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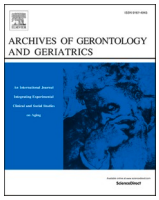

The longitudinal associations between proximity to local grocery shops and functional ability in the very old living with and without multimorbidity: Results from the Newcastle 85+ study

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ABSTRACT

Backgrounds: The very old, people aged ≥85, is a fast-growing age group with high risk of disability and dependence. To identify environmental factors that support maintenance of functional ability, the aim of this study is to investigate the longitudinal associations between proximity to local grocery shops and the ability to shop for groceries in the very old and to examine the potential variation between those living with and without multimorbidity.

Methods: This study was based on the Newcastle 85+ study, a population-based cohort of people aged 85 in North-East England. The numbers of grocery shops were identified within a 500 m road distance to participants' residence. Multilevel Poisson regression modelling was used to investigate whether proximity to local grocery shops was associated with the ability to do grocery shopping over five years in those with and without multimorbidity adjusting for sociodemographic factors and area deprivation.

Results: The very old who lived in more deprived areas were more likely to have a grocery shop within 500 m than those in less deprived areas. Proximity to local grocery shops was not associated with the ability to do grocery shopping in the participants who had none or one chronic condition (IRR: 1.00; 95% CI: 0.89, 1.12) but moderated loss of the ability in those living with multimorbidity (IRR: 0.82; 95% CI: 0.70, 0.96).

Conclusions: For the very old living with multimorbidity, proximity to local grocery shops may support their functional ability. Future research should investigate how to support older people with poor health to access local grocery shops.

1. Introduction

Population ageing is an important issue in many societies across the world (United Nations, 2019). The very old, people aged 85 or above, is a fast-growing group in the UK (Office for National Statistics, 2018). According to estimates from the Office for National Statistics, the numbers of the very old will increase from 1.6 million in 2018 to 3.6 million by 2050, which will be 5% of the general population (Office for National Statistics, 2019). This age group is likely to experience poor health, disability, and dependency (Jagger et al., 2016; Kingston et al., 2017) and has high needs for health and social care (Age UK, 2019; Age UK, 2013). Identifying key factors that support healthy ageing in this group is crucial to address the potential impact of population ageing on societies.

Healthy ageing is defined by the World Health Organization as 'the process of developing and maintaining the functional ability that enables wellbeing in older age' (World Health Organization, 2015). Functional ability, the ability to manage basic needs in daily life, can be influenced by interaction between intrinsic capacity, which combines all the individual's physical and mental health conditions, and environmental characteristics, which form the context of an individual's life (World Health Organization, 2020). In older age, people are likely to live with multiple chronic conditions and health problems, but a supportive environment can facilitate maintaining their functional ability and living independently. The indoor environment can be particularly important for the Basic Activities of Daily Living (BADL) items such as

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personal hygiene, dressing, and toileting (Katz et al., 1963) while the outdoor environment may support Instrumental Activities of Daily Living (IADL) (Lawton & Brody, 1969) such as shopping, managing money and transport.

To the best of our knowledge, most existing studies have examined the relationships between two of the three healthy ageing elements (functional ability, intrinsic capacity, and environment). For example, loss of functional ability has been widely used to assess the impact of chronic diseases on individuals (GBD 2019 Diseases and Injuries Collaborators, 2020). A large body of literature has also investigated the relationships between neighborhood environments and specific health conditions in older people, such as physical activity, obesity, cardiovascular diseases, depression, and dementia (Annear et al., 2014). Few studies have incorporated all three elements and investigated their complicated interaction (Lu et al., 2021) and fewer still have focused on the very old, who are likely to live with complex multimorbidity and spend more time in their local areas than younger age groups (Local Government Association, 2015). It is essential to incorporate data on the three elements and identify their longitudinal associations in population-based studies. In doing so, factors can be identified that are facilitators and barriers to older people maintaining independence in the community.

Based on a longitudinal cohort in North-East England, the aim of this study is to investigate whether proximity to local grocery shops can support the very old to maintain their functional ability, focusing on the ability to manage their own grocery shopping. Being able to shop for food is one of the key indicators for functional ability (Lawton & Brody, 1969) and can be essential to support balanced diets, health and well-being in older age (Age UK, 2021). Grocery shopping is a complex daily life task involving lower and upper body strength (e.g., mobility, balance, carrying groceries) and cognitive function (e.g., orientation, numerical ability) (Kingston et al., 2012). The presence of grocery shops in local areas may increase walkability in the neighbourhood environment and encourage older people to leave their homes and walk to shops (Barnett et al., 2017). For those who reach very old age and live with health problems, local grocery shops might reduce barriers to accessibility such as long distance, lack of public transport, and difficulties of carrying purchases (Gajda & Jeżewska-Zychowicz, 2020; Huang et al., 2012) and maintain their ability to manage grocery shopping in daily life. The analysis further examines whether proximity to local grocery shops can be particularly important to those living with multimorbidity.

2. Methods

2.1. Study population

This study was based on the Newcastle 85+ study, a population-based cohort of 852 people aged 85 in Newcastle upon Tyne and North Tyneside, UK (Collerton et al., 2007, 2009). The aim of the study is to advance understanding of the biological nature of ageing and investigate health trajectories and outcomes in the oldest old as well as biological, medical, and social factors that contribute to the maintenance of health and independence. The study was established in 2006−2007 and included four follow-up waves at 18, 36, 60, and 120 months. More detailed information on study design is reported elsewhere (https://research.ncl.ac.uk/85plus/). In brief, a list of all people born in 1921 was obtained from 64 general practices in the study area and a letter was sent to invite the potential participants. Among the 1459 eligible participants, 1042 consented to take part in the study, including 852 who agreed to a detailed health assessment. The assessment was carried out in the participants' residences by a research nurse. A written consent was obtained from all participants. The Newcastle 85+ study was approved by the Newcastle and North Tyneside 1 research ethics committee (Ref: 06/Q0905/2).

The analysis here excluded 88 participants who lived in care homes at baseline as they did not have to do their own grocery shopping. Participants who had invalid postcodes ($N = 7$) and missing data on functional ability across all four waves ($N = 1$) were also removed. Since participants who moved home during the study period might have different access to local grocery shops over time, this study focused on 594 participants who lived in the same postcodes over the five-year follow-up period (up to Wave 4) and excluded those who had changing postcodes over time ($N = 162$).

2.2. Functional ability

BADL (Katz et al., 1963) and IADL (Lawton & Brody, 1969) were used to measure functional ability in the Newcastle 85+ study. Since environmental factors in local areas might not have a direct impact on supporting activities at home such as personal hygiene, dressing, and preparing hot meals, this study focused on the ability to do grocery shopping, which is directly related to proximity to local shops. The ability was measured using a self-reported question: 'Are you able to do your shopping for groceries?'. Participants were asked to choose from four options: I have no difficulty doing this by myself; I have some difficulty doing this by myself; I can only do this by myself if I use an aid or appliance; I am unable to do this by myself, I need someone else's help. Based on previous work (Kingston et al., 2012; Jagger et al., 2011), these four options were combined into a binary variable (no difficulty vs any level of difficulty) as this cut-off implies dependency on others.

2.3. Local grocery shops

Postcode information of the Newcastle 85+ participants was geocoded into UK Grid References. For all participants, the Ordnance Survey (OS) MasterMap Integrated Transport Network datasets (version 01/2007) (Ordnance Survey, 2010) were used to establish the road network and generate 500 m buffers along road distances. Motorways, A roads with dual carriageway structure and their slip roads were set to be restricted as people cannot walk on these roads. According to the literature, people in their mid-70s may need at least 10 min to walk 500 m (Burton & Mitchell, 2006). Given the old age of the participants, the choice of focusing on the 500 m area around participants' residences was assumed that older people could walk to their local groceries shops and bring back their shopping.

The locations of grocery shops were identified using the OS Addressbase Premium database (Ordnance Survey, 2021). Grocery shops included supermarkets (chain companies) and independent food stores (convenience stores, shops for fruit and vegetable, meat, and seafood). Entry and end dates for the Building Land Property Unit were used to determine whether shops existed at a specific time point. For baseline of the Newcastle 85+ study (2006−2007), an active property needed to have an entry date before 2006 and end date after 2006 (i.e., the shop was active in 2006). The numbers of grocery shops within the 500 m buffers were calculated and categorised into a binary variable (yes/no). All processes were carried out in ArcGIS 10.6.1 (Environmental Systems Research Institute, 2018).

2.4. Covariates

Sociodemographic factors including sex, education and social class were collected in the baseline interviews. Years of education were divided into two groups ($\leq$ 9 years; $\geq$ 10 years) based on compulsory education for this cohort. Social class was measured based on the National Statistics Socio-economic Classification and categorized into three levels: managerial and professional; intermediate; routine and manual occupations. In the baseline interviews, the participants were asked if they had any longstanding physical and mental illnesses. For those who answered yes, the interviewers recorded all the participants' illnesses in free text and calculate the total number. The total number of self-reported chronic conditions was categorized into two groups: those living with <2 condition and those with ≥ 2 conditions

(multimorbidity).

Area deprivation was measured using Indices of Multiple Deprivation 2007 (IMD 2007) (Office for National Statistics, 2007), which is comprised of several characteristics related to socioeconomic disadvantage of people and place at the Lower Layer Super Output Area level. IMD 2007 was used here as it corresponded to the study baseline. Based on all area units in England, the deprivation scores were divided into quintiles given the small sample size of this study. The most deprived quintile (Q1) indicated highly deprived areas in England. Since 95% of the participants lived in urban areas, the analysis did not adjust for urban/rural settings.

2.5. Statistical analysis

Descriptive analysis was carried out to investigate the distributions of individual and environmental measures. Since the percentage of people who had difficulties in grocery shopping was generally higher than those with no difficulties, the reference group was those who could not do their own grocery shopping. Given that being able to do grocery shopping was not a rare event (>10%), logistic regression modeling was not appropriate as the effect sizes could be overestimated. Multilevel Poisson regression modeling was used to investigate whether the presence of grocery shops within 500 m was associated with the ability to do grocery shopping at baseline and the probability of maintain the ability over five years accounting for individual repeated measures. Four waves were parameterized by years of follow-up (0, 1.5, 3, and 5 years) and a linear term of follow-up years was fitted to estimate the slope (changes in the ability over five years). Intercept variance was estimated to allow baseline variation across individuals. Additional models were tested to further include a squared term of follow-up years and allow estimation of slope variance. Since these estimated coefficients were small, this analysis focused on the linear relationship with intercept variance.

The proximity to grocery shops variable was included in the models to estimate its effect on the ability at baseline. The interaction terms between proximity to grocery shops and years of follow-up were also fitted to estimate its effect on the slope. Sex, education, and social class were adjusted for in the modeling. Age was not included as there was nearly no variation among the study population (range 84−86 years old). Deprivation quintiles were also included in the models and used to adjust for unmeasured environmental factors (such as noise, crime, and busy traffic) related to proximity to grocery shops. To investigate whether proximity to grocery shops was particularly important to support those living with multimorbidity, interaction terms between multimorbidity, local grocery shops and years of follow-up were fitted in the unadjusted and adjusted models. A Wald test was used to examine whether the interaction terms achieved statistical significance.

To address missing data and drop-out over time, multiple imputation was employed based on the missing-at-random assumption, and the stratified imputation by the grocery shops variable was used to incorporate the interaction terms (Tilling et al., 2016). The imputation was used to reduce the impact of missingness on statistical power and inform the results if data on all the participants could have been collected over the five-year study period. Forty imputed datasets were generated and estimates from the imputed datasets were combined using Rubin's Rule (Rubin, 1996). Since the numbers of grocery shops might change over time, a sensitivity analysis was carried out to include local grocery shops as a time-dependent variable. Additional sensitivity analyses were carried out to examine whether the results of the final model (i.e., the adjusted model with interaction terms for multimorbidity) were robust to modification of outcome and exposure variables. The binary outcomes of no IADL disability and mild IADL disability (<2 items) were generated based on the six items: being able to do light housework, heavy housework, grocery shopping, to prepare hot meals, to take medication, and to manage money. The analyses also tested local grocery shops within 250 m as an exposure variable. All analyses were conducted using Stata 17.0 (StataCorp, 2021).

3. Results

Table 1 shows descriptive information on the participants who lived in community settings at baseline. Among the 594 participants living in the same postcodes over five years, 58% were women. Most had ≤9 years of education (68 %) and had been employed in a manual occupation (50%). About half (52%) reported two or more chronic conditions. One third of the study population lived the most deprived quintile in England. People who moved over the follow-up period ($N = 162$) generally had similar sociodemographic characteristics to those who did not move.

The numbers of participants reduced from 594 at the baseline to 448 (75.4%) at the 18-month follow-up, 352 (59.3%) at the 36-month follow-up and 262 (44.1%) at the 60-month follow-up. At the baseline, 308 participants had no difficulties in doing their grocery shopping (Fig. 1). The percentage of people who had no difficulties in shopping groceries decreased from baseline (51.9%) to the follow-up wave at 60 months (27.9%). Most participants did not have supermarkets (77%) or food stores (64%) within 500 m of their residences. About 47% of the oldest old (46.6%) had one or more grocery shops within 500 m and the percentage decreased from the most (54.5%) to least deprived areas (26.9%) (Fig. 2). Compared to the decreasing pattern across deprivation levels, variation across individual socioeconomic status was less clear.

Proximity to grocery shops was not associated with the ability to do grocery shopping at baseline (IRR: 0.92; 95% CI: 0.72, 1.18) and maintaining that ability over time (IRR: 1.06; 95% CI: 0.96, 1.17) (Table 2). The associations remained similar after adjusting for both sociodemographic factors and deprivation quintiles. Both supermarkets and food stores had small effects in the overall study population.

Fig. 3 shows the estimated trajectories of the ability to do grocery shopping stratified by participants living with and without multimorbidity. For those who had no or one chronic condition, proximity to grocery shops was not related to the ability at baseline (IRR: 0.95; 95% CI: 0.72, 1.27) and decline rate over the follow-up period (IRR: 1.00; 95% CI: 0.89, 1.12). For those living with multimorbidity, participants who did not have a local grocery shop were less likely to maintain the

Table 1
Descriptive information about the study population.

	Move within five years	
	No	Yes
N	594	162
Sex		
Women	346 (58.3)	109 (67.3)
Men	248 (41.7)	53 (32.7)
Education		
9 years or fewer	407 (68.5)	94 (58.0)
10 years or above	182 (30.6)	68 (42.0)
Missing	5 (0.8)	0 (0.0)
Social class		
Managerial	195 (32.8)	59 (36.4)
Intermediate	79 (13.3)	21 (13.0)
Manual	300 (50.5)	69 (42.6)
Missing	20 (3.4)	13 (8.0)
Number of chronic conditions		
0-1	283 (47.6)	86 (53.1)
2+	310 (52.2)	75 (46.3)
Missing	1 (0.2)	1 (0.6)
Deprivation		
Q1	198 (33.3)	55 (34.0)
Q2	128 (21.6)	30 (18.5)
Q3	78 (13.1)	24 (14.8)
Q4	97 (16.3)	25 (15.4)
Q5	93 (15.7)	28 (17.3)
Supermarket within 500m		
No	457 (76.9)	130 (80.3)
Yes	137 (23.1)	32 (19.8)
Food store within 500m		
No	382 (64.3)	102 (63.0)
Yes	212 (35.7)	60 (37.0)

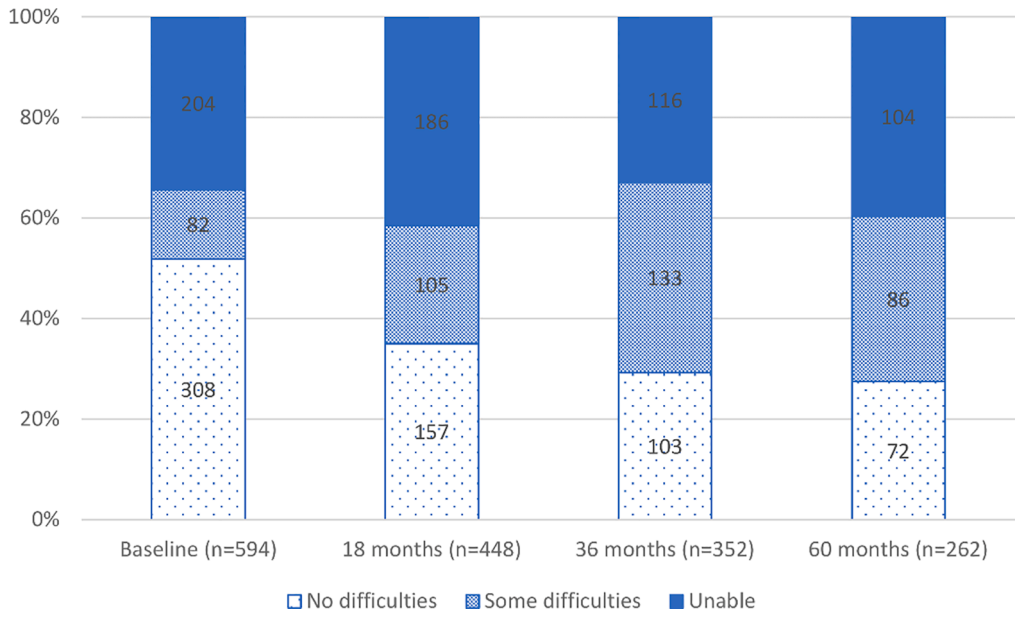

Fig. 1. Percentages of the participants who had no difficulties, some difficulties or were unable to do shopping for groceries.

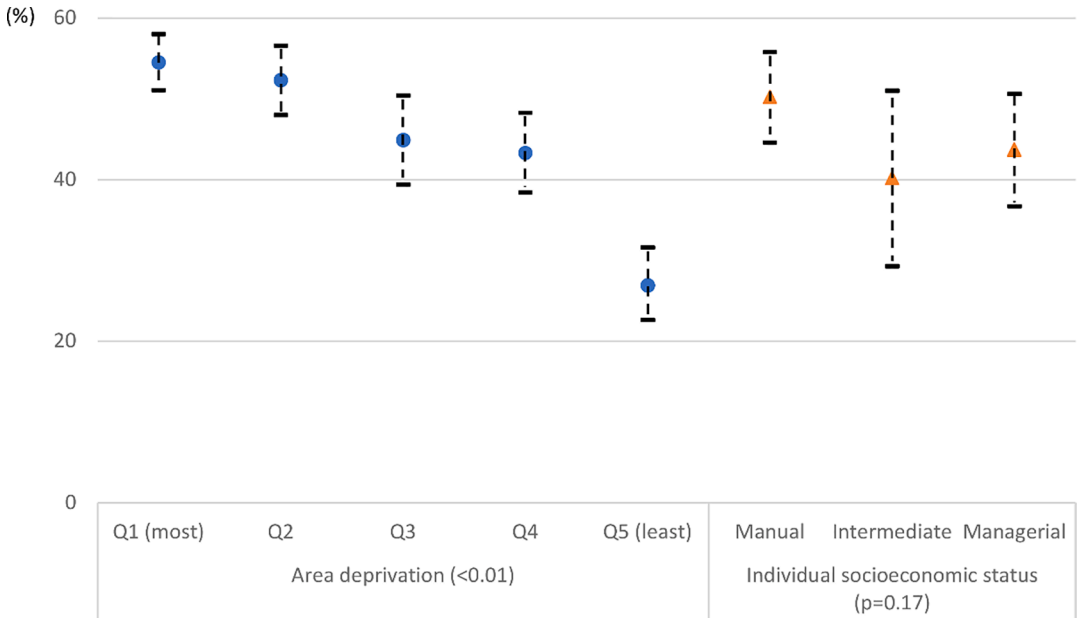

Fig. 2. Percentages of the participants who had at least one grocery shop within 500 m by deprivation levels and individual socioeconomic status (%).

ability over five years (IRR: 0.82; 95% CI: 0.70, 0.96), while those who had local grocery shops showed similar decline rate to their counterparts without multimorbidity (IRR: 1.02; 95% CI: 0.89, 1.17). More detailed information is provided in Table S1, Supporting Information.

For most of the participants (95%), proximity to local grocery shops did not change across the follow-up waves. The sensitivity analysis including local grocery shops as a time-dependent variable showed similar results to the main analysis (Table S2, Supporting Information). The results of no and mild IADL disability are reported in Table S3, Supporting Information, and the results of proximity to local grocery shops within 250 m ($N = 76$, 13%) are provided in Table S4, Supporting Information. All sensitivity analyses showed similar results that proximity to local shops were more important in the very old living with multimorbidity than those without.

4. Discussion

Using a longitudinal study of the very old in North-East England, this study integrated geospatial data on supermarkets and food stores and investigated whether proximity to local grocery shops facilitated maintaining the ability to do grocery shopping over a five-year period. The very old who lived in more deprived areas were more likely to have a grocery shop within 500 m than those in less deprived areas. Proximity to local grocery shops had limited impacts on those who were relatively healthy (0-1 chronic condition), but moderated loss of the ability over time in those living with multimorbidity.

4.1. Strengths and limitations

The longitudinal data from the Newcastle 85+ study provided

Table 2
The associations between proximity to local grocery shops and the ability to shop for groceries in the very old.

	Model 1 IRR (95% CI)	Model 2 IRR (95% CI)	Model 3 IRR (95% CI)	Model 4 IRR (95% CI)
Grocery shops				
Baseline (Any vs None)	1.02 (0.83, 1.26)	1.15 (0.94, 1.41)	0.92 (0.72, 1.18)	1.04 (0.82, 1.32)
Slope (Any vs None)			1.06 (0.96, 1.17)	1.06 (0.96, 1.17)
Supermarkets				
Baseline (Any vs None)	1.11 (0.88, 1.42)	1.19 (0.95, 1.49)	1.03 (0.77, 1.37)	1.09 (0.83, 1.44)
Slope (Any vs None)			1.05 (0.94, 1.17)	1.05 (0.94, 1.17)
Food shops				
Baseline (Any vs None)	0.98 (0.80, 1.21)	1.09 (0.89, 1.23)	0.90 (0.70, 1.16)	0.99 (0.78, 1.27)
Slope (Any vs None)			1.05 (0.95, 1.16)	1.05 (0.95, 1.16)

Models 1 and 3: Unadjusted; Models 2 and 4: Adjusted for sex, education, social class and deprivation quintiles.

valuable information on health and functional ability in very old age. Local grocery shops were identified based on road distances and matched to years of investigation. The integration of epidemiological and geographic data allowed incorporation of all three healthy ageing elements and investigation of their interactions over time.

There were some limitations in this study. The study population was recruited in the Newcastle city and North Tyneside areas. The results might not be generalisable to the very old living in different regions and countries. Proximity to local grocery shops could be particularly important for rural residents but it was not possible to investigate urban/rural difference in this study. Some people may travel to shops outside of their local areas via public transport or private cars but 80% of the participants did not drive at baseline. Therefore, driving was unlikely to be a key travel mode to access local shops in this study population. Family and friends might help older people to shop or deliver their groceries and therefore proximity to local grocery shops might be less relevant to their ability. Other environmental factors (safety, traffic, stairs, the quality of pavement, age-friendliness of local shops) and individual factors (poverty, socioeconomic disadvantage) might affect use of local shops. However, adjustment for deprivation quintiles may account for some unmeasured environmental and socioeconomic factors. This study focused on proximity to local grocery shops at baseline and did not investigate the potential changes over time (newly open or shut down). Only a small percentage of the participants (<5%) had changes in proximity to local grocery shops over the follow-up period and this had minimal impact on the results. Multiple imputation was used to address all types of drop out over time and did not fully consider the missing-not-at-random scenarios due to death or decline in health. These scenarios could be investigated using joint modelling of longitudinal and time-to-event data. However, it was difficult to build these complex models and further incorporate interaction terms and other variables.

4.2. *Interpretation of results*

This study did not find an association between proximity to local shops and the ability to manage grocery shopping in the very old. The literature on food environment, which describes physical, economic, and sociocultural conditions that influence food choices and nutritional status of individuals (Rueter et al., 2020), has recognized proximity to local shops as a key factor affecting physical access to food destinations (e.g., grocery shops, restaurants) (Huang et al., 2012) and other psychological and behavioral aspects such as food insecurity (Gajda & Jeżewska-Zychowicz, 2020), shopping (Rueter et al., 2020) and dietary habits in older people (Pinho et al., 2021; Iizaka et al., 2020). These outcome measures are relevant to the ability to do grocery shopping but their associations with the proximity seemed to be different. In addition to variation in the outcome measures, the difference could be attributed to characteristics of the study population (the young-old vs very old) and

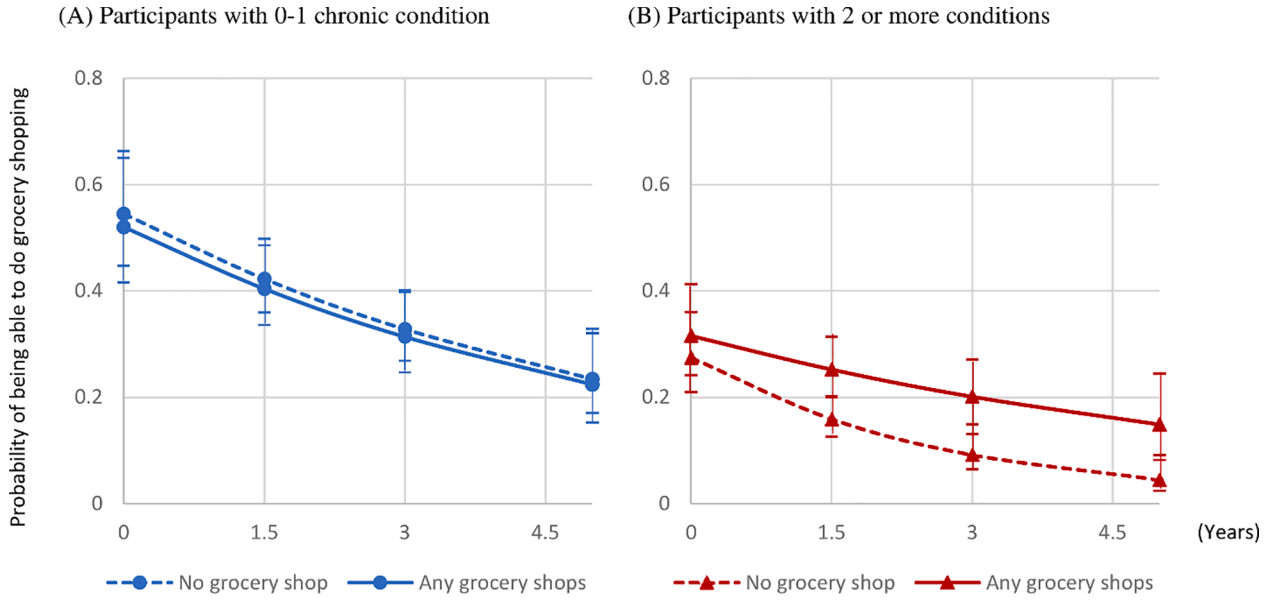

Fig. 3. Estimated probability of being able to do grocery shopping over five years in the very old with and without multimorbidity (adjusted for sex, education, socioeconomic status and deprivation).

wider context of the environment. The Newcastle 85+ study area was generally in highly urbanised settings, which typically provided good access to public transport and infrastructure for pedestrians. Proximity to local grocery shops did not vary across individual socioeconomic status and was higher in more deprived areas. Spatial inequalities of accessing local shops and services in this study population appear to be different from studies in other regions (Hilmers et al., 2012). The perception of walking distance and other environmental conditions altogether may influence how older people use local grocery shops (Chrisinger et al., 2019).

Proximity to local grocery shops was, however, found to support the very old living with multimorbidity and their ability to do grocery shopping. A mixed-method study based on the Built Environment, Accessibility, and Mobility Study in the US investigated 35 older adults who had mobility aids (e.g., canes, walking frames, wheelchairs) and collected in-depth information on their access to grocery shops and other food destinations (restaurants, café, markets) using global positioning system devices and interview data (Huang et al., 2012). The results showed that 86% of participants had visited grocery shops in the past three days, with walking the most common mode of transport. The participants reported that location and proximity were key factors that affected their ability to access these places. In addition to the indoor environment, factors outside of the house can also be particularly important to support older people living with poor health to manage key daily life activities (World Health Organization, 2015, 2020).

4.3. Public health implications and future research directions

According to Age UK, the percentage of older people who have difficulties in grocery shopping is estimated to increase from 20% for ages 80−84 to over 60% by age 90 (Age UK, 2021). The current study captured transitions from age 85 to 90 and suggested that proximity to local grocery shops play an important role in the very old living with multimorbidity. Although home delivery and online shopping services may be alternatives, visiting local shops in person could provide opportunities for physical activity and social interaction (Rueter et al., 2020). To develop possible interventions, future research should investigate how to support older people with poor health to overcome barriers to access local grocery shops. Qualitative research is required to provide a better understanding of their concerns and specific needs and multi-region studies are needed to include older people living in diverse settings.

This study also highlights the complicated interactions between the three healthy ageing elements (World Health Organization, 2015, 2020). Integration of geospatial data into longitudinal cohort studies of older people is a valuable approach to utilising existing data resources and incorporating measures for health conditions, functional ability, and environmental factors in a single study. This interdisciplinary research will provide empirical evidence informing how to adapt the environment and support healthy ageing in the general older populations as well as vulnerable groups.

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CRediT authorship contribution statement

Yu-Tzu Wu: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft, Writing – review & editing. **Andrew Kingston:** Writing – review & editing. **Victoria Houlden:** Writing – review & editing. **Rachel Franklin:** Writing – review & editing.

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Data Availability

Newcastle 85+ Study data may be obtained by agreement from the Data Guardians Group. Full guidance is available on the Newcastle 85+ Study website which can be accessed at https://research.ncl.ac.uk/85plus/.

Supplementary Materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.archger.2022.104703.

References

Age UK. (2019). *Briefing: Health and care of older people in England*. London: Age UK, 2019 https://www.ageuk.org.uk/globalassets/age-uk/documents/reports-and-publications/reports-and-briefings/health–wellbeing/age_uk_briefing_state_of_health_and_care_of_older_people_july2019.pdf (accessed 11/Feb/2022).

Age UK. (2013). Improving later life. *Understanding the oldest old*. London: Age UK.

Age UK. (2021). *Help with shopping*. Age UK. https://www.ageuk.org.uk/services/in-your-area/shopping/ (accessed 11/Feb/2022).

Annear, M., Keeling, S., Wilkinson, T., Cushman, G., Gidlow, B., & Hopkins, H. (2014). Environmental influences on healthy and active ageing: A systematic review. *Ageing and Society, 34*(4), 590–622.

Barnett, D. W., Barnett, A., Nathan, A., Van Cauwenberg, J., & Cerin, E. (2017). Council on environment and physical activity (CEPA) – Older adults working group. Built environmental correlates of older adults' total physical activity and walking: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 14*(1), 103.

Burton, E., & Mitchell, L. (2006). *Inclusive urban design: Streets for life*. Oxford: Architectural Press.

Chrisinger, B. W., King, A. C., & Hua, J. (2019). How well do seniors estimate distance to food? The accuracy of older adults' reported proximity to local grocery stores. *Geriatrics, 4*(1), 11 (Basel).

Collerton, J., Barrass, K., & Bond, J. (2007). The Newcastle 85+ study: Biological, clinical and psychosocial factors associated with healthy ageing: Study protocol. *BMC Geriatrics, 7*, 14.

Collerton, J., Davies, K., & Jagger, C. (2009). Health and disease in 85 year olds: Baseline findings from the Newcastle 85+ cohort study. *BMJ, 339*, b4904.

Environmental Systems Research Institute. (2018). *ArcGIS desktop: Release 10.6.1*. Redlands, CA: Environmental Systems Research Institute.

Gajda, R., & Jeżewska-Zychowicz, M. (2020). Elderly perception of distance to the grocery store as a reason for feeling food insecurity-can food policy limit this? *Nutrients, 12*(10), 3191.

GBD 2019 Diseases and Injuries Collaborators. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: A systematic analysis for the global burden of disease study 2019. *Lancet, 396*(10258), 1204–1222.

Hilmers, A., Hilmers, D. C., & Dave, J. (2012). Neighborhood disparities in access to healthy foods and their effects on environmental justice. *American Journal of Public Health, 102*(9), 1644–1654.

Huang, D. L., Rosenberg, D. E., Simonovich, S. D., & Belza, B. (2012). Food access patterns and barriers among midlife and older adults with mobility disabilities. *Journal of Aging Research, 2012*, Article 231489.

Iizaka, S., Koitabashi, E., Negishi, T., Kawamura, A., & Iizuka, Y. (2020). Distance from the nearest grocery stores and frequency of store-specific shopping are associated with dietary intake frequency among the community-dwelling independent elderly population. *Nutrition and Health, 26*(3), 197–207.

Jagger, C., Matthews, F. E., & Wohland, P. (2016). A comparison of health expectancies over two decades in England: Results of the cognitive function and ageing study I and II. *Lancet, 387*(10020), 779–786.

Jagger, C., Collerton, J. C., & Davies, K. (2011). Capability and dependency in the Newcastle 85+ cohort study. Projections of future care needs. *BMC Geriatrics, 11*, 21.

Katz, S., Ford, A., Moskowitz, R., Jackson, B., & Jaffe, M. (1963). Studies of illness in the aged: The index of ADL, a standardised measure of biological and psychosocial function. *JAMA, 185*(12), 914–919.

Kingston, A., Wohland, P., & Wittenberg, R. (2017). Is late-life dependency increasing or not? A comparison of the cognitive function and ageing studies (CFAS). *Lancet, 390* (10103), 1676–1684.

Kingston, A., Collerton, J., Davies, K., Bond, J., Robinson, L., & Jagger, C. (2012). Losing the ability in activities of daily living in the oldest old: A hierarchic disability scale from the Newcastle 85+ study. *PLoS One, 7*(2), e31665.

Lawton, M., & Brody, E. (1969). Assessment of older people: Self maintaining and instrumental activities of daily living. *Gerontologist, 9*, 179–186.

Local Government Association. (2015). *Ageing: The silver lining. The opportunities and challenges of an ageing society for local government*. London: Local Government Association. https://www.local.gov.uk/sites/default/files/documents/ageing-silver-lining-oppo-1cd.pdf.

Lu, S., Liu, Y., & Guo, Y. (2021). Neighbourhood physical environment, intrinsic capacity, and 4-year late-life functional ability trajectories of low-income Chinese older population: A longitudinal study with the parallel process of latent growth curve modelling. *EClinicalMedicine, 36*, Article 100927.

Office for National Statistics. (2018). *Living longer: How our population is changing and why it matters*. Office for National Statistics. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerhowourpopulationischangingandwhyitmatters/2018-08-13 (accessed 11/Feb/2022).

Office for National Statistics. (2019). *Living longer: Is age 70 the new age 65?* Office for National Statistics. https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerisage70thenewage65/2019-11-19 (accessed 11/Feb/2022).

Ordnance Survey. (2010). *OS mastermap integrated transport network layer: User guide and technical specification*. Southampton: Ordnance Survey. https://digimap.edina.ac.uk/webhelp/os/data_files/os_manuals/itn_user_guide_v1_0.pdf (accessed 11/Feb/2022).

Ordnance Survey. (2021). *OS addressbase premium – Technical specification*. Southampton: Ordnance Survey. https://www.ordnancesurvey.co.uk/documents/product-support/tech-spec/addressbase-premium-technical-specification.pdf (accessed 11/Feb/2022).

Office for National Statistics. Index of multiple deprivation (IMD) 2007. The National Archives. https://webarchive.nationalarchives.gov.uk/ukgwa/20100411141238/http://www.communities.gov.uk/communities/neighbourhoodrenewal/deprivation/deprivation07/ (accessed 11/Feb/2022).

Pinho, M. G. M., Lakerveld, J., & Harbers, M. C. (2021). Ultra-processed food consumption patterns among older adults in the Netherlands and the role of the food environment. *European Journal of Nutrition, 60*(5), 2567–2580.

Rubin, D. B. (1996). Multiple imputation after 18+ years (with discussion). *Journal of the American Statistical Association, 91*(434), 473–489.

Rueter, J., Brandstetter, S., Curbach, J., Lindacher, V., Warrelmann, B., & Loss, J. (2020). How older citizens in Germany perceive and handle their food environment-a qualitative exploratory study. *International Journal of Environmental Research and Public Health, 17*(19), 6940.

StataCorp. (2021). *Stata statistical software: Release 17*. College Station, TX: StataCorp LLC.

Tilling, K., Williamson, E. J., Spratt, M., Sterne, J. A., & Carpenter, J. R. (2016). Appropriate inclusion of interactions was needed to avoid bias in multiple imputation. *Journal of Clinical Epidemiology, 80*, 107–115.

United Nations. (2019). *The world population prospects 2019: Highlights*. New York: United Nations.

World Health Organization. (2015). *World report on ageing and health*. Geneva: World Health Organization.

World Health Organization. (2020). *Decade of healthy ageing: Baseline report*. Geneva: World Health Organization.