

Factors associated with the amount of public home care received by elderly and intellectually disabled individuals in a large Norwegian municipality

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What is known about this topic

- Physical disability and cognitive impairment are the most important predictors of the amount of public home care received by elderly individuals.
- Elderly individuals who live with a cohabitant receive less public home care than those elderly individuals who live alone.
- Challenging behaviour is an important predictor of the amount of care received by intellectually disabled individuals.

What this paper adds

- The marginal effect of physical disability on care provided to elderly individuals depends on individuals' level of cognitive impairment and vice versa.
- Elderly male recipients of care who live with a cohabitant receive substantially less public care than elderly female recipients who live with a cohabitant.
- Physical disability is an important predictor of the amount of care received by intellectually disabled individuals.

Abstract

This study reports an analysis of factors associated with home care use in a setting in which long-term care services are provided within a publicly financed welfare system. We considered two groups of home care recipients: elderly individuals and intellectually disabled individuals. Routinely collected data on users of public home care in the municipality of Trondheim in October 2012, including 2493 people aged 67 years or older and 270 intellectually disabled people, were used. Multivariate regression analysis was used to analyse the relationship between the time spent in direct contact with recipients by public healthcare personnel and perceived individual determinants of home care use (i.e. physical disability, cognitive impairment, diagnoses, age and gender, as well as socioeconomic characteristics). Physical disability and cognitive impairment are routinely registered for long-term care users through a standardised instrument that is used in all Norwegian municipalities. Factor analysis was used to aggregate the individual items into composite variables that were included as need variables. Both physical disability and cognitive impairment were strong predictors of the amount of received care for both elderly and intellectually disabled individuals. Furthermore, we found a negative interaction effect between physical disability and cognitive impairment for elderly home care users. For elderly individuals, we also found significant positive associations between weekly hours of home care and having comorbidity, living alone, living in a service flat and having a safety alarm. The reduction in the amount of care for elderly individuals living with a cohabitant was substantially greater for males than for females. For intellectually disabled individuals, receiving services involuntarily due to severe behavioural problems was a strong predictor of the amount of care received. Our analysis showed that routinely collected data capture important predictors of home care use and thus facilitate both short-term budgeting and long-term planning of home care services.

Keywords: cognitive impairment, elderly, intellectual disability, physical disability, predictors, service use

Introduction

An ageing population increases the fiscal pressure on the long-term care sector. In addition, many countries are increasingly aiming to enable people who need assistance to live at home for as long as possible, and a wide range of public healthcare and social services have been established

to achieve this goal (TNS Opinion & Social 2007, Tarricone & Tsouros 2008). Although the majority of long-term care users are elderly individuals, there are other resource demanding groups, such as intellectually disabled persons. During the past decade, services provided to people with intellectual disabilities have been deinstitutionalised and replaced by service flats or sheltered housing units in many western countries. Such deinstitutionalisation is motivated by the idea that intellectually disabled persons should be able to live independently, as the rest of the community does (Mansell *et al.* 2007).

To plan services, predict costs and allocate resources, information about the determinants of the need for home care services is important. A large body of literature from the 1980s and 1990s discusses the utilisation of home care (see Kadushin 2004 for a review), and in the past few years, interest in this topic has increased. Studies within this research stream differ in that some discuss factors that can predict *whether or not* an individual uses home care (Larsson *et al.* 2006, Blomgren *et al.* 2008, de Meijer *et al.* 2009, Sigurdardottir *et al.* 2012), whereas others investigate factors that can predict the *amount* or volume of care used (Boaz & Hu 1997, Hayward *et al.* 2004, Meinow *et al.* 2005). These studies capture different aspects of home care, as individual determinants of home care use may differ from the determinants of the amount of care received.

In the literature, the Andersen–Newman model is frequently used to identify and structure individual determinants of health service use (Andersen 1995, Andersen & Newman 2005). Within this model, three groups of determinants are emphasised: *need* variables (e.g. functional and health status), *predisposing* variables (e.g. age, gender) and *enabling* variables (e.g. living arrangements).

For physical disabilities, activities of daily living (ADL) and instrumental activities of daily living (IADL) are need variables that are consistently found to be strong predictors of both the use and the amount of home care services (Boaz & Hu 1997, Hayward *et al.* 2004, Kadushin 2004, Meinow *et al.* 2005, Hammar *et al.* 2008, de Meijer *et al.* 2009). The effect of cognitive impairment on the probability of use and the amount of care received is less clear (Roelands *et al.* 2003, Hayward *et al.* 2004, Kadushin 2004). However, Meinow *et al.* (2005) found that cognitive impairment is a main predictor of the amount of public home care received, and Stoddart *et al.* (2002) found that cognitive impairment increases the probability of statutory home care use by almost fivefold in the elderly individuals aged 65 years. Using a composite variable of physical disability and cognitive

impairment, Kalseth (2003) found a non-linear association between this variable and the weekly hours of formal care received by public home care recipients.

Other health-related need variables mentioned in the literature include diagnosis; comorbidity; physical, psychological and emotional well-being; and self-rated health status. The results related to these variables are mixed, and the effects are often non-significant (Algera *et al.* 2004, Kadushin 2004, Hammar *et al.* 2008, Sævareid *et al.* 2012). A large survey of dependent elderly people living at home indicates that individuals with poor self-rated health and chronic conditions are more likely to use both formal and informal care (Rodríguez 2013). Further, people with dementia are nearly five times more likely to use public home care than other older people living alone (Larsson & Silverstein 2004). Studies have also shown the effects of depressive mood (Roelands *et al.* 2003), psychosocial well-being (Hammar *et al.* 2008) and emotional problems (Stoddart *et al.* 2002) on home care use.

Predisposing factors such as age and gender may also explain the use of home care services. Indeed, age is reported to be a stronger predictor of home care use than need variables (Kadushin 2004, Meinow *et al.* 2005, Blomgren *et al.* 2008, de Meijer *et al.* 2009, Sigurdardottir *et al.* 2012). However, the effect of gender is less clear (Roelands *et al.* 2003, Kadushin 2004). The results mostly show that home care use is higher among women; nevertheless, the gender effect may depend on the inclusion of living arrangements in the analysis (Blomgren *et al.* 2008).

The literature is inconclusive with regard to the effect of socioeconomic status, as measured by education and income, on home care use (Meinow *et al.* 2005, Blomgren *et al.* 2008, Sævareid *et al.* 2012). The inconclusive results reported in the literature may arise because education and income may capture different mechanisms. On the one hand, they may represent predisposing factors that capture differences in health conditions and health-promoting and health-care-seeking behaviour in different social segments. On the other hand, education and income may be enabling factors that facilitate or hinder access.

Living arrangements and access to informal care represent other potential enabling factors. Dependent people who live alone typically have higher use of formal care than people who live with spouses or children (Stoddart *et al.* 2002, Kadushin 2004, Blomgren *et al.* 2008, Hammar *et al.* 2008). Algera *et al.* (2004), however, report more mixed results for patients with long-term conditions. Many elderly individuals receive informal care from relatives or

friends in addition to public home care. On the one hand, informal care may reduce the need for public care (Hayward *et al.* 2004, Blomgren *et al.* 2008, de Meijer *et al.* 2009). On the other hand, informal care may complement public care for individuals with excessive needs (Døhl *et al.* 2014). Furthermore, informal care may have a positive effect on formal care because informal care givers, such as children, act as advocates. Blomgren *et al.* (2008) reported that the elderly individuals who receive help from children and the elderly individuals without children had higher use of home care than elderly individuals with children who do not provide informal care. The possibility of informal care being a result of the level of public care rather than the other way round implies that this variable may be estimated with bias. We return to this point below.

Studies of home care services provided to people with intellectual disabilities have focused on the effects of challenging behaviour (Hallam *et al.* 2002, Knapp *et al.* 2005). Although their intellectual disability is the main reason for the provision of public services for these individuals, physical disabilities can also restrict their participation in the community. Nevertheless, few studies have investigated the effect of physical disability variables as predictors of the need for home care services for intellectually disabled individuals. Studies of individuals with a mild or moderate intellectual disability indicate that they have difficulties performing some ADL, and that these activities can be improved by training (Kottorp *et al.* 2003, Hällgren & Kottorp 2005). In addition, in a nursing home setting, physical disability is as important for elderly individuals with intellectual disabilities as for other elderly individuals for describing the need for nursing home services (Martin *et al.* 2011).

Overall, the literature provides mixed conclusions regarding both the type of factors that explain the use of formal home care, and the relationships between these factors and the need for care. This study builds on existing literature, and aims to explore the determinants of the *amount of provided home care* in two groups of recipients: elderly individuals aged 67 years or older and intellectually disabled individuals aged 18 years or older. In addition to variables discussed in the literature that we believe are particularly relevant in our setting, the analysis is based on data that are routinely collected for all home care recipients in Norwegian municipalities. Thus, a secondary aim of the study was to determine whether individual users' routine data may be used for both short- and long-term planning of long-term care in a public setting.

Methods

In Norway, municipalities are required by law to provide necessary primary health and long-term care services to their citizens. However, the municipalities have the authority to define the extent of need, the amount of care supplied and the type of care (i.e. home or institutional care). Home care services are delivered almost free of charge, with only a limited income-dependent co-payment for certain home help services, such as house cleaning. Nursing care is free of charge.

The study setting was the municipality of Trondheim, which has a population of approximately 180,000 inhabitants. Two types of home care recipients were included. The first group included 2493 individuals and consisted of all recipients of home care services aged 67 years or older. We refer to these individuals as 'elderly', and home care recipients constituted approximately 13% of the elderly population. The second group consisted of 270 intellectually disabled people aged 18 years or older living in community-based homes with 24-hour access to care personnel. This group constituted approximately 50% of individuals older than 16 years and diagnosed as intellectually disabled in the municipal Ministry of Local Government and Modernisation (2013).

Dependent variable

Our dependent variable was the amount of home care received by each individual, measured as accrued time. Time was registered electronically as minutes per visit with the use of hand-held computers. In the groups of intellectually disabled individuals, accrued time was registered after each shift. In the analysis reported in this study, time was summarised into hours per week, averaged over a period of 4 weeks in October 2012. Only time spent with users ('face-to-face services') was registered. In both groups, both home help services and nursing care were included. In the group of intellectually disabled individuals, day care services were also included.

In selecting the explanatory variables, we used the framework from Andersen and Newman (2005), but recognised that the use of routinely collected administrative data limits the availability of variables. For the need variables, we used *physical disability and cognitive impairment, diagnosis and comorbidity*. We included *age and gender* as predisposing variables. The enabling variables included *informal care, living arrangements and having a safety alarm*.

Need variables

Physical disability and cognitive impairment were measured using a register-based information system called 'Individual nursing and care statistics' (IPLOS), which has been mandatory in all Norwegian municipalities since 2006. IPLOS covers all recipients of nursing home and home care services. The characterisation of disability in IPLOS is based on the principles described by the World Health Organization's (WHO) classification of disabilities (WHO 1980) and is similar to the Canadian *Système de Mesure de l'Autonomie Fonctionnelle*/The functional autonomy measurement system (SMAF) (Hebert et al. 1988). We used 15 items from the IPLOS system in the analysis (Table 1). Each item was scored from 1 to 5, with 1 indicating no disability, 2 indicating some difficulties performing the task or the ability to perform the task with reduced quality, but without need for assistance and 3 or higher indicating an increasing need for care. In Trondheim, scoring is performed only by trained and licensed personnel.

Factor analysis was used to construct aggregate disability measures. For elderly home care users, the factor analysis revealed two factors representing physical disability [i.e. ADL, mobility and IADL (items 1–9 in Table 1)] and cognitive and behavioural impairment (items 10–15). In the group of intellectually disabled individuals, the factor analysis identified behavioural impairment as a separate factor (item 15), whereas the other items were grouped into one common composite factor, which constitutes both physical disability and cognitive impairment (items 1–14).

The composite variables were constructed as the average score of the items contained in each factor.

For elderly users, we included the three most frequently occurring diagnoses: *dementia/Alzheimer's disease, stroke and diabetes*. Diagnoses were registered according to the International Classification of Primary Care (ICPC) system. *Comorbidity* was defined as having two or more ICPC-coded diagnoses (Fried et al. 2004). Diagnoses were not available for intellectually disabled users.

For intellectually disabled users, we included, in addition to *disability (related to physical and cognitive impairment) and behavioural impairment, the use of coercive measures* as an explanatory variable. The *use of coercive measures* captures recipients who have the most severe behavioural problems, and generally means that some of the services provided are involuntary from the point of view of the user. The use of coercive measures is strongly regulated by law.

Predisposing variables

The elderly recipients were divided into three groups based on *age*: 67–79, 80–89 and 90 years and older. The intellectually disabled individuals were grouped into four groups based on *age*: 18–29, 30–39, 40–49 and 50 years and older. We also adjusted the analysis for gender.

Enabling variables

Regarding *informal care*, the data from the municipality enabled us to separate care recipients into the following groups: no informal care, less than 3 hours per week, 3–9 hours per week, more than 9 hours

Table 1 Disability and impairment variables from 'Individual nursing and care statistics' (IPLOS) used in the analysis, its classification and factor analysis classification

Variables	Classification	Elderly	Intellectually disabled
1 Eating	ADL	} Physical disability	} Physical and cognitive composite score
2 Dressing	ADL		
3 Personal hygiene	ADL		
4 Using the toilet	ADL		
5 Indoor mobility	Mobility		
6 Outdoor mobility	Mobility		
7 Cooking	IADL		
8 Housekeeping	IADL		
9 Shopping	IADL		
10 Maintaining own health	Cognitive impairment	} Cognitive impairment	
11 Communication	Cognitive impairment		
12 Social interaction	Cognitive impairment		
13 Daily decision-making	Cognitive impairment		
14 Memory	Cognitive impairment		
15 Behavioural impairment	Cognitive-/Behavioural impairment		

ADL, activities of daily living; IADL, instrumental activities of daily living.

per week and a category 'yes, but unknown amount'.

Two variables describing the *living arrangements* of care recipients were included: whether users were *living alone* or with a cohabitant and whether users lived in their own home or in one of two types of *service flats*. One type of service flat (also called extra care sheltered housing) offers 24-hour service and is very similar to a nursing home. For elderly recipients, this type of living arrangement was *not* included in the analysis. The other type of service flat is similar to ordinary home care services. These service flats differ, however, from ordinary home care services in that they are localised together, have special features and share a common pool of personnel. All intellectually disabled individuals in this study lived in service flats with 24-hour access to services.

Having a *safety alarm* may act as a substitute for home care, but may also signal greater need. We also included a dummy variable for individuals who had a *short-term stay* at a nursing home or rehabilitation institution during the analysis period. A short-term stay in an institution obviously reduces the amount of home care received during that period. Unfortunately, the available information was limited to whether the individual had a short-term stay during the analysis period and not the length of stay. This variable was therefore included solely as a control variable. Safety alarm and short-term stay were not relevant variables for the intellectually disabled individuals.

Statistical methods

Multivariate regression analyses were used. Trondheim is administratively divided into 12 districts for elderly home care recipients and 9 for intellectually disabled recipients. We adjusted for possible heterogeneity between these districts by using dummy variables. Single disability variables were treated as discrete variables in the analysis, and factors containing an average of several ordinal variables were treated as continuous variables. For both groups, a Cook–Weisberg test indicated the presence of heteroscedasticity. We therefore used White's heteroscedasticity-consistent estimators (White 1980). Because of the skewed distribution of the error term, a natural logarithm was used to normalise the distribution. For categorical dummy variables or discrete variables, Kennedy's approximation was used to adjust the data for bias (Kennedy 1981, Jan van Garderen & Shah 2002). The estimated coefficient for a continuous variable was interpreted as the percentage increase in outcomes resulting from a one-unit

increase in the explanatory variables measured by the exponential.

All analyses were performed in SPSS version 21 and Stata version 13.

Ethics

The study was approved by the Regional Committee for Medical and Health Research Ethics and the Ombudsman for Research at the Norwegian Social Science Data Services. All data from the municipality were anonymised.

Results

Description of the study population

Elderly individuals living at home received an average of 3.1 hours of public care per week (Table 2), ranging from a minimum of 0.05 hours to a maximum of 68.6 hours. The median value was 1.8 hours per week. The average score was 2.24 for physical disability and 1.77 for cognitive impairment. Thus, on average, physical disability would seem to represent a higher challenge than cognitive impairment. Sixty-six per cent of the home dwelling elderly individuals were female, and 50% of cohabitating elderly individuals were female. Seventy-one per cent of care recipients were *living alone*. This percentage is slightly higher than the population average (69%) in Trondheim and the national average (70%) for individuals older than 67 years (Statistics Norway 2013).

Intellectually disabled individuals received an average of 62.6 hours of public health and social services per week (Table 3), ranging from a minimum of zero hours to a maximum of 211 hours. As more than one person may provide services, the amount of care can exceed 168 hours per week. The median value was 55.3 hours per week. The average score for physical and cognitive impairment was 3.21, and the corresponding score for behavioural impairment was 2.86. Again, physical disability, on average, represented a higher challenge than cognitive impairment, and the scores were also higher than the corresponding scores for the elderly individuals. Forty-six per cent of intellectually disabled individuals were female.

Multiple regression analysis

Both physical disability and cognitive impairment were strongly and positively associated with the amount of home care provided to elderly home care recipients (Table 4). Notably, we found a negative interaction effect between physical disability and

Table 2 Descriptive statistics for elderly home care recipients: average amount of public care per week with standard deviation (SD), 95% confidence interval (CI) and physical disability and cognitive impairment score

	Percentage	Mean score (SD)	Elderly N = 2493		
			Median hours	Mean hours (SD)	95% CI for mean
Home care			1.78	3.12 (4.40)	(2.94, 3.29)
Need variables					
Physical disability		2.24 (0.77)			
Score 1–1.99	39		0.71	1.22 (1.31)	(1.14, 1.30)
Score 2–2.99	43		2.41	2.98 (2.64)	(2.82, 3.14)
Score 3–3.99	15		4.68	6.14 (5.26)	(5.61, 6.68)
Score 4–5	3		13.67	15.86 (12.51)	(12.91, 18.82)
Cognitive and behavioural impairment		1.77 (0.58)			
Score 1–1.99	67		1.13	2.05 (2.70)	(1.92, 2.18)
Score 2–2.99	28		3.21	4.74 (5.30)	(4.35, 5.13)
Score 3–3.99	5		5.51	8.12 (8.88)	(6.53, 9.71)
Score 4–5	0				
Diagnosis					
Dementia/Alzheimer's disease	9		2.92	3.91 (4.00)	(3.87, 4.44)
Stroke	12		2.26	4.22 (6.06)	(3.53, 4.92)
Diabetes	11		2.29	3.57 (4.34)	(3.06, 4.09)
Comorbidity					
0–1 diagnosis	44		1.26	2.62 (3.87)	(2.39, 2.84)
2+ diagnosis	55		2.18	3.53 (4.75)	(3.28, 3.78)
Predisposing variables					
Age					
67–79	28		1.43	3.39 (5.98)	(2.94, 3.83)
80–89	54		1.75	2.86 (3.56)	(2.67, 3.05)
90+	18		2.56	3.46 (3.74)	(3.11, 3.80)
Gender					
Female	66		1.84	3.18 (4.48)	(2.97, 3.40)
Male	34		1.63	2.99 (4.23)	(2.70, 3.27)
Enabling variables					
Informal care					
No informal care	12		0.92	2.12 (3.14)	(1.76, 2.48)
Less than 3 hours	31		1.67	2.67 (3.30)	(2.44, 2.91)
3–9 hours	27		2.22	3.47 (3.93)	(3.17, 3.77)
9 hours or more	8		2.59	5.57 (8.17)	(4.39, 6.76)
Unknown amount	19		1.81	3.26 (4.99)	(2.81, 3.70)
Cohabitant					
Living alone	71		1.95	3.28 (4.30)	(3.07, 3.48)
Cohabitant	27		1.55	2.82 (4.76)	(2.46, 3.18)
Service flat					
No	89		1.61	2.67 (3.62)	(2.51, 2.82)
Yes	11		4.74	6.76 (7.42)	(5.88, 7.64)
Safety alarm					
No	16		0.75	1.60 (2.61)	(1.35, 1.86)
Yes	84		2.08	3.40 (4.61)	(3.21, 3.60)
Other					
Short-term stay					
None	94		1.79	3.12 (4.42)	(2.94, 3.30)
1 or more	6		1.78	3.01 (4.12)	(2.34, 3.67)

cognitive impairment; thus, the effect of each of these factors on the amount of care provided decreased as the level of the other factor increased. At the mean value of cognitive and behavioural impairment score, the marginal effect of a one-point increase in physical disability score [i.e. $e^{1.18-0.22*1.77} - 1$] was an increase

of 120% in the amount of care provided. At the mean value of physical disability score, the marginal effect of a one-point increase in cognitive and behavioural impairment score [i.e. $e^{1.00-0.22*2.24} - 1$] was an increase of 66% in the amount of care provided. Assuming a median amount of care at 1.78 hours per

Table 3 Descriptive statistics for intellectually disabled home care recipients: average amount of public care per week with standard deviation (SD), 95% confidence interval (CI) and physical disability, and cognitive impairment and behavioural impairment score

	Percentage	Mean score (SD)	Intellectually disabled <i>N</i> = 270		
			Median hours	Mean hours (SD)	95% CI for mean
Total amount of care			55.3	62.6 (39.8)	(57.9, 67.4)
Home care	75		36.0	47.2 (38.2)	(42.7, 81.8)
Need variables					
Physical and cognitive composite		3.21 (0.86)			
Score 1–1.99	5		18.2	33.1 (32.5)	(15.3, 50.9)
Score 2–2.99	37		43.1	49.2 (33.2)	(42.7, 55.7)
Score 3–3.99	35		58.4	67.1 (39.6)	(59.1, 75.2)
Score 4–5	23		75.8	83.4 (40.0)	(73.5, 93.3)
Behavioural impairment		2.86 (1.16)			
Score 1	21		45.5	45.8 (29.7)	(38.1, 53.6)
Score 2	8		38.5	58.5 (47.9)	(38.4, 78.6)
Score 3	39		52.0	55.0 (32.8)	(48.7, 61.4)
Score 4–5	32		77.9	83.8 (42.4)	(74.8, 92.8)
Use coercive measures					
No	84		47.6	53.1 (34.5)	(48.5, 57.8)
Yes	16		92.9	96.6 (39.0)	(86.6, 106.6)
Predisposing variables					
Age					
18–29	29		62.8	64.1 (40.7)	(54.9, 73.2)
30–39	20		55.7	68.4 (49.4)	(55.3, 81.5)
40–49	28		52.4	58.5 (34.9)	(50.3, 66.1)
50+	23		54.7	61.1 (34.5)	(52.5, 69.8)
Gender					
Female	46		55.8	64.0 (40.6)	(56.9, 71.2)
Male	54		54.8	61.4 (39.2)	(55.0, 67.8)
Enabling variables					
Informal care					
No informal care	44		54.9	62.1 (38.2)	(55.2, 69.0)
0.1–3 hours	37		57.1	65.8 (43.5)	(57.2, 74.4)
3–9 hours	8		52.7	56.4 (34.1)	(42.1, 70.8)
9 hours or more	6		51.8	48.7 (32.0)	(33.0, 64.5)
Unknown amount	5		63.7	70.3 (41.3)	(48.5, 92.1)
Service flat					
No	0				
Yes	100				

week, this would imply an increase of respectively 2.14 and 1.17 hours per week. For a marginal effect of one-point increase in cognitive and behavioural impairment, the negative interaction effect is larger than the direct effect for physical disabilities above 4.55. Only 0.8% of the home dwelling elderly individuals had score above 4.55. For a marginal effect of one-point increase in physical disability, the negative interaction effect is not larger than the direct for any score within the definition area 1–5.

Type of diagnosis was not associated with the amount of provided care. However, we found a positive association between comorbidity and the amount of care provided. On average, elderly individuals with comorbidity received 21% more care than individuals without comorbidity.

We found a weak association between age and the amount of care provided to elderly individuals older than 90 years. Moreover, intellectually disabled men received 18% less care than intellectually disabled women. However, for the elderly individuals, we found no direct association with gender, for those living alone. Those living with a cohabitant received substantially less care than those living alone. Furthermore, the consequence of living with a cohabitant differed between men and women. Females living with a cohabitant received 30% less home care than those living alone. Furthermore, the amount of home care was an additional 19% less for men living with a cohabitant than for females living with a cohabitant.

We found no association between access to informal care and the amount of publicly provided care

Table 4 Regression results showing association with hours of public care per week in elderly individuals ($n = 2493$)

	Est. coeff.*	(Est. coeff.) [†]	95% CI	P-value
Need variables				
Physical disability	1.18		(1.02, 1.34)	<0.001
Cognitive and behavioural impairment	1.00		(0.80, 1.22)	<0.001
Physical × cognitive/behavioural	-0.22		(-0.29, -0.14)	<0.001
Dementia/Alzheimer's disease	0.02	(0.02)	(-0.12, 0.17)	0.755
Stroke	-0.04	(-0.04)	(-0.16, 0.08)	0.499
Diabetes	0.03	(0.03)	(-0.09, 0.16)	0.618
Comorbidity	0.19	(0.21)	(0.11, 0.27)	<0.001
Predisposing variables				
Age 80–89 [‡]	0.09	(0.09)	(-0.00, 0.18)	0.058
Age 90+ [‡]	0.12	(0.12)	(0.00, 0.24)	0.054
Male	0.01	(0.01)	(-0.08, 0.11)	0.786
Enabling variables				
0.1–3 hours [§]	0.00	(-0.01)	(-0.13, 0.12)	0.941
3–9 hours [§]	0.07	(0.07)	(-0.06, 0.21)	0.285
More than 9 hours [§]	0.07	(0.07)	(-0.11, 0.25)	0.457
Unknown amount [§]	0.02	(0.02)	(-0.12, 0.16)	0.748
Cohabitant	-0.36	(-0.30)	(-0.47, -0.24)	<0.001
Male living with cohabitant	-0.21	(-0.19)	(-0.39, -0.04)	0.017
Service flat	0.48	(0.62)	(0.36, 0.61)	<0.001
Safety alarm	0.16	(0.18)	(0.05, 0.28)	0.007
Other				
Short-term stay	-0.60	(-0.45)	(-0.76, -0.44)	<0.001
Intercept	-0.95		(-1.17, -0.73)	<0.001
Adjusted R^2	0.45			

*Twelve regional dummies were added, but not shown.

[†]Kennedy's approximation for categorical variables: $(\hat{\beta}^c) = (e^{\hat{\beta} - \frac{1}{2}V(\hat{\beta})} - 1)$, where $V(\hat{\beta})$ is the variance of the estimated coefficient $\hat{\beta}$.

[‡]Age group 67–79 serves as a reference group.

[§]No informal care serves as a reference group.

for elderly or for intellectually disabled care recipients.

Individuals who lived in a service flat received 62% more help than those who did not, and individuals with a safety alarm received 18% more help than those without a safety alarm.

The results for the smaller group of intellectually disabled individuals are shown in Table 5. We found a positive association between the composite index of physical disability and cognitive impairment and the amount of care provided. For the average care recipient, the marginal effect of a one-point increase in the composite index was an increase of 77% in weekly care hours. A one-point change in behavioural impairment increased the amount of public care provided by 50%. We found no interaction effect between the composite index of physical disability and cognitive impairment and the variable describing behavioural impairment. Individuals who underwent coercive measures received 56% more care per week than individuals who did not undergo such measures.

The model explained 29% of the variation in the amount of care received by intellectually disabled individuals and 45% of the variation in the amount

of care received by elderly individuals, both measured with an adjusted R^2 .

Discussion

Variables reflecting physical disability and cognitive impairment have been shown to be good predictors of the probability of receiving home care for elderly individuals. In our analysis, an increase in physical disability increased the provision of public care to a greater extent than an increase in cognitive impairment. One interpretation of this result is that physical disability is more important for the amount of care than cognitive impairment. On the other hand, it might reflect that the system is not as well aware of the needs of individuals with cognitive impairments as it is for individuals with physical impairments. While our data do not make it possible to follow up this, a potential underestimation of the needs of people with cognitive needs should be a subject for further studies.

Consistent with other studies, we found that physical disability is a strong predictor of the amount of public home care received by elderly individuals; however, here we found a strong effect of cognitive

Table 5 Regression results showing association with hours of public care per week in intellectually disabled individuals ($N = 270$)

	Est. coeff.*	(Est. coeff.) [†]	95% CI	P-value
Need variables				
Physical disability and cognitive impairment	0.57		(0.29, 0.84)	<0.001
Behavioural impairment	0.42	(0.50)	(0.04, 0.81)	0.032
Physical disability and cognitive impairment × Behavioural impairment	-0.08		(-0.18, 0.01)	0.090
Coercive measures	0.45	(0.56)	(0.26, 0.64)	<0.001
Predisposing variables				
Age 30–39 [‡]	-0.15	(-0.16)	(-0.50, 0.20)	0.387
Age 40–49 [‡]	-0.07	(-0.07)	(-0.33, 0.20)	0.627
Age 50+ [‡]	-0.15	(-0.14)	(-0.42, 0.12)	0.287
Male	-0.20	(-0.18)	(-0.39, -0.00)	0.045
Enabling variables				
0.1–3 hours [§]	-0.05	(-0.05)	(-0.26, 0.16)	0.644
3–9 hours [§]	0.08	(0.07)	(-0.26, 0.41)	0.650
More than 9 hours [§]	-0.13	(-0.16)	(-0.68, 0.41)	0.625
Unknown amount [§]	-0.07	(-0.17)	(-1.04, 0.90)	0.888
Intercept	1.48		(0.33, 2.63)	0.012
Adjusted R^2	0.29			

*Nine regional dummies were added, but not shown.

[†]Kennedy's approximation for categorical variables: $(\hat{\beta}') = (e^{\hat{\beta} - \frac{1}{2}V(\hat{\beta})} - 1)$, where $V(\hat{\beta})$ is the variance of the estimated $\hat{\beta}$.

[‡]Age group 18–29 serves as a reference group.

[§]No informal care serves as a reference group.

impairment. Our analysis also revealed an interaction effect between physical disability and cognitive impairment. Thus, across the population of elderly home care recipients, the effect of worsening physical disability on the amount of care provided decreased as the degree of cognitive impairment increased and vice versa. This finding may reflect a 'scale effect' in the provision of care for physical disability and cognitive impairment. A similar interaction effect has not been reported in other studies on home care, but our finding is consistent with findings reported in a Norwegian nursing home setting (Døhl *et al.* 2014). Kalseth (2003) also reports a diminishing marginal effect of a composite measure of physical disability and cognitive impairment in home care users in a subsection of Norwegian municipalities. Furthermore, Li & Conwell (2009) show that worsening cognitive status, as well as depression, predicts subsequent increases in ADL and IADL scores, and an increased likelihood of dependency in both domains of functioning in home care elders. Moreover, Meinow *et al.* (2005) report that physical disability and cognitive impairment explain 48.9% of the variation in numbers of hours of home help in an elderly (67 years and older) population, which is consistent with our results. Outside the Scandinavian context, studies from Canada have explained 37% of variations in costs by using individual-level disability variables (Bjorkgren *et al.* 2000, Poss *et al.* 2008).

The role of informal care (cohabitant, spouse or children) in home care for the elderly individuals is

well documented. Filial informal care may act as a substitute for and a complement to formal care; furthermore, the amount of informal care is higher in countries with stronger family ties (Bolin *et al.* 2008). Our results indicate that cohabitants act as a substitute for public care for the elderly individuals, and that the effect of cohabitation on the amount of care given can be quite substantial. We also found that the effect of cohabitation differs between males and females. Specifically, men living with cohabitants received substantially less care than females. This result implies that female cohabitants act as a substitute for public care to a larger degree than male cohabitants. Blomgren *et al.* (2008) find that men living with a spouse have a lower probability of receiving formal help than those living alone, and that those living with a spouse who provides help have a lower probability of receiving formal help than those living with a non-helping spouse. However, such a difference was not found for women; both groups living with their spouse do not differ from the reference category of those living alone. We did not find any effect of informal care on the amount of formal care, beyond the effect captured with the cohabitant variable. This finding is consistent with Meinow *et al.* (2005). In a supplementary analysis in which we excluded cohabitation, the effect of informal care remained insignificant (results not shown). Also excluding informal care from the analysis did not affect the other results; thus, we are less

concerned about the potential estimation bias for this variable.

None of the three types of diagnoses were associated with the amount of care given. Dementia has been shown to be an important cause of disability (Agüero-Torres *et al.* 1998), and it is also considered as the most important cause of nursing home admission (Luppa *et al.* 2010). Larsson *et al.* (2006) find that a diagnosis of dementia could increase the probability of home care, at least for those living alone; however, the authors did not include any measure of cognitive impairment. When we excluded cognitive impairment, the dementia diagnosis became clearly significant ($P < 0.001$) (results not shown). Whether stroke influenced the use of home care beyond the effect captured by physical disability and cognitive impairment is uncertain. Some argue that stroke is an important predictor of nursing home admission in elderly individuals living at home, apart from the effect explained by physical impairment and cognitive impairment (Luppa *et al.* 2010). Other researchers, however, suggest that the effect disappears after disability is controlled for (Banaszak-Holl *et al.* 2004, Lindholm *et al.* 2012). Our results are consistent with research showing that the effect of stroke on home care use disappears after disability is controlled for, as we found that individuals with a stroke diagnosis received significantly more care after we excluded disability and impairment from the analysis. Thus, the use of public home care by individuals who have suffered a stroke may be sufficiently explained by disability alone. Diabetes could also affect both physical disability and cognitive impairment (Gregg *et al.* 2002). Our findings suggest that given appropriate measures of physical disability and cognitive impairment, such measures more accurately explain the amount of care relative to any of these three diagnoses. One reason for this finding is that diagnoses may be too crude of a measure to accurately describe the need for care. A diagnosis is a yes/no variable, whereas the degree of disability resulting from a diagnosis could vary substantially.

Our results suggest that comorbidity significantly increased the amount of services provided. Several studies have found that comorbidity among elderly people is associated with worsened physical disability and increased hospitalisation. Indeed, comorbidity may act as a proxy for some underlying causes that are not captured by physical disability or cognitive impairment.

Our results suggest that elderly individuals living in service flats received more care than elderly individuals in other living arrangements. This finding is contrary to other studies reporting no effect between

individuals in different residential settings (Meinow *et al.* 2005, Sævareid *et al.* 2012). We also found that individuals with a safety alarm received more public care than those without a safety alarm. Thus, living in a service flat or having a safety alarm may substitute for other care; it may also signal a higher need for care. In addition, ease of access may increase the amount of care. We cannot infer which of these explanations is most relevant; therefore, these issues require further investigation.

Behavioural impairment and coercive measures were important predictors of care provided to intellectually disabled care recipients. This finding supports the notion that behavioural problems are among the strongest predictors of public care use for intellectually disabled individuals (Hallam *et al.* 2002, Knapp *et al.* 2005). Although intellectual disability is the main reason that these individuals need public services, physical disabilities may also restrict their participation in the community. Few studies have considered the effect of ADL or IADL as predictors of need in this group (Rhoades & Altman 2001). Studies on individuals with mild or moderate intellectual disability have found that these individuals may have problems with ADL and that their situation can be improved by training (Kottorp *et al.* 2003, Hällgren & Kottorp 2005). Our findings indicate that physical disability and cognitive impairment are important factors explaining the variation in long-term care provided to intellectually disabled service recipients. We also found a gender difference, with men receiving less care than women. Nevertheless, the sample size for the intellectually disabled individuals was less than optimal, and the small sample size could have influenced the estimated effects. Further research should thus include data from several municipalities.

Forty-five per cent of the variation in public care for the group of elderly care recipients and 29% for the group of intellectually disabled care recipients were explained by physical disability and cognitive impairment in the analysis. These findings indicate that physical disability and cognitive impairment, and other predictors of public care could be used for planning and budgeting purposes. The financing of the home care sector in Europe is a complicated mosaic, with a wide variety of funding and payment systems for providers (Genet *et al.* 2011). If providers are not compensated for differences in casemix, they will adjust the level of care, and elderly (and intellectually disabled) care recipients may thus receive varying amounts of care (Døhl *et al.* 2014).

Some possible caveats in this study should be mentioned. First, although we included the entire

population of elderly users, the sample does not represent the entire elderly population. Thus, we are likely to exaggerate the effect of physical disability and cognitive impairment on the need for care in the population. In addition, the results may not be readily transferrable to other municipalities (or countries) if they have different criteria for providing access to services. Second, we did not include socioeconomic variables in the analysis. Because some of the services are subject to out-of-pocket payments and because the payments are related to income, income level should be considered in the analysis. However, payment is restricted to help with practical tasks, such as house cleaning. If people with low income were more disabled than those with high income, then income could be a confounder. Nevertheless, only 9% of the total amount of delivered services were paid services, and the rest of the services were provided free of charge. We therefore consider this potential confounding effect to be a minor concern.

For elderly and intellectually disabled care recipients, 55% and 71%, respectively, of the variation in the amount of care given remain unexplained; therefore, there is obvious room for further research into the determinants of home care use.

Our results corroborate some of the results from similar studies and provide new insights into the effect of residential setting on the amount of care provided. The level of cognitive impairment influences the marginal effect of worsened physical disability and vice versa. Adding covariates to physical disability, and cognitive and behavioural impairment provided useful insights into the actual provision of services, but did not substantially increase the overall explained variance.

The aim of this analysis was to contribute to the understanding of the determinants of home care provision. We found that a standardised registration system for physical disability, and cognitive and behavioural impairment explained provided care reasonably well for the elderly individuals, and that the information was also valuable for the smaller and possibly more heterogeneous group of intellectually disabled individuals. Thus, by introducing standardised registration of ADL, IADL and cognitive variables, public service providers will be able to plan and organise their services more efficiently.

Financing and budgeting is a major challenge in public provision of health and social services. Information about the determinants of need will be useful when fixed budgets are to be allocated between service providers. Thus, our results could be an important input when the aim is to establish a reimbursement system based on the recipient casemix.

Finally, we believe that information about the determinants of need is valuable for those aiming to improve the functioning of home care users.

Conflict of interest

The authors declare that there are no conflicts of interests or any dependence on funders.

References

- Agüero-Torres H., Fratiglioni L., Guo Z., Viitanen M., von Strauss E. & Winblad B. (1998) Dementia is the major cause of functional dependence in the elderly: 3-year follow-up data from a population-based study. *American Journal of Public Health* **88**, 1452–1456.
- Algera M., Francke A.L., Kerkstra A. & Van Der Zee J. (2004) Home care needs of patients with long-term conditions: literature review. *Journal of Advanced Nursing* **46**, 417–429.
- Andersen R.M. (1995) Revisiting the behavioral model and access to medical care: does it matter? *Journal of Health and Social Behavior* **36**, 1–10.
- Andersen R. & Newman J.F. (2005) Societal and individual determinants of medical care utilization in the United States. *Milbank Quarterly* **83**, 1–28.
- Banaszak-Holl J., Fendrick A.M., Foster N.L. *et al.* (2004) Predicting nursing home admission: estimates from a 7-year follow-up of a nationally representative sample of older Americans. *Alzheimer Disease Associated Disorders* **18**, 83–89.
- Bjorkgren M.A., Fries B.E. & Shugarman L.R. (2000) A RUG-III case-mix system for home care. *Canadian Journal on Aging* **19**, 106–125.
- Blomgren J., Martikainen P., Martelin T. & Koskinen S. (2008) Determinants of home-based formal help in community-dwelling older people in Finland. *European Journal of Ageing* **5**, 335–347.
- Boaz R.F. & Hu J. (1997) Determining the amount of help used by disabled elderly persons at home: the role of coping resources. *The Journal of Gerontology: Social Sciences* **52**, S317–S324.
- Bolin K., Lindgren B. & Lundborg P. (2008) Informal and formal care among single-living elderly in Europe. *Health Economics* **17**, 393–409.
- Døhl Ø., Garasen H., Kalseth J. & Magnussen J. (2014) Variations in levels of care between nursing home patients in a public health care system. *BMC Health Services Research* **14**, 108.
- Fried L.P., Ferrucci L., Darer J., Williamson J.D. & Anderson G. (2004) Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care. *The Journal of Gerontology: Medical Sciences* **59**, 255–263.
- Genet N., Boerma W.G., Kringos D.S. *et al.* (2011) Home care in Europe: a systematic literature review. *BMC Health Services Research* **11**, 207.
- Gregg E.W., Engelgau M.M. & Narayan V. (2002) Complications of diabetes in elderly people: underappreciated problems include cognitive decline and physical disability. *British Medical Journal* **325**, 916.
- Hallam A., Knapp M., Jarbrink K. *et al.* (2002) Costs of village community, residential campus and dispersed

- housing provision for people with intellectual disability. *Journal of Intellectual Disability Research* **46**, 394–404.
- Hällgren M. & Kottorp A. (2005) Effects of occupational therapy intervention on activities of daily living and awareness of disability in persons with intellectual disabilities. *Australian Occupational Therapy Journal* **52**, 350–359.
- Hammar T., Rissanen P. & Perälä M.-L. (2008) Home-care clients' need for help, and use and costs of services. *European Journal of Ageing* **5**, 147–160.
- Hayward L.M., Davies S., Robb R., Denton M.A. & Auton G. (2004) Publicly funded and family-friendly care in the case of long-term illness: the role of the spouse. *Canadian Journal on Aging* **23**, S39–S48.
- Hebert R., Carrier R. & Bilodeau A. (1988) The Functional Autonomy Measurement System (SMAF): description and validation of an instrument for the measurement of handicaps. *Age and Ageing* **17**, 293–302.
- Jan van Garderen K. & Shah C. (2002) Exact interpretation of dummy variables in semilogarithmic equations. *The Econometrics Journal* **5**, 149–159.
- Kadushin G. (2004) Home health care utilization: a review of the research for social work. *Health and Social Work* **29**, 219–244.
- Kalseth J. (2003) *Politics and Resource Use in Local Government Service Production*. Department of Economics, Norwegian University of Science and Technology, Trondheim.
- Kennedy P.E. (1981) Estimation with correctly interpreted dummy variables in semilogarithmic equations. *The American Economic Review* **71**, 801.
- Knapp M., Comas-Herrera A., Astin J., Beecham J. & Pendaries C. (2005) Intellectual disability, challenging behaviour and cost in care accommodation: what are the links? *Health and Social Care in the Community* **13**, 297–306.
- Kottorp A., Bernspång B. & Fisher A.G. (2003) Activities of daily living in persons with intellectual disability: strengths and limitations in specific motor and process skills. *Australian Occupational Therapy Journal* **50**, 195–204.
- Larsson K. & Silverstein M. (2004) The effects of marital and parental status on informal support and service utilization: a study of older Swedes living alone. *Journal of Aging Studies* **18**, 231–244.
- Larsson K., Thorslund M. & Kåreholt I. (2006) Are public care and services for older people targeted according to need? Applying the Behavioural Model on longitudinal data of a Swedish urban older population. *European Journal of Ageing* **3**, 22–33.
- Li L.W. & Conwell Y. (2009) Effects of changes in depressive symptoms and cognitive functioning on physical disability in home care elders. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences* **64**, 230–236.
- Lindholm C., Gustavsson A., Jönsson L. & Wimo A. (2012) Costs explained by function rather than diagnosis – results from the SNAC Nordanstig elderly cohort in Sweden. *International Journal of Geriatric Psychiatry* **28** (5), 454–462.
- Luppa M., Luck T., Matschinger H., König H.H. & Riedel-Heller S.G. (2010) Predictors of nursing home admission of individuals without a dementia diagnosis before admission – results from the Leipzig Longitudinal Study of the Aged (LEILA 75+). *BMC Health Services Research* **10**, 186.
- Mansell J., Knapp M., Beadle-Brown J. & Beecham J. (2007) *Deinstitutionalisation and Community Living – Outcomes and Costs: Report of a European Study. Volume 2: Main Report*. University of Kent, Canterbury.
- Martin L., Fries B.E., Hirdes J.P. & James M. (2011) Using the RUG-III classification system for understanding the resource intensity of persons with intellectual disability residing in nursing homes. *Journal of Intellectual Disabilities* **15**, 131–141.
- de Meijer C.A., Koopmanschap M.A., Koolman X.H. & van Doorslaer E.K. (2009) The role of disability in explaining long-term care utilization. *Medical Care* **47**, 1156–1163.
- Meinow B., Kåreholt I. & Lagergren M. (2005) According to need? Predicting the amount of municipal home help allocated to elderly recipients in an urban area of Sweden. *Health and Social Care in the Community* **13**, 366–377.
- Ministry of Local Government and Modernisation (2013) *Inntektssystemet for kommunar og fylkeskommunar 2013 – Grønt hefte*. Ministry of Local Government and Modernisation, Oslo (in Norwegian).
- Poss J.W., Hirdes J.P., Fries B.E., McKillop I. & Chase M. (2008) Validation of Resource Utilization Groups version III for Home Care (RUG-III/HC): evidence from a Canadian home care jurisdiction. *Medical Care* **46**, 380–387.
- Rhoades J.A. & Altman B.M. (2001) Personal characteristics and contextual factors associated with residential expenditures for individuals with mental retardation. *Mental Retardation* **39**, 114–129.
- Rodríguez M. (2013) Use of informal and formal care among community dwelling dependent elderly in Spain. *European Journal of Public Health* **24**, 668–673.
- Roelands M., Van Oyen H., Depoorter A., Baro F. & Van Oost P. (2003) Are cognitive impairment and depressive mood associated with increased service utilisation in community-dwelling elderly people? *Health and Social Care in the Community* **11**, 1–9.
- Sævreid H.I., Thygesen E., Lindstrom T.C. & Nygaard H.A. (2012) Association between self-reported care needs and the allocation of care in Norwegian home nursing care recipients. *International Journal of Older People Nursing* **7**, 20–28.
- Sigurdardottir S.H., Sundstrom G., Malmberg B. & Bravell M.E. (2012) Needs and care of older people living at home in Iceland. *Scandinavian Journal of Public Health* **40**, 1–9.
- Statistics Norway (2013) *Personer 67 år og over i privathusholdninger, etter alder og antall personer i husholdningen [Inhabitants 67 years or Older in Families and Households Sorted According to Age and Number of People per Household]*. Statistics Norway, Oslo.
- Stoddart H., Whitley E., Harvey I. & Sharp D. (2002) What determines the use of home care services by elderly people? *Health and Social Care in the Community* **10**, 348–360.
- Tarricone R. & Tsouros A.D. (2008) *Home Care in Europe: The Solid Facts*. WHO Regional Office for Europe, Copenhagen.
- TNS Opinion & Social (2007) *Health and Long-Term Care in the European Union*. Special Eurobarometer 283/Wave 67.3. European Commission, Brussels.
- White H. (1980) A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica: Journal of the Econometric Society* **48**, 817–838.
- WHO (1980) *International Classification of Impairments, Disabilities and Handicaps: A Manual of Classification Relating to the Consequences of Disease*. World Health Organization, Geneva.