Demographic, socioeconomic, and social barriers to use of mobility assistive products: a multistate analysis of the English Longitudinal Study of Ageing

Jamie Danemayer, Mikaela Bloomberg, Adam Mills, Cathy Holloway, Shereen Hussein

Summary

Background Cross-sectional evidence suggests that access to essential mobility assistive products (MAPs) might be dependent on non-clinical factors. However, MAP use is better understood as a dynamic process wherein individuals pass through different states of MAP need and use. We aimed to test associations of demographic, socioeconomic, and social factors with transitions between MAP need and use states.

Methods For this multistate modelling study, data were drawn from 13 years (May, 2006, to July, 2019) of the English Longitudinal Study of Ageing, a prospective cohort study. We included respondents aged 50–89 years who participated in at least two waves of data collection. We used multistate models to examine associations of demographic, socioeconomic, and social factors, including age, sex, education, employment, wealth, marital status, and help with activities of daily living (ADL), with transitions between three main states: no need for MAPs, unmet need for MAPs, and use of MAPs.

Findings We used data collected from 12 080 respondents (6586 women and 5494 men). During follow-up, 5102 (42·2%) of participants had unmet MAP need and 3330 (27·6%) used MAPs. Women were more likely than men to transition from no need to unmet need (hazard ratio [HR] 1·49, 95% CI 1·38–1·60) and less likely to transition from unmet need to use (0·79, 0·72–0·86). We found an increase in risk of transitioning from no need to unmet need for each 1-year increase in age (1·06, 1·06–1·07), for those with low education level (1·34, 1·23–1·45), those with help with ADL (1·32, 1·16–1·49), and who were not employed (1·22, 1·07–1·40) or disabled (3·83, 2·98–4·93). Similarly, we found an increase in risk of transitioning unmet need to use for each 1-year increase in age (1·06, 1·05–1·06), for those with low education level (1·20, 1·10–1·31), and those with help with ADL (1·25, 1·13–1·38). Increasing wealth was associated with a reduced risk of transitioning from no need to unmet need (0·78, 0·74–0·81) and from unmet need to use (0·94, 0·89–0·99). Single people were more likely to transition from unmet need to use than partnered people (HR 1·21, 95% CI 1·10–1·33).

Interpretation Women might be disproportionately likely to have unmet MAP needs, whereas other demographic, socioeconomic, and social factors are associated with high MAP need overall. Our findings directly support efforts towards expanding access to assistive products and identifying groups that could particularly benefit. As the first study of its kind to our knowledge, replication with other longitudinal datasets is needed.

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See Comment page e4

Global Disability Innovation Hub, Department of Computer Science, University College London, London, UK (J Danemayer MSc, Prof C Holloway PhD); **Department of Epidemiology and Public Health, University College London, London, UK** (M Bloomberg PhD); **Institute of Pharmaceutical Sciences, Kings College London, London, UK** (A Mills MSc); **Department of Health and Social Care Policy, London School of Hygiene & Tropical Medicine, London, UK** (Prof S Hussein PhD)

Correspondence to: Jamie Danemayer, Global Disability Innovation Hub, Department of Computer Science, University College London, London E20 2AE, UK **jamie.danemayer.21@ucl.ac.uk**

Introduction

Assistive technology, including canes, walkers, and wheelchairs, is crucial to support independence and social participation for individuals with functional limitations and disabilities.[1] Factors including rapid global population ageing, improved survival of individuals who are disabled at all ages, and rising rates of injury and non-communicable diseases contribute to the increasing prevalences of disabilities, leading to an increased need for assistive technology.[2] However, access to assistive technology can be poor, even in high-income countries;[1,3,4] the 2023 England Country Capacity Assessment found that more than 30% of people with disabilities in England had unmet assistive technology need.[5] To address clusters of unmet need with targeted expansion of assistive technology access, it is necessary to identify factors associated with unmet assistive technology need.

Access to assistive technology can be understood as a dynamic social process during which an individual can progress through stages of needing and using different products and services,[6] influenced by social and environmental factors beyond individual health. Cross-sectional studies have previously examined sex,[7,8] age,[9,10] residence,[11] marital status,[12] and socioeconomic[12–14] differences in access to assistive technology, which had mixed results and have overwhelmingly focused on glasses and hearing aids.[15] The ramifications of these associations in context have been explored in greater detail in national reports.[5,16] However, cross-sectional studies do not capture

Research in context

Evidence before this study

Assistive technology refers to the products and services that support individuals with disabilities, including canes, walkers, and wheelchairs. The 2022 Global Report on Assistive Technology identified inequities in access to assistive technology as a pressing global public health issue, even in high-income countries; in England, more than 30% of individuals with disabilities are estimated to have unmet assistive technology needs. Even so, assistive technology use and access indicators are infrequently included in multiwave population-based datasets. We searched PubMed for full-length articles published from Jan 1, 2020, until June 27, 2024, with keywords related to assistive technology ("assistive product" or "assistive device" or "assistive technology"), assistive technology access (use* or need* or has or have), and data type (panel or longitudinal or "multi-wave" or "repeated measure"), identifying no articles on this topic that used population-based, longitudinal data. Cross-sectional studies have identified demographic and socioeconomic disparities in assistive technology use with mixed results.

Added value of this study

Assistive technology use is best examined as a dynamic social process, during which an individual progresses through multiple states of need and use of assistive technology, requiring large-scale, longitudinal datasets. In our analysis, we use longitudinal data from a nationally representative cohort study and multistate models to examine inequalities in assistive technology need and use, a novel application of these methods. The analysis focuses on mobility assistive products (MAPs), as mobility is a particularly under-represented domain of assistive technology in population-level data collection, despite the increasingly prominent role MAPs have in public health, and emphasises the role of non-clinical factors in shaping disparities in assistive technology need and use. We identify sex as particularly implicated in disproportionate unmet need for MAPs. These findings directly support policy efforts to expand access to assistive products by identifying groups which could particularly benefit.

Implications of all the available evidence

Although assistive technology need and use is associated with a range of non-clinical factors, women in particular could encounter barriers to assistive technology use. Previous cross-sectional evidence suggests that non-clinical factors associated with MAP access vary by context, indicating the importance of longitudinal research in other settings. Future research should also examine the barriers to assistive technology that might drive disparities in need and access in other domains of assistive technology.

the dynamic nature of assistive technology need, and the few longitudinal datasets that include indicators of assistive technology access (eg, use) have not been used to examine inequalities.[4,15,17] Furthermore, mobility assistive products (MAPs) have received less attention than glasses and hearing aids, despite a projected increase in MAP need.[2,3] Research that focuses on understanding disparities in the need and use of assistive products will help to identify groups with very poor access, indicating who can most benefit from supportive interventions at policy and provision levels.

In the absence of longitudinal data on assistive technology need, a combination of data on functional limitations and assistive technology use can be used to identify gaps in access to assistive technology in a population.[4,9,15,17–19] The advantage of this definition of assistive technology need is that it includes individuals who might not self-identify as having a disability, as some of those experiencing important limitations or changes in functioning do not renegotiate their identity to include disability[5,20] but could nonetheless benefit from supportive measures.

We aimed to identify inequalities in need and use of assistive technology while examining access as a dynamic longitudinal process, focusing on the associations of key demographic, socioeconomic, and social factors with transitions into unmet need and use of MAPs. We hypothesised that participants who were older, women, of lower socioeconomic position, single, and not receiving help with activities of daily living (ADL) would be more likely to have unmet needs.

Methods

Study design and participants

In this modelling study, we used 13 years of data on lower body mobility limitations and use of MAPs from the prospective cohort study of the English Longitudinal Study of Ageing (ELSA). ELSA is a nationally representative study of the English population aged 50 years and older, with data collection beginning in 2002–04 and biennial follow-up until 2018–19; the most recent wave of data collection occurred in 2021–23. ELSA enrols individuals (and their partners) living in private households in England and has period follow-up through the Health Survey for England. Details of survey design and implementation are available elsewhere.[21] ELSA waves 3–9 (2006–08 to 2018–19) were included in the present study; waves 1 and 2 were omitted due to inconsistencies with later waves in survey questions assessing MAP use. ELSA respondents aged 50–89 years participating in at least two waves of data collection were eligible for inclusion in our analyses. ELSA received relevant local ethics approval at each wave of data collection, with written informed consent given at each interview. No further ethics approval or consent were required for this study.

Defining unmet MAP need and use

We assessed need for MAPs through self-report of lower body mobility limitations and use of MAPs collected at each assessment wave, This proxy for need is commonly used in previous studies in which assistive technology need was not directly reported.[4,9,15,17–19] At each wave, ELSA participants were able to report use of six MAPs: a buggy or scooter, a cane or walking stick, a Zimmer frame or walker, a manual wheelchair, an electric wheelchair, or elbow crutches.

Participants were considered to have a lower body mobility limitation and MAP need if they reported difficulty with one or more of the following mobility activities: walking 100 yards, climbing a flight of stairs without resting, kneeling or crouching, and getting up from a chair after sitting for long periods of time. Unmet need was defined as experiencing one or more lower body mobility limitations and not reporting the use of any MAPs. Use was defined as experiencing one or more lower body mobility limitations and reporting the use of one or more MAPs.

Factors associated with states of MAP need

Demographic, socioeconomic, and social factors associated with inequalities in access to assistive technology were identified from broader assistive technology literature[15] and included age, sex, education, employment, wealth, and marital status. A further social factor of help with ADL was included, as this factor is relevant to assistive technology access, particularly at older ages,[14] but is underexplored in relation to assistive technology use and unmet need. All factors were self-reported at the first wave of assessment of MAP need for each individual (referred to as the baseline wave).

Participants were asked to report their age in years, which was categorised into 9-year age groups (50–59 years to 80–89 years). Sex was self-reported by participants via the ELSA survey, with the options of man or woman; gender was not recorded. As such, we refer to sex throughout the results, although this could be used as a proxy for gender.[22]

Ethnicity data are self-reported. A further breakdown of this variable is not available; ELSA is not representative of ethnic minorities in England, and we did not model transitions by ethnicity.

Highest educational qualification was reported and dichotomised as low (before upper secondary) or high (upper secondary or more). Participants were asked to report their current employment status, which was categorised into employed (employed or self-employed), not employed (unemployed or looking after home or family), retired (retired or partly retired), and disabled (indicating the participant receives a disability benefit as they are unable to work). Non-housing wealth was standardised by year, and individuals were categorised into tertiles, with the third tertile representing the most wealth.

Marital or partnership status was dichotomised as married or partnered or single (never married or partnered, separated, divorced, or widowed). ADL help consisted of professional or informal personal assistance received for difficulties with any ADL, and is divided into three categories for this analysis: those reporting no ADL difficulties, those reporting ADL difficulties but not reporting receiving any help, and those reporting both ADL difficulties and receiving help. Participants missing demographic, socioeconomic, or social factors were excluded from analyses as missingness was less than 5% of the analytical sample.

Statistical analysis

We constructed a continuous-time multistate model accounting for interval censoring with the msm R package.[23] These models are used to simultaneously estimate transition probabilities between states, and hazard ratios (HRs) can be extracted to examine coefficient associations with each transition. In this analysis, we examined associations of demographic, socioeconomic, and social factors with transitions between three main states: no need for MAPs, unmet need for MAPs, and use of MAPs. As individuals previously reporting mobility difficulty might be more likely to have MAP need in the future than those who have never reported any mobility difficulty,[24] we also included a state indicating a participant previously had mobility difficulty but does not currently. Possible pathways are illustrated in figure 1. States are defined as follows: state 1 is defined as no previous or current mobility difficulty (no need); state 2 as mobility difficulty and no MAP use (unmet need); state 3 as mobility difficulty and MAP use (MAP use); and state 4 as previous but no current mobility difficulty (previous need).

First, we fitted a multistate model with no covariates to extract transition probabilities at 2, 4, and 8 years, corresponding to the median follow-up time and IQR, with 95% CIs bootstrapped with 100 random samples. The total length of time spent in each state and observed prevalence of unmet need was also extracted at 2, 4, and 8 years of follow-up. Then, six separate multistate models were used to estimate associations of demographic, socioeconomic, and social factors with transitions between states of MAP need. The models had (1) age and sex only; (2) model 1 factors plus education; (3) model 2 factors plus employment; (4) model 3 factors plus wealth;

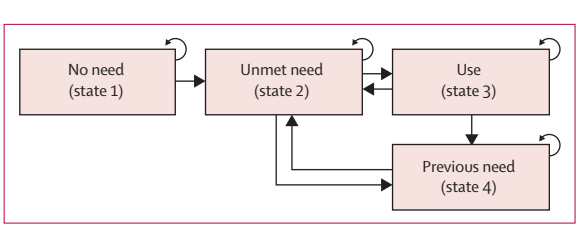

Figure 1: **Transition pathways for use or need of mobility assistive products**
All possible pathways for transitions are indicated by arrows.

(5) model 4 factors plus marital or partnership status; and (6) model 5 factors plus ADL help. Multistate models were adjusted to account for confounding without including variables on the causal pathway. Model 1 was used to estimate associations of age and sex with transitions between states; models 2–6 were used to estimate associations for education, employment, wealth, marital or partnership status, and ADL help. Age and wealth tertiles were considered as continuous variables and fitted linearly. All analyses were done in R version 4.2.2.

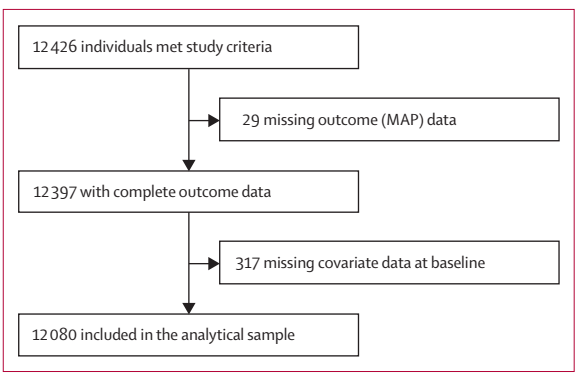

Figure 2: **Flowchart of participant inclusion in the analytical sample**
MAP=mobility assistive products.

See Online for appendix

	Overall (n=12 080)	Starting state		
		State 1—no need (n=8225)	State 2—unmet need (n=2480)	State 3—use (n=1375)
Age, years				
50–59	5438 (45·0%)	4269 (51·9%)	874 (35·2%)	295 (21·5%)
60–69	3552 (29·4%)	2370 (28·8%)	818 (33·0%)	364 (26·5%)
70–79	2365 (19·6%)	1286 (15·6%)	622 (25·1%)	457 (33·2%)
80–89	725 (6·0%)	300 (3·6%)	166 (6·7%)	259 (18·8%)
Sex				
Female	6586 (54·5%)	4095 (49·8%)	1664 (67·1%)	827 (60·1%)
Male	5494 (45·5%)	4130 (50·2%)	816 (32·9%)	548 (39·9%)
Race				
White	11 639 (96·3%)	7939 (96·5%)	2374 (95·7%)	1326 (96·4%)
Other than White	441 (3·7%)	286 (3·5%)	106 (4·3%)	49 (3·6%)
Education				
Lower than upper secondary	3716 (30·8%)	2024 (24·6%)	987 (39·8%)	705 (51·3%)
Upper secondary or higher	8364 (69·2%)	6201 (75·4%)	1493 (60·2%)	670 (48·7%)
Employment				
Disabled	651 (5·4%)	102 (1·2%)	216 (8·7%)	333 (24·2%)
Employed	5240 (43·4%)	4441 (54·0%)	717 (28·9%)	82 (6·0%)
Not employed	1056 (8·7%)	687 (8·4%)	273 (11·0%)	96 (7·0%)
Retired	5133 (42·5%)	2995 (36·4%)	1274 (51·4%)	864 (62·8%)
Wealth tertile				
1 (lowest)	4027 (33·3%)	2305 (28·0%)	973 (39·2%)	656 (47·7%)
2 (middle)	4027 (33·3%)	2919 (35·5%)	844 (34·0%)	483 (35·1%)
3 (highest)	4026 (33·3%)	3001 (36·5%)	663 (26·7%)	236 (17·2%)
Marital or partnership status				
Married or partnered	8975 (74·3%)	6485 (78·8%)	1713 (69·1%)	777 (56·5%)
Single	3105 (25·7%)	1740 (21·2%)	767 (30·9%)	598 (43·5%)
ADL help				
No help with ADL difficulties	2361 (19·5%)	1926 (23·4%)	1674 (67·5%)	361 (26·3%)
Help with ADL difficulties	3961 (32·8%)	541 (6·6%)	806 (32·5%)	1014 (73·7%)
No ADL difficulties	5758 (47·7%)	5758 (70·0%)	NA	NA

Data are n (%). ADL=activities of daily life. NA=not applicable.

Table 1: **Baseline characteristics**

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Of 12 426 participants in waves 3–9 of ELSA aged 50–89 years with at least two waves of data collection, 29 (0·2%) individuals were missing MAP data and 317 (2·6%) were missing demographic, socioeconomic, or social factors and were excluded, leading to 12 080 individuals being included in the analysis (figure 2).

The analytical sample had a median age of 61 years (IQR 55–69) at baseline and consisted of 6586 women and 5494 men (table 1). Most participants had upper secondary or greater education, were employed or retired, and were married or partnered (table 1). 5758 participants did not report any ADL difficulties, 3961 reported receiving help with their ADL difficulties, and 2361 reported no help with their ADL difficulties (table 1). At baseline, 8225 (68·1%) participants had no mobility difficulty and no MAP need (state 1), 2480 (20·5%) had unmet needs (state 2), and 1375 (11·4%) were using MAPs (state 3). The proportion of the analytical sample using each MAP type and reporting difficulty with each lower body mobility activity are provided in the appendix (p 2).

During the study period, during which 48 471 observations of state occurred, there were 2313 transitions (4·8%) from no need to unmet need and 1274 (2·6%) from unmet need to use (appendix pp 2–3). Overall, 5102 (42·2%) people in the sample had an unmet need at least once during the follow-up period; 3330 (27·6%) used MAPs. The median follow-up time was 4 years (IQR 2–8).

Overall, the transition probabilities of remaining in each state declined during the follow-up period, although at 2, 4, and 8 years of follow-up, individuals who at baseline had no need or current MAP use were generally most likely to stay in their current state of MAP need (table 2). At 2 years of follow-up, the probability of transitioning from no need at baseline to unmet need was 0·074 (95% CI 0·072–0·077) and 0·183 (0·176–0·189)for unmet need to use (table 2). The transition probabilities at 8 years of follow-up were 0·162 (0·156–0·166) for transitioning from no need to unmet need and 0·349 (0·338–0·362) for unmet need to use. Our model estimated that individuals with unmet need had a probability of continuing to have

	State 1—no need	State 2—unmet need	State 3—use	State 4—previous need
2 years of follow-up				
No need	0·899 (0·895–0·902)	0·074 (0·072–0·077)	0·011 (0·010–0·011)	0·016 (0·015–0·017)
Unmet need	0	0·557 (0·550–0·566)	0·183 (0·176–0·189)	0·260 (0·250–0·267)
Use	0	0·077 (0·072–0·081)	0·839 (0·831–0·846)	0·084 (0·080–0·090)
Previous need	0	0·334 (0·324–0·345)	0·053 (0·051–0·055)	0·613 (0·601–0·626)
4 years of follow-up				
No need	0·808 (0·802–0·814)	0·114 (0·111–0·119)	0·033 (0·031–0·035)	0·045 (0·043–0·047)
Unmet need	0	0·411 (0·403–0·420)	0·269 (0·261–0·276)	0·320 (0·311–0·327)
Use	0	0·136 (0·129–0·144)	0·722 (0·710–0·737)	0·142 (0·133–0·150)
Previous need	0	0·395 (0·384–0·406)	0·138 (0·132–0·145)	0·467 (0·452–0·482)
8 years of follow-up				
No need	0·652 (0·643–0·662)	0·162 (0·156–0·166)	0·088 (0·083–0·092)	0·098 (0·095–0·102)
Unmet need	0	0·332 (0·324–0·341)	0·349 (0·338–0·362)	0·319 (0·309–0·329)
Use	0	0·210 (0·200–0·221)	0·578 (0·558–0·595)	0·212 (0·201–0·225)
Previous need	0	0·366 (0·358–0·374)	0·270 (0·260–0·281)	0·364 (0·352–0·376)

Data are probabilities (95% CI). Transition probability at time *t* refers to the probability of being in a given state at time *t*.

Table 2: **Transition probabilities at 2, 4, and 8 years of follow-up**

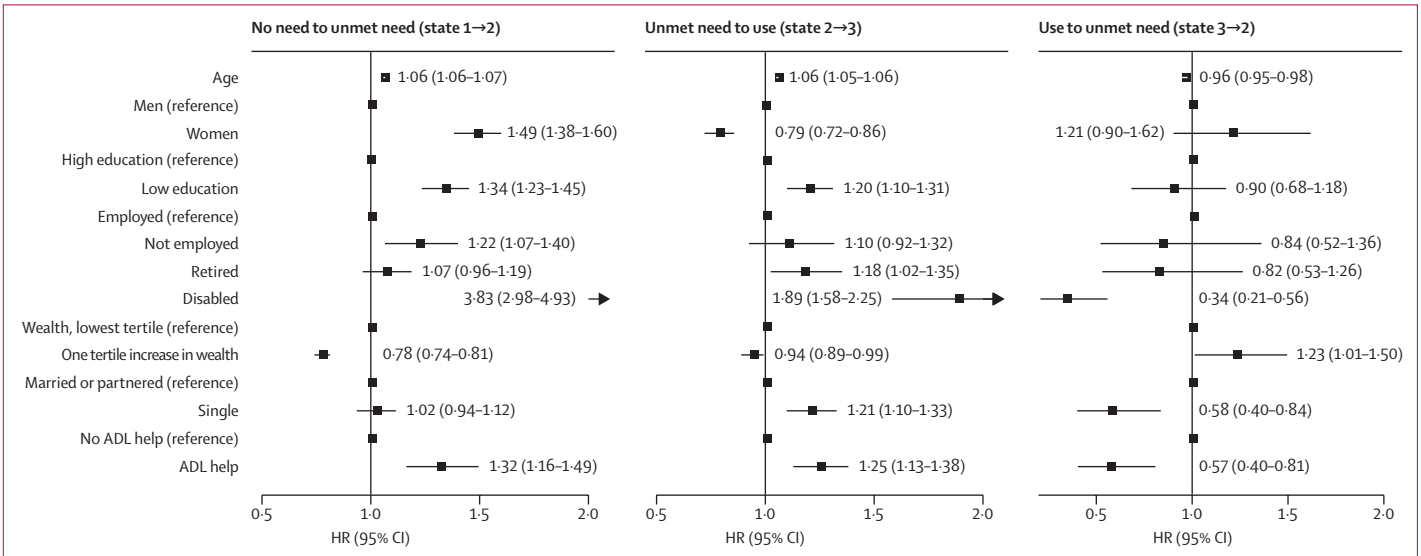

Figure 3: **HRs for covariate associations with transition probabilities**

HRs for sex and age are from model 1. HRs for education are from model 2, adjusted for sex and age. HRs for employment are from model 3, adjusted for sex, age, and education. HRs for wealth are from model 4, adjusted for sex, age, education, and employment. HRs for marital or partnership status are from model 5, adjusted for sex, age, education, employment, and wealth. HRs for ADL help are from model 6, adjusted for sex, age, education, employment, wealth, and marital or partnership status. Estimates to the right of the reference line indicate an increased likelihood of transitioning to the other state, whereas estimates to the left indicate a reduced likelihood, both in comparison to the reference group. HR=hazard ratio.

unmet need of 0·557 (0·550–0·566) after 2 years of follow-up, which decreased to 0·332 (0·324–0·341) after 8 years of follow-up. From 2 to 8 years after baseline, the total time (mean average estimate) in a state of unmet need increased from 0·08 to 0·84 years, whereas the total time in a state of use increased from 0·01 to 0·29 years (appendix p 3). The observed prevalence of unmet need remained consistent at 1779 (20·8%) of 8520 at 2 years, 1548 (20·2%) of 7661 at 4 years, and 1052 (19·3%) of 5453 at 8 years of follow-up.

Associations of demographic, socioeconomic, and social factors with transitions between states are expressed as HRs for transition probabilities, giving the comparative risk of making a transition between two groups. Figure 3 illustrates HRs for main transitions (appendix pp 4–5). Compared with men, women were more likely to transition from no need to unmet need (HR 1·49, 95% CI 1·38–1·60) and from previous need to unmet need (1·34, 1·19–1·50), but were less likely to transition from unmet need to use (0·79, 0·72–0·86). Each increase in age of a year corresponded to an increase

in risk of transitioning from no need to unmet need (1·06, 1·06–1·07) and from unmet need to use (1·06, 1·05–1·06).

Compared with those with high education level, low education level was associated with increased risk of transitioning from no need to unmet need (HR 1·34, 95% CI 1·23–1·45) and unmet need to use (1·20, 1·10–1·31). Compared with employed individuals, those who were not employed (1·22, 1·07–1·40) or disabled (3·83, 2·98–4·93) had an increased risk of transitioning from no need to unmet need. People who were retired (1·18, 1·02–1·35) or disabled (1·89, 1·58–2·25) also had an increased risk of transitioning from unmet need to use, but people who were not employed had no association with the transition from unmet need to use (1·10, 0·92–1·32). Disabled individuals also had a decreased risk of transitioning from use to unmet need (0·34, 0·21–0·56) and from use to previous need (0·56, 0·37–0·85). Increasing wealth was associated with a reduced risk of transitioning from no need to unmet need (HR for one tertile increase in wealth 0·78, 95% CI 0·74–0·81) and from unmet need to use (HR 0·94, 0·89–0·99).

Marital or partnership status had no association with transitioning from no need to unmet need (HR 1·02, 95% CI 0·94–1·12); however, single participants were more likely to transition from unmet need to use (1·21, 1·10–1·33) and less likely to transition from use to unmet need (0·58, 0·40–0·84) than married or partnered participants (figure 3). Compared with those reporting no help with ADL difficulties, those with help had an increased risk of transitioning from no need to unmet need (1·32, 1·16–1·49) and from unmet need to use (1·25, 1·13–1·38). People with ADL help were also less likely to transition from use to unmet need (0·57, 0·40–0·81) and use to previous need (0·55, 0·44–0·70) than those with no help.

Discussion

In this modelling analysis of transitions between states of MAP need and use in 12 080 adults aged 50–89 years, we identified key demographic, socioeconomic, and social disparities in transitions between states of MAP need and use. Women were more likely to transition from both no need and previous need to unmet need, and less likely to transition from unmet need to use, suggesting barriers to MAP access among women. Individuals who were older, less educated, less wealthy, disabled, or who reported ADL help were more likely to transition from no need to unmet need, and from unmet need to use, indicating a higher prevalence of mobility limitations and MAP need overall among these groups. Finally, marital or partnership status was not associated with transitioning to unmet need; however, single people were more likely to transition from unmet need to use compared with married or partnered people.

In general, we found that unmet need was common in our analytical sample, with 42·2% of participants having an unmet need at some point during the follow-up period and people spending a mean of 0·84 years with an unmet need and 0·29 years using MAPs by 8 years of follow-up. Research in England or similar high-income contexts typically finds high rates of access when compared with need for assistive technology overall.[1,5] For example, the Global Report on Assistive Technology reported a median of 79·3% (range 40·2–83·5) of individuals with assistive technology need had access to assistive technology (when excluding glasses) among countries with very high development, indicating about 20% of people had an unmet need in this grouping.[1] However, the rate of unmet need can outpace the rate of use when considering individual MAPs,[5] particularly those that are more complex (eg, more expensive or difficult to set up and use), evidencing barriers specific to the access and use of mobility products.

Findings related to demographic factors in our analysis are consistent with cross-sectional studies, particularly with respect to increased MAP need and use at older ages,[3,14] as the incidence of mobility limitations increases with age.[25] We also found that women were more likely than men to transition from two states without need (ie, no need and previous need) to unmet need, and less likely to transition from an unmet need to MAP use, indicating sex disparities in MAP access. Evidence from similar contexts has identified more proactive seeking of health care and health information among women, in particular women with disabilities,[26,27] suggesting that the reduced probability of transitioning from unmet need to use could be a systemic rather than behavioural barrier. Hughes and colleagues note three barriers identified by focus group participants: "lack of accessibility, providers' negative attitudes and perceived discrimination, and lack of disability-related sensitivity and knowledge among medical providers".[26] Our finding is also consistent with the Global Report on Assistive Technology, which identified better access to assistive technology among men than women in countries surveyed with the population-based rapid Assistive Technology Assessment, further noting sex disparities were exacerbated in countries with low Human Development Index scores but were present in various settings.[1] Conversely, England's Country Capacity Assessment for assistive technology found less unmet MAP need among women than men.[5] However this finding was not disaggregated by age and included additional types of mobility assistive products.[5]

Socioeconomic factors are consistently associated with assistive technology need and use, both in our analysis and in cross-sectional studies in similar contexts.[14,16] For example, our analysis identified that wealthier participants were less likely to transition from no need to unmet need, whereas participants reporting disability precluding employment were more likely to make this transition. Evidence suggests associations of employment

factors with assistive technology use could differ depending on the severity of the functional limitation.[14] Indeed, the level of difficulty, use of assistive products, and timing of the onset of limitations can bidirectionally affect employment behaviours; for example, the Irish National Disability Survey found higher levels of difficulty (compared with lower levels) and unmet needs for disability-specific services and aids were associated with being outside employment. Furthermore, individuals with disabilities occurring later in life (but before retirement) were more likely to be outside employment compared with those having disabilities while still at school, potentially reflecting barriers associated with the need to make changes occupationally.[16] Finally, some individuals might have functional limitations that preclude employment but do not qualify them for benefits, contributing to difficulty accessing MAPs. We found that individuals with low education levels were more likely to transition from no need to both unmet need and use, indicating higher overall MAP need than those with high education levels. This finding is consistent with evidence collated by Lin and Wu highlighting that older adults in the USA with more education are less likely to develop activity limitations and are subsequently more likely to be aware of and adopt assistive products when needed.[14]

Overall, the social factors included in this analysis have been underexplored in the broader assistive technology literature. The role of marital or partnership status has been examined in an analysis of the Medical Expenditure Panel Survey in the USA, which showed higher assistive technology use among married participants than single participants, perhaps due to partnership assisting with assistive technology affordability or the desire of assistive technology users to be less dependent on their partner.[12] In contrast to this previous study, our analysis found unmarried or unpartnered individuals were more likely to transition to use after first MAP need compared with married or partnered individuals, but no difference by marital or partnership status in transitions from no need to unmet need. These findings could suggest that single individuals might use MAPs more than married or partnered individuals, but that marital or partnership status itself might not constitute a strong barrier to MAP use. Possible reasons for the discrepancy with previous results include the previous study's use of broader measures (namely, any physical functioning difficulty and any assistive technology use), a cross-sectional study design compared with our analysis' focus on transitions, and a younger study population. ADL help has been examined in combination with assistive technology to illustrate how these two factors can positively or negatively affect different dimensions of wellbeing,[14] or examine how device use can affect the odds of receiving personal assistance,[28] but neither approach has been explored with respect to unmet need. Our analysis found that those receiving help with ADL were more likely to transition from no need to unmet need and from unmet need to use than those without ADL help, suggesting more MAP need overall in this group.

A major strength of our analysis is its use of multistate models to allow assistive technology need and use to be modelled as a dynamic process, whereas previous studies are cross-sectional. Our incorporation of a fourth state indicating previous need also allowed us to separate the effect of previous mobility difficulty on transitions, to account for the role of recurrent states of difficulty. A further strength is in the ELSA study design; ELSA is nationally representative, does not exclude individuals from enrolment based on pre-existing conditions, and has follow-up mechanisms for individuals who become hospitalised or institutionalised. These features improve the cohort's representation of assistive technology users.

There are several limitations to our study. Although questions on other activity limitations are asked in ELSA protocols, the use of other related assistive technologies (eg, hearing aids or home modifications) is not. As a result, assistive technology use across multiple functional domains cannot be explored, although the use of other assistive technologies can affect individual awareness and capacity to use or access new assistive technology. Other social variables, including loneliness and social isolation, could affect assistive technology access but due to a high proportion of missing data were excluded from analyses. Future research should examine other social dimensions associated with assistive technology need and use, as social isolation is particularly salient among people with disabilities.[29] Our study definitions assume anyone with lower body mobility functional difficulty has capacity to benefit from MAPs, and so anyone reporting difficulty but not reporting use has unmet need. Although these definitions are used when self-reported data on assistive technology need are unavailable,[4,9,15,17–19] further research has also shown gaps between perceived functional difficulties and assistive technology need.[1,18] Mobility difficulty as a proxy for need can underestimate true unmet need or need when individuals without these specific mobility difficulties could still benefit from MAP use, or individuals currently using MAPs require updated or alternative MAPs. Mobility difficulty can also overestimate MAP unmet need as not all mobility difficulties warrant a MAP, especially after accounting for an individual's personal wants, environment, daily tasks, and comorbidities. Therefore, the difficulty–use gap as a substitute measure could mis-estimate the true prevalence of MAP unmet need or need. Due to poor representation of participants who are races or ethnicities other than White, the dataset did not allow for the estimation of transition probabilities by race and ethnicity. However, this factor is important to consider in future work.

Our analysis identifies sex as a particularly important factor associated with disproportionate unmet MAP need, suggesting targeted efforts to expand MAP use for

women could reduce unmet MAP need. As access to assistive technology is shown to vary by functional domain and country income,[1] these findings are most relevant within the sphere of mobility products in a high-income setting. The present study nonetheless establishes the importance of non-clinical factors for disparities in MAP need and use. This finding is useful for studies in low-income and middle-income countries, where population-level datasets including assistive technology access are more often limited to demographic, socioeconomic, and social factors,[17] and clinical data are more subject to diagnostic availability or ascertainment bias. Future research and new data collection in low-income and middle-income settings is necessary, as need and use disparities could have a stronger association with socioeconomic and social factors in these settings.[1]

Data indicators on access to assistive technology are under-represented in multiwave population-based surveys, particularly for MAPs, and previous cross-sectional examinations of barriers to assistive technology access do not consider the dynamic nature of assistive technology need and use. Our analysis suggests a nuanced contribution of demographic, socioeconomic, and social factors to MAP access and highlights the importance of non-clinical factors for shaping need and use of these products. In this study, we identify groups that are more likely to need MAPs, and further identify that women are disproportionately likely to have unmet MAP needs. These findings can be used to inform policies aiming to improve access to MAPs, by providing evidence to expand outreach and improve follow-up, ensuring people more likely to need MAPs are especially considered in provision planning, and those more likely to have unmet needs have increased support to meet their needs. Our findings can be used in conjunction with prevalence estimates from national studies (eg, the England Country Capacity Assessment)[5] to improve awareness among service providers of groups that might be more likely to have unmet needs. Finally, this study provides a basis for future research to focus on identifying barriers that could drive disparities in assistive technology need and access, comparing and validating proxy measures of assistive technology need, examining other domains of assistive technology in addition to MAPs, and reproducing results in low-income and middle-income settings where access disparities could be exacerbated.

Contributors

JD conceived the study. JD, MB, and SH devised the study methods and investigation inquiry. JD led the investigation. JD, MB, and AM directly accessed and verified the underlying data. JD, MB, and AM analysed the data. JD and MB curated the data. JD wrote the first draft of the manuscript. MB, SH, AM, and CH reviewed and edited the manuscript. JD and AM visualised the data. AM and MB advised on software. SH supervised the study. CH acquired the study funding. All authors had full access to all the data in the study and had final responsibility for the decision to submit for publication.

Declaration of interests

We declare no competing interests.

Data sharing

The ELSA data are freely available to researchers through the UK Data Service at https://beta.ukdataservice.ac.uk/datacatalogue/series/series?id=200011.

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