1.37***	1.27, 1.48	1.39***	1.28, 1.51	1.46***	1.36, 1.56
Diagnosed conditions (range 0–9)	1.12***	1.06, 1.20	1.10**	1.03, 1.17	1.14**	1.05, 1.24	1.10*	1.02, 1.18
Hospital stay in past year	1.98***	1.51, 2.58	1.95***	1.59, 2.40	1.69***	1.29, 2.20	2.05***	1.65, 2.54
Fall in past year	1.20	0.97, 1.49	1.29**	1.07, 1.56	1.07	0.81, 1.41	1.05	0.81, 1.34
PHQ-4 score (range 0–12)	1.13***	1.08, 1.17	1.11***	1.06, 1.15	1.06***	1.02, 1.11	1.12***	1.07, 1.18
Neighbourhood problems (range 0–4)	1.15*	1.00, 1.33	1.11	0.97, 1.28	1.07	0.91, 1.27	1.25**	1.07, 1.18
Constant	0.01	0.01, 0.03	0.02	0.01, 0.04	0.01	0.01, 0.02	0.01	0.01, 0.02

Notes: OR: odds ratio. CI: confidence interval. Ref.: reference group. ADL: activities of daily living. PHQ-4: Patient Health Questionnaire-4.
Significance levels: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

TABLE 3. *Logistic regression on social activity restrictions examining moderating effects of economic vulnerability*

	Family/friend visits		Religious services		Clubs/classes/ organised activities		Going out for enjoyment	
Characteristic	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Mode of transportation:								
Drive	0.83	0.59, 1.15	0.70*	0.53, 0.92	0.87	0.59, 1.29	0.70*	0.51, 0.97
Rides from others	1.95***	1.41, 2.69	1.66***	1.27, 2.18	1.60*	1.11, 2.30	1.77**	1.23, 2.55
Walk	0.72*	0.53, 0.96	0.69***	0.56, 0.86	0.80	0.60, 1.07	0.69*	0.51, 0.93
Public transit	0.78	0.41, 1.45	0.49**	0.29, 0.82	0.66	0.36, 1.24	0.64	0.40, 1.03
Economic vulnerability (Medicaid)	0.75	0.31, 1.82	0.57	0.29, 1.15	0.30*	0.10, 0.90	0.27*	0.09, 0.83
Age 85 or older	0.71*	0.52, 0.98	1.49**	1.15, 1.93	0.98	0.73, 1.32	1.03	0.82, 1.28
Female	1.27	0.97, 1.67	1.93***	1.55, 2.41	1.37*	1.07, 1.75	1.15	0.92, 1.45
Race/ethnicity (Ref. White):								
African American	0.93	0.68, 1.26	1.34**	1.11, 1.62	1.04	0.77, 1.41	0.84	0.61, 1.15
Latino/Hispanic any race	1.12	0.62, 2.03	1.20	0.82, 1.75	1.31	0.77, 2.22	1.03	0.66, 1.58
Other	1.29	0.69, 2.43	0.90	0.53, 1.53	0.84	0.41, 1.70	0.84	0.44, 1.62
Married	0.97	0.72, 1.29	1.19	0.95, 1.51	1.17	0.91, 1.50	0.94	0.77, 1.15
High school graduate	0.83	0.62, 1.10	0.77	0.59, 1.00	1.46*	1.08, 1.98	1.55***	1.23, 1.95
ADL limitations (range 0–6)	1.46***	1.35, 1.58	1.38***	1.28, 1.49	1.40***	1.30, 1.52	1.46***	1.36, 1.57
Diagnosed conditions (range 0–9)	1.12**	1.05, 1.20	1.10**	1.03, 1.17	1.14**	1.05, 1.23	1.09*	1.02, 1.18
Hospital stay in past year	1.98***	1.51, 2.59	1.95***	1.59, 2.40	1.69***	1.30, 2.20	2.07***	1.66, 2.57
Fall in past year	1.20	1.51, 2.59	1.29**	1.07, 1.55	1.07	0.81, 1.41	1.05	0.81, 1.35
PHQ-4 score (range 0–12)	1.12***	1.08, 1.17	1.11***	1.06, 1.15	1.06*	1.01, 1.11	1.12***	1.07, 1.18
Neighbourhood problems (range 0–4)	1.14	0.98, 1.32	1.09	0.95, 1.25	1.06	0.90, 1.26	1.22*	1.05, 1.43
Economic vulnerability × Drive	1.58	0.92, 2.72	2.31**	1.30, 4.09	1.79	0.82, 3.94	2.91**	1.45, 5.85
Economic vulnerability × Rides	0.95	0.38, 2.39	1.06	0.59, 1.93	1.42	0.58, 3.45	2.05	0.76, 5.53
Economic vulnerability × Walk	1.00	0.45, 2.20	1.27	0.72, 2.24	2.02*	1.04, 3.92	1.89	0.97, 3.67
Economic vulnerability × Public transit	1.55	0.63, 3.80	2.77*	1.10, 6.98	2.14	0.77, 5.94	1.82	0.72, 4.58
Constant	0.02	0.01, 0.03	0.03	0.02, 0.04	0.01	0.01, 0.02	0.01	0.01, 0.02

Notes: OR: odds ratio. CI: confidence interval. Ref.: reference group. ADL: activities of daily living. PHQ-4: Patient Health Questionnaire-4.
Significance levels: * $p<0.05$, ** $p<0.01$, *** $p<0.001$.

interaction between using public transit and economic vulnerability was significantly associated with a restriction in religious attendance. For both, the positive effects of the mode of transportation on social activity participation was attenuated for the economically vulnerable respondents. There were no significant interaction terms between getting rides from others and economic vulnerability.

Discussion

Previous research has documented the role that transportation plays in older adults' participation in activities. Driving cessation, for example, can result in a perceived loss of independence and participation (Rudman *et al.* 2006), and former drivers experience a more precipitous decrease in social activities compared to those who remain behind the wheel (Curl *et al.* 2014). Our study adds to this literature by finding significant relationships between certain modes of transportation and restrictions in different social activities. Specifically, those who received rides from others were more likely to report social activity restrictions. Older adults who walked for transportation, however, were less likely to report restrictions in visiting with family and friends, attending religious services or going out for enjoyment. Furthermore, prior work using the 2001 and 2009 National Household Travel Surveys has shown that both age and economic vulnerability are associated with less travel around the community (Pucher and Renne 2003; Pucher *et al.* 2011; US Government Accountability Office 2004). Our study extends the literature on the barriers to community mobility by demonstrating that financial resources not only influence transportation options, but also the beneficial effects of transportation, specifically driving, walking and public transit use, on activity participation. Economically vulnerable older adults thus may be at a higher risk for social exclusion even if they have access to these modes of transportation. Finally, our results highlight the importance of taking a more nuanced approach to understanding social participation in later life, including examining specific types of social activity rather than a composite measure and taking into account not only whether an older adult participates in an activity but also whether they would like to do so.

Supporting the findings of prior research (Burkhardt 2000), our study shows that those who get rides from others are more likely to have social activity restrictions. Friends and family members may have limited availability to drive an older adult to activities in the community. In addition, given that in previous work older adults have noted that rides from others foster feelings of obligation (Burkhardt *et al.* 2002), they may only ask for

transportation help when absolutely necessary. Davey (2007), for example, found that older adults 'coping without a car' were able to continue taking essential trips into the community for medical appointments or grocery shopping, but experienced major challenges in taking more discretionary trips such as visiting friends. Although we did not have data to analyse trip purpose, it is possible that in our sample the older adults receiving rides from others primarily took 'life-sustaining' trips as opposed to 'life-enhancing' trips (US Government Accountability Office 2004: 10).

Even when they used independent modes of transportation, economically vulnerable older adults were disadvantaged in social activity participation compared to their counterparts with more financial resources. While a smaller percentage of low-income older adults drove compared to those with more financial resources, a sizeable minority (approximately 43% in the present study) used their own car for transportation at least occasionally. Our finding that economically vulnerable older adults who drove reported more restrictions in religious attendance and going out for enjoyment, but not for visiting with others or clubs and organised activities, raises questions for future research regarding the differences by social activity type. Furthermore, because driving is often the fastest and most convenient form of travel in the USA, it is possible that costs are an important consideration. One explanation is that these older adults are self-regulating their driving habits.

While the cross-sectional design of our study precludes us from drawing conclusions about causality, our findings suggest that some older adults may not only self-regulate their driving because of health problems, but also because of poor finances. Previous research not focused specifically on older adults indicates that such self-regulation is typical in younger households. Data from the Consumer Expenditure Survey of the Bureau of Labor Statistics, for example, shows that households across age and income categories spend an average of US $8,600 per year on transportation, while low-income households annually spend an average of US $3,400 (Agrawal *et al.* 2011). Low-income households are more likely to have less than a one-to-one ratio between drivers and cars, so each driver may not be able to use a car whenever they wish (Blumenberg and Pierce 2013). Driving can be costly, and often the cars purchased by those with low incomes require maintenance and repairs (Clifton 2004). Fuel prices also pose a major barrier to vehicle use for low-income households. For example, in a 2009 survey in California, 83 per cent of low-income households reported that fuel prices were causing them financial hardship, compared to two-thirds of moderate-income and slightly more than half of higher-income households (Baldassare *et al.* 2009). Drivers who self-regulate for financial reasons might reduce the number of trips, take shorter

trips or combine several tasks into one trip (Agrawal *et al.* 2011). Furthermore, they may cut out community activities they perceive as unnecessary (Agrawal *et al.* 2011), such as the social activities examined in the current study.

While walking and public transit offer a less-expensive alternative to owning and operating a vehicle, economically vulnerable respondents using these modes of transportation were also disadvantaged in their participation in social activities. Beyond the health limitations adjusted for in our analyses, the neighbourhood environment potentially presents the greatest barrier to these modes of transportation. We included interviewer observations of neighbourhood problems, which likely reflect potential social disorder and safety concerns that could limit older adults' willingness to walk or use public transit. While the NHATS does not include measures reflecting the built environment, we plan to seek out and merge these data with other sources that will allow us to capture more fully the neighbourhood environment in future research. In interviews with low-income households, for example, Clifton (2004) reported that walking is seen as a viable mode of transportation only for those living close to businesses and services.

Thus, even when economically vulnerable older adults have access to driving, walking or public transit, they may be at a higher risk of social exclusion than their counterparts with more financial resources. Future research should examine whether similar patterns occur among other groups at a high risk for limited transportation options and restricted community mobility, including those who are older, women, or from racial and ethnic minority groups (Dugan and Lee 2013). These findings are concerning because the key components of social inclusion, including social integration, social support and access to resources, have been linked to health, wellbeing and life satisfaction among older adults (*e.g.* Andrew 2005; Borglin *et al.* 2006; Jang *et al.* 2004). Furthermore, qualitative research suggests that for older adults with mobility limitations, participating in discretionary activities (such as those investigated in the present study) is critical to fostering a sense of community belonging (Siren, Hjorthol and Levin 2015).

Finally, our results suggest barriers to participation vary depending on the specific type of social activity. For example, some characteristics (*e.g.* health limitations) were associated with restricted participation in all activities, while other characteristics (*e.g.* age, gender, and race or ethnicity) were only associated with certain activities. Similarly, depending on others for rides was related to restricted participation in all activities, while the other modes of transportation were only associated with certain activities, particularly among those who are economically vulnerable. The explanation for these differences is likely a combination of variations in the value placed

on each activity (highlighted by the significantly higher percentage of economically vulnerable older adults reporting a restriction in religious attendance), their spatial distribution, and the physical and social demands of each activity.

This study has limitations to address in future research. These include the cross-sectional design of the analyses, the use of self-report data and using Medicaid receipt as a proxy for economic vulnerability. Furthermore, the variables reflecting mode of transportation were not mutually exclusive, so we were unable to assess for a main mode of transportation for each respondent. While this limitation is outweighed by the ability to examine multiple modes of transportation, future studies should collect data on the frequency of different forms of transport. Future research should also use longitudinal designs to examine the potential differential effects of financial resources on the relationship between modes of transportation and social activity restrictions, and include more in-depth measures of older adults' travel (*e.g.* the purpose of trips). Finally, our study did not include geographic data, which prevented us from examining the contextual factors that could contribute to social activity restrictions. For example, we were unable to look at urban–rural differences, or to conduct multi-level models to account for individual and neighbourhood characteristics. Future research should incorporate comprehensive measures of the community environment (*e.g.* the presence of ageing-friendly social and physical infrastructure) and examine variations by geographic location.

Conclusion

This study adds to the growing literature on the ways modes of transportation may contribute to the social exclusion of older adults. Specifically, regardless of financial resources, depending on rides from family and friends impedes social activity participation. In addition, the positive association between driving, walking and public transit with social activity participation is less for economically vulnerable older adults compared to those with more financial resources, at least for certain social activities. These findings add to prior work documenting existing and widening disparities in the USA in access to and use of modes of transportation by socio-economic status, gender, and race and ethnicity (*e.g.* Choi and Mezuk 2013; Choi *et al.* 2015). Policies and programmes that aim to facilitate older adults' community mobility should therefore not only address the needs of those who have difficulty using independent modes of transportation because of physical health limitations, but also those who have difficulty with transportation because of financial resource limitations.

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