

Ageing and loneliness: The role of mobility and the built environment



Pauline van den Berg*, Astrid Kemperman, Boy de Kleijn, Aloys Borgers

Eindhoven University of Technology, PO Box 513, 5600MB Eindhoven, The Netherlands

ARTICLE INFO

Article history:

Received 3 November 2014
Received in revised form 23 February 2015
Accepted 7 March 2015
Available online 14 March 2015

Keywords:

Loneliness
Social isolation
Age
Residential environment
Transportation
Mobility

ABSTRACT

The ageing of the population raises questions regarding the quality of life of future generations. This article focuses specifically on feelings of loneliness as an important aspect of quality of life in relation with mobility aspects and built environmental characteristics. Based on data collected in the southeast of the Netherlands among 344 respondents in 2014 four ordered logit models were estimated to explain the extent to which people feel lonely or socially isolated. The explanatory variables in the models are age; other personal and household characteristics; characteristics of the built environment and mobility aspects. The results indicate that, although age has little explanatory power, older people are likely to feel lonelier. Other personal and household characteristics, such as household composition, education, health status, being a volunteer and the number of social interactions are found to have more explanatory power. Characteristics of the built environment also explain a substantial part of variance in loneliness. Significant effects are found for living in an apartment, length of residence in the neighbourhood and satisfaction with the neighbourhood and its facilities. Finally, we find that the use of different transport modes (bicycle, car and public transport) significantly reduces loneliness.

© 2015 Hong Kong Society for Transportation Studies. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Improving quality of life in both the fast growing and urbanising city areas, as well as in the regions that face a decreasing population is an important objective for urban planners and policy makers. In different fields, such as psychology and sociology, there has recently been an increasing interest in subjective aspects of quality of life, such as subjective well-being, happiness, social satisfaction and loneliness (e.g., Cattan et al., 2005; Helliwell and Putnam, 2004; Ettema et al., 2010; Schwanen and Wang, 2014). According to Schwanen and Wang (2014) “well-being provides a useful concept to move beyond biomedical understandings of health”. In that sense the increased attention for subjective aspects of quality of life reflects the concerns regarding the consequences of an ageing society. Whereas the elderly nowadays are more educated, have a better physical health and are more mobile than earlier generations of elderly, they have a heightened risk of social isolation and loneliness (e.g., Scharf and De Jong Gierveld, 2008; Pino et al., 2014). Older people, in general, have fewer social support networks due to changes in their life cycle stage (e.g., retirement), or age-related losses and critical events (e.g., death of partner

(e.g., Oh, 2003; Tang and Lee, 2011). However, loneliness and social isolation occur among all age groups.

Loneliness has been found to be related to socio-demographic characteristics such as income and health, as well as to neighbourhood characteristics such as perceived quality of the neighbourhood (e.g., Scharf and De Jong Gierveld, 2008). Also, mobility becomes increasingly important as it provides access to quality interactions that are necessary for life's necessities as well as social and emotional well-being (Metz, 2000; Spinney et al., 2009). However, the impact of mobility aspects on feelings of loneliness has been largely overlooked.

The aim of the current article is to contribute to this knowledge by analysing the socio-demographic, mobility and spatial factors that influence subjective feelings of loneliness or social isolation, with a specific focus on the (interaction) effects of age. For this purpose an ordered logit model is estimated based on data collected in the Netherlands among 344 respondents in 2014.

The remainder of this article is structured as follows. Section 2 discusses the existing literature on loneliness as an aspect of subjective wellbeing and quality of life and the possible factors influencing feelings of loneliness. Section 3 describes the data collection effort and the sample characteristics, followed by the methods and results in Section 4. Section 5 discusses the implications of our findings for urban and transport research and policy.

* Corresponding author. Tel.: +31 40 247 5417; fax: +31 40 243 8488.

E-mail address: p.e.w.v.d.berg@tue.nl (P. van den Berg).

2. Literature review

Social relationships are essential for people's quality of life and well-being. If the quality or the quantity of relationships with family and friends is lower than is considered desirable, people feel lonely (Perلمان and Peplau, 1981). As the reduction of loneliness is crucial in creating quality of life, there is an ongoing interest in this topic in the social sciences.

There seems to be a widespread belief that loneliness only occurs among seniors (Demakakos et al., 2006). Many studies on loneliness focus specifically on elderly. However, loneliness has been found to occur in all age groups. According to De Jong-Gierveld and Van Tilburg (2010), the reason for specifically studying loneliness of older adults is the fact that some of the determining factors of loneliness, such as lower levels of health and income, or the loss of a spouse, are directly related to older age. This shows that loneliness not only relates to age but also to other socio-demographic characteristics.

In social sciences, loneliness has extensively been studied in relation to socio-demographic characteristics (although many studies are confined to older adults). In these studies, low education and low income have been found to be associated with loneliness (e.g., Pinqart and Sørensen, 2001; Demakakos et al., 2006; Hawkey et al., 2008). Household composition has also been found to affect feelings of loneliness. Older people tend to feel less lonely if they live with a partner (Demakakos et al., 2006; De Jong-Gierveld and Van Tilburg, 2010) and if they have (more) children (De Jong-Gierveld and Van Tilburg, 2010). In addition, a number of studies showed that a higher (self-perceived) health is related to lower levels of loneliness (e.g., Hawkey et al., 2008; Scharf and De Jong Gierveld, 2008; De Jong-Gierveld and Van Tilburg, 2010; Weijjs-Perrée et al., 2015).

Loneliness is also related to more objective measures of social relations. For instance, Demakakos et al. (2006) found that loneliness is related to the size of one's social network. Hawkey et al. (2008) also found that loneliness decreases if one's social network is larger. They did however not find a relationship between frequency of social interaction and loneliness. Hughes et al. (2004) stress that the relationship between objective and subjective social isolation is relatively modest, which "suggests the importance of studying both aspects of social relationships". Hughes et al. (2004) used a number of objective measures of social integration or isolation, including marital status, living arrangements, whether the respondent volunteers at least 100 h a year whether the respondent provides any kind of help to family members and the respondent's rating of his or her neighbourhood's safety. They did however not use direct information about frequency of social interaction (e.g., how often the respondent contacts others). Moreover, Pinqart and Sørensen (2001) found that lower quality of contact is more closely related with loneliness than lower quantity of social contacts.

In addition to socio-demographics, social interactions and loneliness have been studied in relation to neighbourhood characteristics, such as neighbourhood income and urban density. However, the number of studies taking these aspects into account is limited. In this regard Scharf and De Jong Gierveld (2008) found that people living in high urbanised and deprived neighbourhoods are lonelier. They also found that the subjective evaluation of the quality of the neighbourhood is significantly related to loneliness. In the same vein, Weijjs-Perrée et al. (2015) found that people who feel more attached to their residential location are less lonely.

Quality of life from a living environment perspective includes both objective factors such as provision of services, availability of green and condition of houses, and subjective characteristics as

perception of safety, social cohesion, degeneration and satisfaction with their environment (e.g., Van Kamp et al., 2003). Built environment characteristics such as neighbourhood walkability and access to facilities have also emerged as an important theme in studies on local social interaction and community liveability (e.g., du Toit et al., 2007; Wood et al., 2008; Hanibuchi et al., 2012). For example, Wood et al. (2008) explored the relationship between social capital and aspects of the built environment, specifically focusing on the walkability. They concluded that the built environment appears to be important and potentially modifiable, with shops nearby (but not too many) and suburb upkeep being positive aspects of the anatomy of a suburb conducive to social capital. Also other characteristics of the built environment such as the availability of green spaces support social contacts among neighbours and strengthen communities for the ageing population (Kemperman and Timmermans, 2014).

Subjective well-being is assumed to be increased through engagement in everyday activities (e.g., Ettema et al., 2010; Schwanen and Wang, 2014). In turn, activity engagement is related to the travel options people have. In the field of transportation research there is therefore a growing interest in studying the relationship between quality of life or subjective well-being and activity-travel behaviour (e.g., Metz, 2000; Spinney et al., 2009; Ettema et al., 2010; Kolodinsky et al., 2013). Although the definitions of mobility and quality of life differ, studies agree that quality of life and mobility are related.

In the field of transportation research there are only very few studies that consider the relationship between mobility attributes and subjective measures of social interaction. Thus far, attention has mainly been paid to the more objective measures of social activity-travel behaviour, such as the frequency and distance of social trips (e.g., Carrasco and Miller, 2006, 2009; Kemperman et al., 2006; Farber and Páez, 2009; Carrasco, 2011; van den Berg et al., 2009, 2011, 2012; Kowald et al., 2013), with a number of them focussing specifically on the ageing population (e.g., Tacken, 1998; Páez et al., 2006; van den Berg et al., 2011).

Regarding the subjective aspects of social interaction Delmelle et al. (2013) analysed which personal characteristics, housing and residential neighbourhood characteristics and commuting and transportation characteristics influence social satisfaction. They measured social satisfaction on a six-point Likert scale, asking respondents how satisfied they are with their social contacts, and used an ordinal probit regression model to analyse the data. With respect to the mobility-related variables they found that car ownership increases social satisfaction. They suggest that car ownership "increase[s] mobility in a time of increasingly dispersed social networks". In addition, their results show a positive effect of living close to a public transport stop with a high frequency of departures, which may also be explained by a higher accessibility of social network members. Regarding commute times they found a negative effect of a long commute.

In a recent study, Weijjs-Perrée et al. (2015) analysed the relationships between personal characteristics, neighbourhood characteristics, travel behaviour, social interactions, social satisfaction and loneliness using path analysis. They measured loneliness using a three-item Loneliness Scale that was developed by Hughes et al. (2004), based on the 20-item Revised UCLA Loneliness Scale (Russell et al., 1980), asking respondents how often they feel they lack companionship, how often they feel left out and how often they feel isolated from others. The response categories were: hardly ever (1), some of the time (2), and often (3). Their results indicate that people who own a car feel less lonely and that loneliness has a negative effect on social satisfaction. In addition, it was found that people who walk more often have a higher social satisfaction and people who cycle more often

have more social interactions, which in turn has a positive effect on social satisfaction.

This review of the literature has shown that several studies have examined the effects of socio-demographics and characteristics of the residential neighbourhood on loneliness and social satisfaction. In the field of transportation attention has been paid to the relationship between mobility and objective measures of social activity patterns. However, the more subjective measures of social life are lagging behind. This study therefore examines the role of mobility characteristics, neighbourhood and personal characteristics in subjective feelings of loneliness, with a specific focus on the role of age.

3. Data collection

This section discusses the data collection instrument, the fieldwork and the basic sample characteristics.

3.1. Data collection instrument

To collect data on the relationship between loneliness and personal, mobility and built environment characteristics, a data collection instrument was designed, consisting of a paper-and-pencil questionnaire and a two-day social interaction diary.

In the literature there are two common operationalisations of loneliness. The first one considers loneliness to be unidimensional and asks directly for the frequency or intensity of feeling lonely. The second one considers loneliness to be a multidimensional construct that has to be measured with a number of items (Pinquart and Sörensen, 2001). The scales that are used most often are the UCLA Loneliness Scale (Russell, 1982) and the De Jong-Gierveld Loneliness Scales (De Jong-Gierveld and Kamphuis, 1985; De Jong-Gierveld and Van Tilburg, 2010). To measure feelings of loneliness, we used a Likert scale response to the question: “to what extent do you agree with the statement: I experience social isolation/loneliness?” The answers ranged from fully agree (1) to fully disagree (5). According to Pinquart and Sörensen (2001) this method has face validity, however, they stress that loneliness has negative connotations and is therefore likely to be underreported when addressed directly.

Based on the discussed literature, the following relevant personal and household characteristics are collected: age, gender, household composition, education level, work, income, health status and social contacts. Health is measured on a five point Likert scale, asking the extent to which the respondent is satisfied with his/her own health. To measure social contacts, the number of face-to-face social interactions in 2 days, as recorded in the social interaction diary, is used. Respondents were asked to record all their face-to-face social interactions during 2 days in the interaction diary. They were first given a list of location types (e.g., home, another person's home, work, school, supermarket, shopping centre, restaurant, and park). For each location type they were asked to indicate whether they had visited it that day and whether or not they had had contact with someone (other than household members) at that location. They were then asked to record for each social interaction the location, the number of contacted persons at that location and their roles (relatives, neighbours, friends, etc.), the aim of the contact and how important it was for them. The other characteristics are all measured the usual way. Regarding the built environment the following characteristics are collected: type of dwelling, urban density, distance to and satisfaction with facilities. Type of dwelling and satisfaction with facilities (consisting of public, commercial, and cultural services in the residential area) were asked in the survey; urban density and distance to several facilities (e.g., public green, school, bar, restaurant, supermarket,

daily shop, non-daily shop, shopping centre, community centre, train station, highway) were retrieved from Statistics Netherlands based on postal code. With respect to mobility characteristics the questionnaire asked whether or not the respondents use a car, a bicycle and public transport.

3.2. Fieldwork

Data collection for this study took place in Noord-Limburg, which is located in the southeast of the Netherlands. Noord-Limburg is the northern part of the province Limburg and consists of the municipalities Beesel, Bergen, Gennep, Horst aan de Maas, Mook en Middelaar, Peel en Maas, Venlo and Venray. At this moment, the area has around 280,600 inhabitants, out of which 18% is 65 or older. This percentage is slightly higher than the percentage of 17% for the Dutch population. However, the area is expecting a demographic decline and increased ageing. In 2030 the area is expected to inhabit 271,900 people, out of which 28% will be 65 and over, as opposed to 24% of the total Dutch population. The expected demographic changes make the area an interesting case study for our research.

To be able to estimate the impact of the built environment on loneliness, data was collected in several towns with varying population densities.

In the Netherlands, five classes of urban density are distinguished based on the ‘surrounding address density’, which is the average number of addresses per 500 meter square within a kilometre radius from the address:

1. very high density (2500 or more addresses per km²),
2. high density (1500–2500 addresses per km²),
3. moderate density (1000–1500 addresses per km²),
4. low density (500–1000 addresses per km²),
5. very low density (less than 500 addresses per km²).

In Noord-Limburg only 5440 residents (2%) live in very high density (in the centre of Venlo); 21% live in high density; 17% live in moderate density; 28% live in low density and 32% live in very low density. Because of the low percentage of the population in very high density areas, very high and high density were merged. The aim was to collect equal numbers of diaries for the remaining four classes of urban density. Furthermore, in order to be able to estimate age effects, we intended half of the sample to consist of elderly people aged 65 or over. To achieve this, surveys were distributed in neighbourhoods with high percentages of seniors, some of which with seniors housing.

Between January and March 2014 a total of 430 surveys were distributed by contacting respondents in person at their home address. The completed surveys and diaries were picked up one week later. This resulted in a good response. Out of the 430 diaries that were distributed, 380 returned, out of which 344 are suitable for the analyses. Fig. 1 shows a map of Noord-Limburg in the Netherlands and the locations of the sampled respondents.

3.3. Sample characteristics

The basic sample characteristics are shown in Table 1. As can be seen, the sample is almost equally divided by gender. With respect to age, the sample is not representative of the population of Noord-Limburg. The age group 35–64 is underrepresented, whereas the oldest cohorts are overrepresented in the sample. More than half of the respondents are aged 65 years and over, whereas these age groups make up 24% of the population of Noord-Limburg (Statistics Netherlands, 2014). This was done intentionally, in order to be able to estimate interaction effects of age. As a result of the distribution of the sample over age

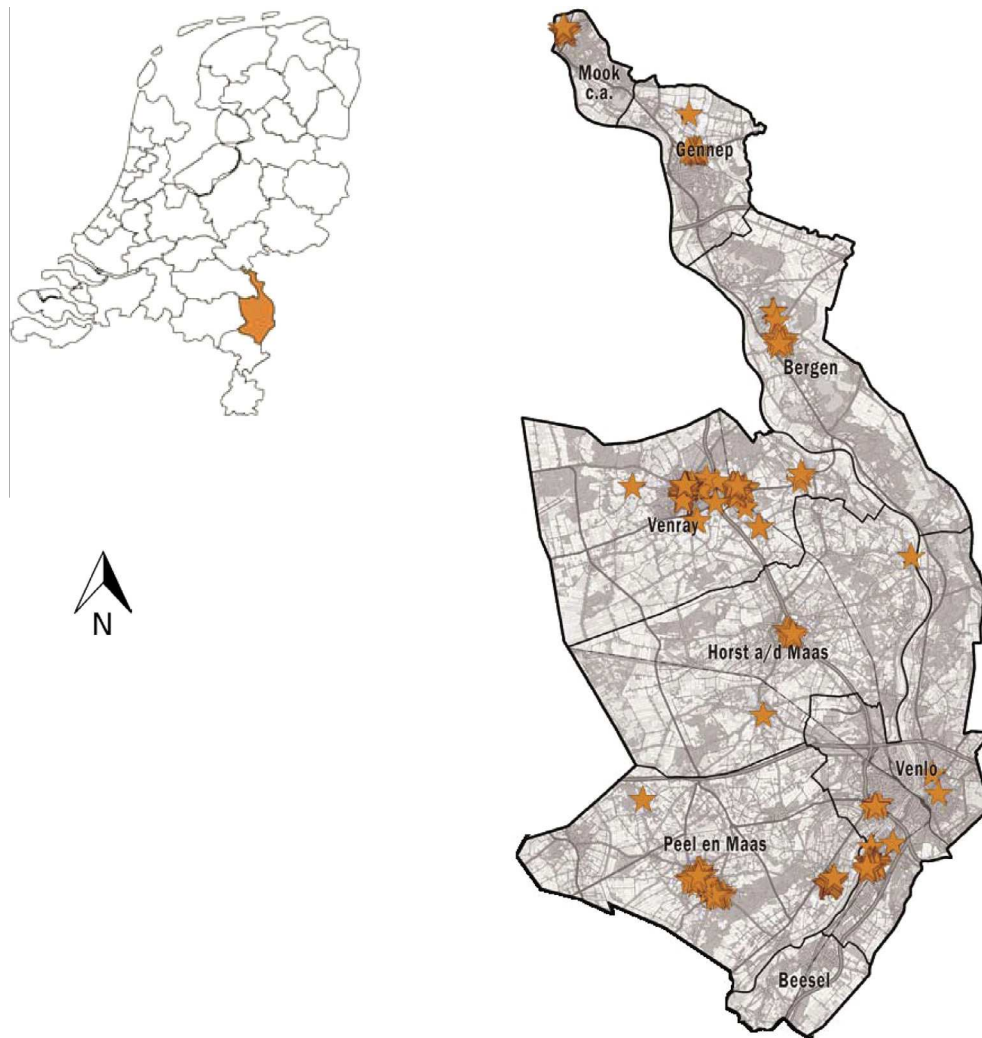


Fig. 1. Location of Noord-Limburg and the sampled respondents.

categories, the sample also differs from the population with respect to household composition. Half of the respondents are couples. Households with children make up only 22% of the sample, and 28% of the sample consists of single person households. One third of the respondents has a bachelor's degree or higher, whereas 14% only has primary education. One fifth of the respondents work full time. More than half of the respondents do volunteer work. 15% of the respondents assess their health as very good. On average, the respondents recorded 6 face-to-face social interactions in 2 days in the social interaction diary.

With respect to the characteristics of the living environment [Table 1](#) shows that one fourth of the respondents live in an apartment. One third of the respondents have lived at their current address for at least 20 years, whereas 10% have moved there in the last 2 years. 36% is very satisfied with their neighbourhood and 67% is satisfied with the amenities and facilities in the neighbourhood. Regarding urban density the results show that 21% lives in an urban area, which is defined as more than 1500 addresses per square kilometre. 26% live in rural areas with a density of less than 500 addresses per square kilometre. The distances to a daily shop, a public green facility and a highway access road were retrieved from Statistics Netherlands. The average distances are 0.85; 0.62 and 1.12 km respectively. The mobility characteristics show that 85% of the respondents use a bicycle, 88% use a car and 47% use public transport.

The dependent variable in our analyses is the individuals' perception of loneliness. [Table 2](#) shows the distribution of this variable. Loneliness was measured on a five point scale. However, for the analyses we recoded it into four categories. As can be seen in [Table 2](#) almost half of the respondents fully disagree with the statement "I experience social isolation/loneliness"; and another 30% disagrees. 17% of the sample neither disagree nor agree, 3% agree and 2% fully agree. These last two categories were merged for the analyses. The percentage of respondents who agree or fully agree to feel lonely or socially isolated (5%) seems low compared to other studies. For instance [RIVM \(2013\)](#) concluded that 30% of the Dutch adults are somewhat lonely and 8% are (very) lonely. The relatively low percentage of respondents agreeing to be lonely may be caused by the fact that we used a question asking directly about loneliness. Because the term loneliness has negative connotations, this may have caused respondents not to admit to being lonely ([Pinquart and Sörensen, 2001](#)). In addition, people who are lonely are probably less likely to take part in a survey on social activity behaviour. One should therefore interpret the findings with caution.

4. Methods and results

The aim of this paper is to explain feelings of loneliness as a result of personal and household characteristics, attributes of the

Table 1
Sample characteristics (N = 344).

		N	%	Mean	St. dev.
<i>Personal characteristics</i>					
Gender	Male	177	51.5		
	Female	167	48.5		
Age	Age <35	75	21.8		
	Age 35–64	82	23.8		
	Age 65–75	116	33.7		
	Age 75+	71	20.6		
Household composition	Single person	96	27.9		
	Couple without children	173	50.3		
	Household with child(ren)	75	21.8		
Gross household income	<€ 21,000 per year	44	12.8		
	€ 21,000–34,000 per year	94	27.3		
	€ 34,000–43,000 per year	86	25.0		
	>€ 43,000 per year	90	26.2		
Education	High (BSc)	112	32.6		
	Medium	184	53.5		
	Low	48	14.0		
Work status	Full time work	69	20.1		
	Part time	29	8.6		
	No work	246	71.3		
Volunteer	Volunteer	193	56.1		
	No volunteer	151	43.9		
Health status	Very good health	51	14.8		
	Less good health	293	85.2		
Social contacts	Number in 2 days			5.96	3.25
<i>Built environment characteristics</i>					
Type of residence	Apartment	89	25.9		
	House	255	74.1		
Length of residence	<2 years	36	10.5		
	2–20 years	187	54.4		
	>20 years	121	35.2		
Neighbourhood satisfaction	Very satisfied	123	35.8		
	Less satisfied	221	64.2		
Satisfaction with facilities	(Very) satisfied	232	67.4		
	Less satisfied	112	32.6		
Urban density	>1500 addresses per km ²	72	20.9		
	1000–1500 addresses per km ²	107	31.1		
	500–1000 addresses per km ²	77	22.5		
	<500 addresses per km ²	88	25.6		
Accessibility	Distance to daily shop (km)			0.85	0.41
	Distance to public green (km)			0.62	0.31
	Distance to highway (km)			1.12	0.42
<i>Mobility characteristics</i>					
Uses bicycle	Yes	292	84.9		
	No	52	15.1		
Uses car	Yes	302	87.8		
	No	42	12.2		
Uses public transport	Yes	160	46.5		
	No	184	53.5		

residential location and mobility characteristics. As the dependent variable is measured at an ordinal scale, we use ordered logistic regression. We estimate four models. The first one only includes age as an explanatory variable. In model 2 the other personal and household characteristics are added. In model 3 the characteristics

Table 2
Distribution of loneliness.

Loneliness	N	%	Loneliness (merged)	N	%
1 Fully agree	7	2.0			
2 Agree	10	2.9	1 Agree	17	4.9
3 Neutral	60	17.4	2 Neutral	60	17.4
4 Disagree	104	30.2	3 Disagree	104	30.2
5 Fully disagree	163	47.4	4 Fully disagree	163	47.4

of the built environment are added and in the final model the mobility characteristics are added.

The results of the models can be seen in Table 3. As the dependent variable was coded in a way that a higher score means that one is less lonely, negative coefficients in Table 3 suggest that the variable has an increasing effect on loneliness, and positive coefficients suggest that the variable decreases loneliness. The first model, containing only age as an explanatory variable has a Cox and Snell R^2 of 0.021, the Nagelkerke R^2 is 0.023, and the McFadden R^2 is equal to 0.009. This indicates that the fit of the model is poor and only a small improvement over the null model. The coefficients for the age categories are all negative, with the largest value for the oldest cohort. This indicates that older people are more likely to feel lonely compared to their younger counterparts.

In the second model, other personal and household characteristics are added. This model is a substantial improvement over the first model, with a Cox and Snell R^2 of 0.226, a Nagelkerke R^2 of 0.250, and a McFadden R^2 of 0.109. Income is not included in the models as it is strongly correlated with education. As can be seen in Table 3, the coefficients for the age groups change considerably. In this model we find the largest negative coefficient for the age group 35–64. This is probably due to correlations between age and other variables. Older people are likely not to work, to have a lower level of health, to be lower educated and to volunteer. Our results suggest that age-related differences in loneliness are thus partially attributable to these other personal and household characteristics. In addition, we find that having children in the household has a positive effect. However, the results show a large negative effect of having children for the youngest age group. This indicates that especially people under 35 who have children tend to feel lonelier. This is probably the group who only recently entered parenthood and is experiencing a decrease in (time for) social activities. In line with expectations we find that lower educated people are more likely to feel lonely or socially isolated. In addition, the results indicate that people who participate in volunteer work are less lonely. This might be explained by the fact that volunteering activities usually involve presence of other people. This finding is in line with previous research (e.g., Hughes et al., 2004). We find a strong positive effect of a good perceived health, which is in line with earlier studies (e.g., Scharf and De Jong Gierveld, 2008; De Jong-Gierveld and Van Tilburg, 2010; Delmelle et al., 2013; Weijs-Perrée et al., 2015). The number of social interactions recorded in 2 days has a small positive effect, suggesting that the number of social interactions contributes in reducing feelings of loneliness. No effects are found for gender or work status.

The third model shows again a substantial improvement over the previous model. It has a Cox and Snell R^2 of 0.395, the Nagelkerke R^2 is 0.437, and the McFadden R^2 is 0.218, indicating a good model fit. In addition to the significant personal and household characteristics in model 2, the results of model 3 show a significant positive coefficient for single person households. This result is surprising as one would expect people living with a partner to feel less lonely, which was found in other studies (e.g., Scharf and De Jong Gierveld, 2008; De Jong-Gierveld and Van Tilburg, 2010). Moreover, the results show larger coefficients for the age categories, with again the largest negative effect for people aged 35–64.

Table 3
Results for ordered logit model of loneliness ($N = 344$).

	Model 1	Model 2	Model 3	Model 4
Threshold 1	-3.57***	-2.95***	-3.51***	-1.82
Threshold 2	-1.75***	-1.10**	-1.39	0.35
Threshold 3	-0.38*	0.53	0.60	2.39*
Age 35–64	-0.52*	-1.52***	-2.57***	-1.08
Age 65–75	-0.57**	-0.97**	-1.92**	-0.42
Age >75	-0.80***	-0.56	-1.70	-0.18
Male		-0.14	0.03	-0.13
Single person		0.08	0.77**	0.69*
Children		1.45***	1.41***	1.56***
Children * age < 35		-2.26***	-3.13***	-3.33***
High education		0.14	0.24	0.07
Low education		-1.01***	-1.32***	-1.39***
Full time work		0.23	0.43	0.60
Volunteer		0.67***	0.55**	0.48*
Very good health		1.48***	1.47***	1.43***
Nr of contacts		0.11***	0.12***	0.08*
Lives in apartment			-2.20***	-2.17***
Apartment * 66–75			2.40***	2.37***
Apartment * >75			1.74**	1.80**
Residence < 2 years			0.23	0.11
Residence < 2 years * <35			2.07*	2.01*
Residence > 20 years			0.15	0.11
Residence > 20 years * >75			1.13*	1.27**
Perceived neighbourhood			1.34***	1.31***
Perceived facilities			1.21***	1.19***
Lives in high density			0.22	0.34
Lives in very low density			0.07	0.16
Distance to daily shop (km)			-0.11	-0.08
Distance to green (km)			0.03	0.08
Distance to highway (km)			-0.58*	-0.61*
Uses bicycle				-0.23
Uses bicycle * age <35				1.60*
Uses car				0.70*
Uses public transport				0.56**
Cox and Snell R^2 -Square	0.021	0.226	0.395	0.413
Nagelkerke R^2 -Square	0.023	0.250	0.437	0.458
McFadden R^2 -Square	0.009	0.109	0.218	0.228

* Significant at 0.10 level.

** Significant at 0.05 level.

*** Significant at 0.01 level.

With respect to the characteristics of the residential environment we find a negative coefficient of living in an apartment. This indicates that people living in an apartment tend to feel more lonely and isolated. This is in line with findings of [Delmelle et al. \(2013\)](#). However, the interaction effects show positive coefficients for the oldest two cohorts living in an apartment, which (largely) neutralise the effect. This means that living in an apartment only has a negative effect for the youngest age groups. This is counter-intuitive since one would expect a negative effect for older age groups as well, particularly for older adults who recently moved to an apartment. The explanation for this is unclear.

Regarding length of residence in the neighbourhood we find a positive effect of a short residence for the youngest age group, which is significant at the 10% level. For this age group a recent move is probably related to a positive life event such as moving out of the parental house to live independently or moving in with a partner. In addition, as expected, we find a positive effect of a long residence in a neighbourhood for the oldest age group.

The results indicate that people who are very satisfied with their neighbourhood tend to feel less lonely. This is also in line with expectations. A higher satisfaction with the neighbourhood might imply that people are better integrated in the neighbourhood and have more social contacts there. [Weijs-Perrée et al. \(2015\)](#) found that people with a stronger neighbourhood attachment are less lonely. Satisfaction with the facilities in the neighbourhood is also associated with a lower likelihood of feeling

lonely. However, the distance to shops and green facilities is not found to affect loneliness and social isolation. Also, urban density is not found to affect feelings of loneliness or social isolation either, whereas [Delmelle et al. \(2013\)](#) did find a significant relationship between urban density and social satisfaction, with a positive effect of a high density level. However, we find that, although only significant at the 10% level, distance to a highway access road has a negative effect. This might suggest that accessibility reduces feelings of loneliness.

Finally, the mobility characteristics are added to the analyses. The Cox and Snell R^2 of the final model is equal to 0.413, the Nagelkerke R^2 is 0.458, while the McFadden R^2 is equal to 0.228. This indicates a good model fit, however, it is only a small improvement over the third model. Specifically, adding the effects of transport mode use reduces the effects of age. The coefficients for the age groups become insignificant in this model. Differences among age cohorts in feeling lonely can thus partly be explained by differences in their mobility. Regarding the use of transport modes, we find a positive interaction effect of using a bicycle for the youngest age group, and positive main effects for using a car and also for using public transport. This is in line with our expectations as different transport modes increase the opportunities to interact with others at larger distances. It is also in line with [Weijs-Perrée et al. \(2015\)](#) who found a positive effect of car ownership, and [Delmelle et al. \(2013\)](#) who concluded that there are positive effects of car ownership and public transport accessibility on social satisfaction.

5. Conclusions and discussion

Social relations are important for people's quality of life. In addition to the more objective aspects (such as social network size and frequency of social interaction) it is important to study subjective aspects of social relations. This study therefore aimed at predicting the extent to which people feel lonely or socially isolated. Based on a survey among 344 respondents in Noord-Limburg in the Netherlands in 2014, four ordered logit models were estimated. Age, other personal and household characteristics, characteristics of the residential environment and mobility characteristics were used as explanatory variables.

The results of the first model, including only age, showed that older people are likely to feel lonelier. However, age explains only a small portion of variance in loneliness. Adding other personal and household characteristics increased the model fit considerably. It also changed the effect of age, showing the largest negative effect for the age category 35–64. Regarding the other personal and household characteristics, the results indicated that households in the age category of 35–64 with children are less lonely, whereas household younger than 35 years of age with children are more likely to be lonely. In line with other studies we found lower educated people to be lonelier and healthier people, people who volunteer and people who have more social interactions to be less lonely.

In addition to the personal and household characteristics, our results show that characteristics of the built environment play an important role in explaining loneliness. We found that younger people living in an apartment are more likely to be lonely. This may however also be a reflection of income, as high income households in the Netherlands are less likely to live in an apartment. For the youngest age group a recent move is related to a lower likelihood of being lonely, whereas we found a positive effect of a long residence for the oldest age group. The latter suggests that older adults profit from ageing-in-place, i.e. to remain living in the community, where they can maintain independence and connections to social relations and support (e.g., [Wiles et al., 2011](#)).

The urban density level of the residential area was, in contrast with other studies (e.g., [Delmelle et al., 2013](#)), not affecting feelings of loneliness or social isolation. We did however find that people who are more satisfied with their neighbourhood and the facilities in the neighbourhood tend to feel less lonely. These people probably feel more at home in their living environment and therefore experience less loneliness. Results also suggest that accessibility reduces feelings of loneliness. People living closer to a highway access road were found to be less lonely. These results suggest that feeling at home in the neighbourhood and accessibility are important for people's quality of life in all neighbourhoods, regardless of urban density. Urban planners and policy makers should take this into consideration.

Finally, our study looked into the impact of mobility characteristics on loneliness, whereas this impact has generally been overlooked in the existing literature. We found that the use of different transport modes (bicycle, car and public transport) significantly reduces loneliness and explains away the age effect. Transportation modes provide access to social relations outside the neighbourhood and may be essential to maintain one's social network. In addition, public transport provides a space where people are in close proximity and where social interactions can take place.

Overall, our study has shown that people's residential environment and access to social relations (enabled by mobility tools) play an important role in feelings of loneliness or social isolation. Although our study provides interesting outcomes for urban and transport planners and policy makers, it has some shortcomings. The first one is the way we measured loneliness. We used a single question, asking directly whether the respondents experienced loneliness. Because the term loneliness has negative connotations, this may have caused respondents not to admit to being lonely. For future research it might be better to use a multidimensional scale, which does not directly mention loneliness.

Second, the data collection took place between January and March 2014. The fact that the data were collected in wintertime, may have affected the outcomes. It is plausible that there are seasonal effects on feelings of loneliness and social behaviour. It would thus be better to collect data in all seasons.

Third, the objective measures of social relationships we used in this study were restricted to the number of out-of-home face-to-face social interactions with non-household members. To reduce respondent burden we only asked respondents to record the interactions that are most relevant with respect to transportation. However, this decision may have some impact on the results, since we omitted interactions that probably also affect feelings of loneliness, such as interactions within the household and ICT mediated social interactions. For future research it is therefore advisable to include these interactions.

Fourth, we found that the neighbourhood characteristics explain a considerable part of variance in loneliness. However, the most important variables are people's perception of the neighbourhood and its facilities. We should be cautious when interpreting the influence of neighbourhood perception on loneliness, because it is plausible that people who are generally more optimistic tend to score more positive on all self-rated aspects. Additional (objective) measures of urban form, and neighbourhood walkability and neighbourhood income could strengthen the analyses.

Finally, although we found the mobility characteristics to have a significant effect on loneliness, the explanatory power was rather modest. This is probably related to the fact that we measured the use of car, bicycle and public transport as binary variables, instead of asking about the frequency of transport mode use. More extensive measures of mobility will probably show stronger relationships with feelings of loneliness. Moreover, additional measures could be added, such as frequency of walking in the neighbourhood,

public transport level of service, and car availability. Our study suggests that including built environment and mobility characteristics in the study of subjective measures of quality of life is relevant, although further research is needed.

References

- Carrasco, J.A., 2011. Personal network maintenance, face to face interaction, and distance: studying the role of ICT availability and use. *Transp. Res. Rec.* 2231, 120–128.
- Carrasco, J.A., Miller, E.J., 2006. Exploring the propensity to perform social activities: a social networks approach. *Transportation* 33, 463–480.
- Carrasco, J.A., Miller, E.J., 2009. The social dimension in action: a multilevel, personal networks model of social activity frequency. *Transp. Res. Part A* 43, 90–104.
- Cattan, M., White, M., Bond, J., Learmouth, A., 2005. Preventing social isolation and loneliness among older people: a systematic review of health promotion interventions. *Ageing Soc.* 25, 41–67.
- De Jong-Gierveld, J., Kamphuis, F.H., 1985. The development of a Rasch-type loneliness-scale. *Appl. Psychol. Meas.* 9, 289–299.
- De Jong-Gierveld, J., Van Tilburg, T., 2010. The De Jong Gierveld short scales for emotional and social loneliness: tested on data from seven countries in the UN Generations and Gender Surveys. *Eur. J. Ageing* 7, 121–130.
- Delmelle, E.C., Haslauer, E., Prinz, T., 2013. Social satisfaction, commuting and neighborhoods. *J. Transp. Geogr.* 30, 110–116.
- Demakakos, P., Nunn, S., Nazroo, J., 2006. Loneliness, relative deprivation and life satisfaction. In: Banks, J., Breeze, E., Lessof, C., Nazroo, J. (Eds.), *Retirement, Health and Relationships of the Older Population in England: The 2004 English Longitudinal Study of Ageing*. Institute for Fiscal Studies, London.
- Du Toit, L., Cerin, E., Leslie, E., Owen, N., 2007. Does walking in the neighbourhood enhance local sociability? *Urban Stud.* 44, 1677–1695.
- Ettema, D., Gärling, T., Olsson, L.E., Friman, M., 2010. Out-of-home activities, daily travel, and subjective well-being. *Transp. Res. Part A* 44, 723–732.
- Farber, S., Pérez, A., 2009. My car, my friends, and me: an exploratory analysis of automobile and social activities. *J. Transp. Geogr.* 17, 216–225.
- Hanibuchi, T., Kondo, K., Nakayama, T., Shirai, K., Hirai, H., Kawachi, I., 2012. Does walkable mean sociable? Neighbourhood determinants of social capital among older adults in Japan. *Health Place* 18, 229–239.
- Hawkey, L.C., Hughes, M.E., Waite, L.J., Masi, C.M., Thisted, R.A., Cacioppo, J.T., 2008. From social structural factors to perceptions of relationship quality and loneliness: the Chicago health, aging, and social relations study. *J. Gerontol. Soc. Sci.* 63B, S375–S384.
- Helliwell, J.F., Putnam, R., 2004. The social context of well-being. *Philos. Trans. R. Soc. Lond. B* 359, 1435–1446.
- Hughes, M.E., Waite, L.J., Hawkey, L.C., Cacioppo, J.T., 2004. A short scale for measuring loneliness in large surveys: results from two population-based studies. *Res. Aging* 26, 655–672.
- Kemperman, A., Timmermans, H., 2014. Green spaces in the direct living environment and social contacts of the aging population. *Landscape Urban Plan.* 129, 44–54.
- Kemperman, A., Arentze, T., Timmermans, H., 2006. Social commitments and activity-travel scheduling decisions. In: *Proceedings of the 85th Annual Meeting of the Transportation Research Board*, Washington, DC.
- Kolodinsky, J.M., DeSisto, T.P., Proppen, D., Putnam, M.E., Roche, E., Sawyer, W.R., 2013. It is not how far you go, it is whether you can get there: modelling the effects of mobility on quality of life in rural New England. *J. Transp. Geogr.* 31, 113–133.
- Kowald, M., van den Berg, P., Frei, A., Carrasco, J.A., Arentze, T., Axhausen, K., Mok, D., Timmermans, H., Wellman, B., 2013. Distance patterns of personal networks in four countries: a comparative study. *J. Transp. Geogr.* 31, 236–248.
- Metz, D.H., 2000. Mobility of older people and their quality of life. *Transp. Policy* 7, 149–152.
- Oh, J., 2003. Assessing the social bonds of elderly neighbours: the roles of length of residence, crime victimization, and perceived disorder. *Sociol. Inq.* 73 (4), 490–510.
- Pérez, A., Scott, D., Potoglou, D., Kanaroglou, P., Newbold, K., 2006. A mixed ordered probit analysis of elderly trip generation in the Hamilton CMA. In: *11th International Conference on Travel Behaviour Research*, Kyoto.
- Perlman, D., Peplau, L.A., 1981. Toward a social psychology of loneliness. In: Gilmour, R., Duck, S. (Eds.), *Personal Relationships 3: Personal Relationships in Disorder*. Academic Press, London, pp. 31–43.
- Pino, L., González-Vélez, A.E., Prieto-Flores, M.E., Ayala, A., Fernandez-Mayoralas, G., Rojo-Perez, F., Martínez-Martín, P., Forjaz, M.J., 2014. Self-perceived health and quality of life by activity status in community-dwelling older adults. *Geriatr. Gerontol. Int.* 14, 464–473.
- Pinquart, M., Sörensen, S., 2001. Influences on loneliness in older adults: a meta-analysis. *Basic Appl. Soc. Psychol.* 23, 245–266.
- RIVM, 2013. Bijna veertig procent van de volwassen Nederlanders voelt zich eenzaam. Retrieved 21-10-2014 from: <http://www.rivm.nl/Documenten_en_publicaties/Algemeen_Actueel/Nieuwsberichten/2013/Bijna_veertig_procent_van_de_volwassen_Nederlanders_voelt_zich_eenzaam>.
- Russell, D.W., 1982. The measurement of loneliness. In: Peplau, L.A., Perlman, D. (Eds.), *Loneliness. A Sourcebook of Current Theory, Research and Therapy*. Wiley, New York, pp. 81–104.

- Russell, D., Peplau, L., Cutrona, C., 1980. The revised UCLA Loneliness Scale: concurrent and discriminant validity evidence. *J. Pers. Soc. Psychol.* 39, 472–480.
- Scharf, T., De Jong Gierveld, J., 2008. Loneliness in urban neighbourhoods: an Anglo-Dutch comparison. *Eur. J. Ageing* 5, 103–115.
- Schwanen, T., Wang, D., 2014. Well-being, context, and everyday activities in space and time. *Ann. Assoc. Am. Geogr.* 104, 833–851.
- Spinney, J., Scott, D., Newbold, K., 2009. Transport mobility benefits and quality of life: a time-use perspective of elderly Canadians. *Transp. Policy* 16, 1–11.
- Statistics Netherlands, 2014. Statline. Retrieved 29-10-2014 from: <<http://statline.cbs.nl/statweb/>>.
- Tacken, M., 1998. Mobility of the elderly in time and space in the Netherlands: an analysis of the Dutch national travel survey. *Transportation* 25, 379–393.
- Tang, F., Lee, Y., 2011. Social support networks and expectations for aging in place and moving. *Res. Aging* 33, 444–464.
- Van den Berg, P., Arentze, T., Timmermans, H., 2009. Size and composition of ego-centered social networks and their effect on travel distance and contact frequency. *Transp. Res. Rec.* 2135, 1–9.
- Van den Berg, P., Arentze, T., Timmermans, H., 2011. Estimating social travel demand of senior citizens in the Netherlands. *J. Transp. Geogr.* 19, 323–331.
- Van den Berg, P., Arentze, T., Timmermans, H., 2012. A multilevel path analysis of contact frequency between social network members. *J. Geogr. Syst.* 14, 125–141.
- Van Kamp, I., Leidelmeijer, K., Marsman, G., De Hollander, A., 2003. Urban environmental quality and human well-being. Towards a conceptual framework and demarcation of concepts; a literature study. *Landscape Urban Plan.* 65, 5–18.
- Weijs-Perrée, M., van den Berg, P., Arentze, T.A., Kemperman, A., 2015. Factors influencing social satisfaction and loneliness: a path analysis. *J. Transp. Geogr.* 45, 24–31.
- Wiles, J., Leibing, A., Guberman, N., Reeve, J., Allen, R., 2011. The meaning of “ageing in place” to older people. *Gerontology* 52, 357–366.
- Wood, L., Shannon, T., Bulsara, M., Pikora, T., McCormack, G., Giles-Corti, B., 2008. The anatomy of the safe and social suburb: an exploratory study of the built environment, social capital and residents’ perceptions of safety. *Health Place* 14, 15–31.